

VITAL and HEALTH STATISTICS
DATA FROM THE NATIONAL HEALTH SURVEY

Periodontal Disease in Adults

United States - 1960 - 1962

A discussion of the examination and criteria for periodontal disease, with data on the prevalence of periodontal disease by age, sex, and race, and an analysis of differentials by income, education, and residence.

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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.

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IN THIS REPORT are included national estimates of the prevalence and severity of periodontal disease by age, sex, and race and a brief analysis of the amount of periodontal disease occurring by family income, education, and place of residence.

The underlying data were collected in 1960-62 by examination of a probability sample of persons 18-79 years of age selected from the U.S. civilian, noninstitutional population. Periodontal disease was assessed by the Periodontal Index.

Periodontal disease, although conservatively measured, was found to affect a majority of both young and older adults. Among the 90 million men and women at risk to the disease, about 2 out of 4 had gingivitis— inflammation of the gum—and about 1 in 4 had periodontitis—advanced disease with characteristic pocket formation. The prevalence of destructive periodontal disease, however, increased sharply with advancing age. In addition, proportionately more men than women had destructive disease, and proportionately more Negro than white adults.

The Periodontal Index varied inversely with both family income and education. Each variable was independently associated with periodontal disease, but the correlation was higher with education.

Much of the difference in the occurrence of periodontal disease by race was accounted for by differences in income and to an even greater extent by differences in education. The prevalence and severity of periodontal disease by specified place of residence did not vary significantly.

SYMBOLS

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

PERIODONTAL DISEASE IN ADULTS

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INTRODUCTION

Periodontal disease is a general term denoting an insidious process, often of long standing, which attacks the tissues supporting the teeth. During its early course the disease is seldom attended by pain or even by undue discomfort. Only rarely is it believed to be a serious threat to life. Nearly 25 million deaths occurred throughout the United States from 1949 through 1963, but periodontal disease was implicated as the underlying cause in only about 900.¹ Although its course is deceptively quiet, it can be nonetheless relentless. Largely unheeded by thousands of persons, periodontal disease with little hue and cry exacts a yearly toll in tooth loss which mounts into the millions.

Incipient periodontal disease often appears as a mild inflammatory response within the gingiva to local deposits of oral debris (soft foreign material loosely attached to the tooth) and calculus (hardened foreign material firmly attached to the tooth and sometimes called tartar). If unchecked, the disease process can be accelerated by continuing accumulations of calculus, by the presence of infectious organisms, and by a number of other contributing factors which are usually local but are sometimes systemic. The periodontal fibers which normally anchor the tooth securely in its bony socket become progressively detached, destruction of neighboring bone occurs at an increased rate, and in time the tooth becomes loose and nonfunctional (fig. 1).

Inflammatory disease of tissues and structures that invest and support the teeth probably occurs almost universally, for, with the exception of persons who no longer have any of their own teeth, no one is fully immune to attack. While estimates of the prevalence and severity of peri-

odontal disease have never before been endeavored on a national scale, numerous surveys, both within the United States and elsewhere, have reported that gingivitis is extremely common even among children and youths. In this country, for example, half of 32,000 students 6-17 years old were found to have gingivitis, and nearly 40 percent of the school children 5-14 years old examined in suburban Chicago were reported to have mild gingivitis.^{2 3}

Surveys conducted in other countries indicate that gingivitis in children and young persons is equally prevalent abroad. Upon examination, gingival inflammation was encountered in about 60 percent of a group of English children aged 2-15 years, in nearly 40 percent of a group of Italian children aged 6-10 years, and in approximately 90 percent of a sample of Ethiopian children whose ages ranged from 5 through 14 years.⁴⁻⁶

The results of several surveys of the prevalence of gingivitis among young groups in the United States have contrasted sharply. One survey, for example, noted gingivitis in about 1 out of 5 of more than 22,000 U.S. children whose ages ranged from 5 through 14 years.⁷ Another, however, which was conducted on a probability sample of the population of Tecumseh, Mich., estimated that more than 95 percent of the children aged 5-14 years had at least some degree of gingival inflammation.⁸

Widely differing survey results, as exemplified above, draw attention to an important consideration which must be taken into account whenever findings of separate surveys are compared. Surveys of periodontal disease have usually been cross-sectional and limited to discrete groups of the population. They frequently were conducted on persons with greatly diverse racial, cultural, and socioeconomic backgrounds. In such in-

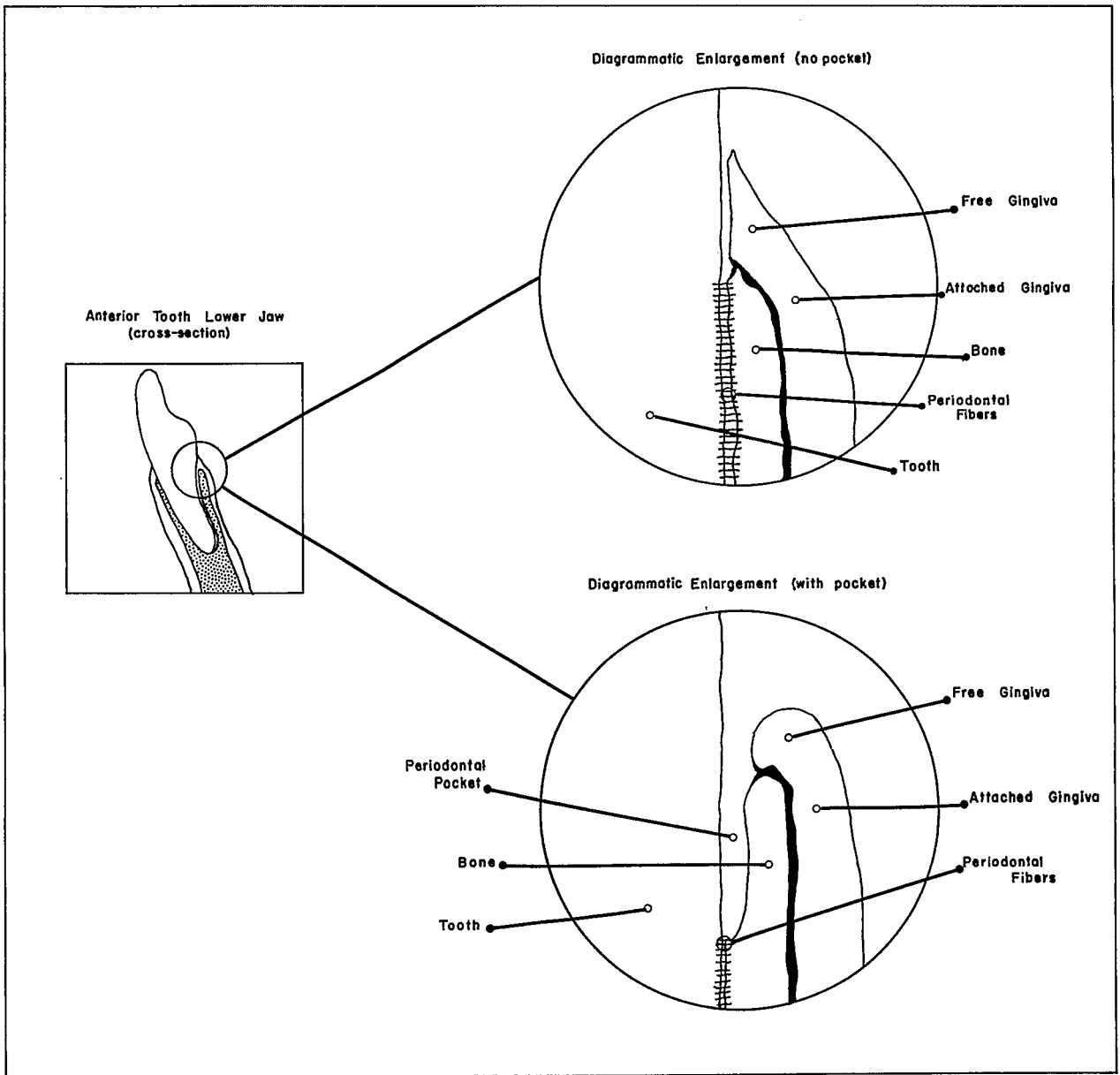


Figure 1. The tooth and its supporting structures.

stances, differences in reported prevalence are hardly surprising.

On the other hand, pronounced differences in prevalence are very likely to result even in the same population when definitions or methods of measuring gingival and periodontal disease are dissimilar. Before 1950 surveys of gingival con-

ditions relied upon examination criteria which were too ill defined and imprecise to permit scarcely more than token agreement. With the introduction in 1950 of the P.M.A. Index (papillary, marginal, attached gingiva), a more adequate measure for gingivitis became available.³ Later within the same decade, the introduction

of two periodontal indexes, the PI and the PDI (the Periodontal and the Periodontal Disease Indexes), enabled more objective evaluations of destructive periodontal disease, as well as gingivitis, than had previously been possible.^{9 10} While today, as in the past, there still is no single set of diagnostic criteria unanimously accepted as definitive, surveys in which more rigorous methods of measurement were used have reported, almost without exception, high percentages of participating boys and girls with at least some evidence of gingival disease.

Another finding common to many surveys of gingivitis in children is a steady rise in prevalence and severity with age until about the 13th or 14th year. A slight drop has been observed by some investigators at or within a year or two of age 20, but shortly thereafter both the prevalence and severity of gingivitis begin to increase again. Over 80 percent of the adults 20 years of age and older examined in two U.S. studies and nearly every person examined in surveys conducted in India, Ethiopia, and South Vietnam were found to have gingivitis.^{6 8 11-13}

Gingivitis develops into periodontitis when the inflammatory process, left either untreated or unchecked, penetrates to the deeper tissues supporting the teeth. Although destructive periodontal disease has been observed in children under 10 years of age, it is relatively rare. A number of studies employing various evaluative procedures found periodontitis increasing with age, as did gingivitis, in both prevalence and severity. In a survey of the general adult population of Baltimore, the prevalence of destructive disease increased from a low of 5.5 percent among persons under 25 years of age to a high of 33.2 percent in persons 55-64 years old.¹⁴ By ages 35-44 nearly everyone in a group of approximately 1,200 adults in Boston was reported to have destructive disease.¹¹ An increase in the prevalence of destructive periodontal disease with age has been observed in numerous other studies.¹⁵⁻¹⁷

A higher prevalence of destructive disease also has been reported among men than among women and among Negro adults than among white adults.^{18 19} In addition, destructive disease has been observed more frequently in persons with lesser educational attainment than in persons with higher attainment and in persons with lower incomes than with higher incomes.¹⁹⁻²¹

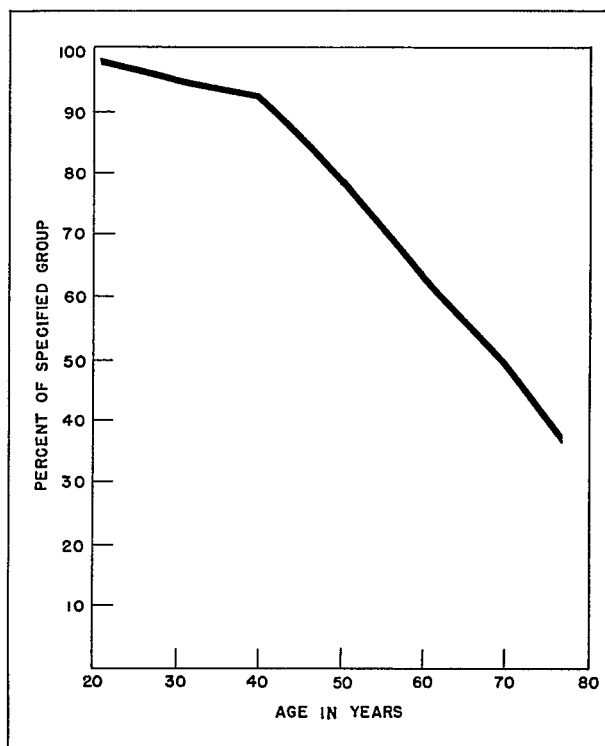


Figure 2. Percent of persons with at least one natural tooth, by age.

FINDINGS

This report describes the prevalence and severity of periodontal disease as it is distributed in the U.S. adult population by age, sex, race, and other selected demographic characteristics. The estimates of the amount and distribution of periodontal disease are based upon examination findings on 6,672 persons who comprised a probability sample of the civilian, noninstitutional population 18-79 years of age. The selection of sample persons, a description and assessment of the dental examination, and an explanation of the procedure for obtaining national estimates appear in earlier reports of the *Vital and Health Statistics* series.^{22 23}

All of the dental examinations were given under comparable conditions by one of five dentists painstakingly trained in a uniform examination procedure. Periodontal disease in the sample population was evaluated by the Periodontal Index, the system of classification described by Russell

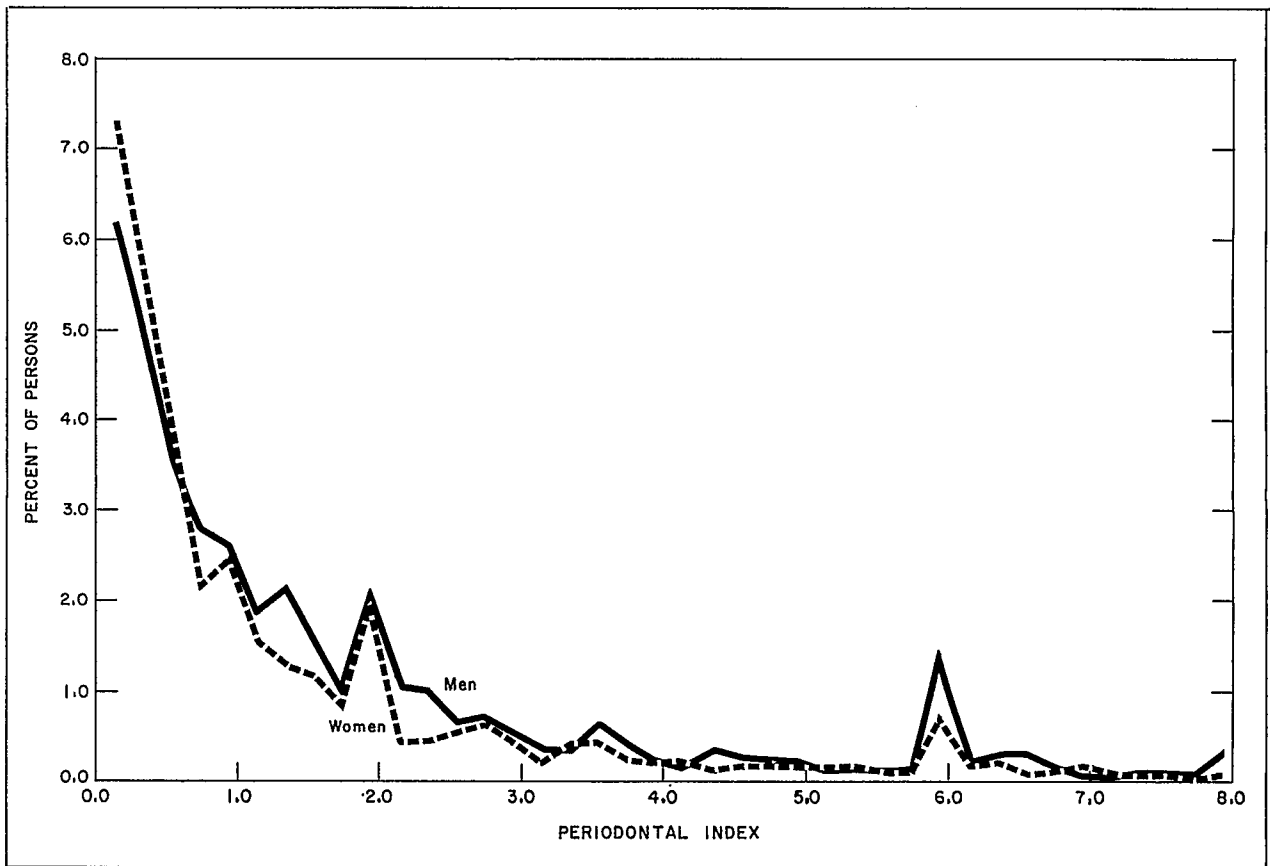


Figure 3. Percent distribution of Periodontal Index scores, by sex.

in 1956.⁹ By this method each tooth is scored on a scale according to the presence or absence of manifest signs of periodontal disease. When a portion of the free gingiva is overtly inflamed, a score of 1 is assigned. When completely circumscribed by inflammation, a tooth is scored 2. Teeth with frank periodontal pockets are scored 6 when their masticatory function is unimpaired and 8 when it is impaired. In the absence of obvious signs of inflammation, pocket formation, and loss of function, teeth are given a score of 0. Each tooth in the mouth is scored, and the arithmetic average of all scores is the individual's Periodontal Index.

Estimates of periodontal disease in this report include only persons who have at least one natural tooth and are thereby still susceptible to destructive periodontal disease. Based upon ex-

aminations, approximately 90 million adults throughout the United States had teeth in either one or both of their jaws. More than 20 million others were edentulous, no longer having any teeth in either jaw. The exclusion of edentulous persons results in progressively smaller proportions of persons eligible for periodontal classification within each older age group (fig. 2), and within specified age ranges, proportionately fewer white persons than Negroes and fewer women than men.

Total Prevalence

Among the 90 million adults with teeth, about one out of four had destructive periodontal disease. About two out of four had gingivitis ranging from mild inflammation involving a few teeth to severe inflammation involving all their teeth. The remain-

ing one out of four exhibited no signs of the disease (table 1). The average Periodontal Index for adults was 1.13.

The Periodontal Index is purely and simply a quantitative assessment of severity. Not purporting to discriminate between clinically recognized types of periodontal disease, index classification heeds only those signs of disease that immediately strike the eye. In this fashion, larger differences between examiners, almost invariably inherent in more intricate methods of clinical evaluation, are greatly reduced. But even though the index is unsuitable for clinical evaluation, ranges of scores correspond in general to various clinical conditions. Table 2 and figure 3 give the distribution of scores in the population. According to Russell, "Most persons considered to be normal, clinically, score from zero to .1 or .2; those with a clinical diagnosis of gingivitis, from .1 to 1.0; those with severe gingivitis to incipient destructive disease, from .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."⁶

National estimates, of the number of adults (in millions) within each of these ranges were as follows:

| | <i>Men</i> | <i>Women</i> |
|----------------------|------------|--------------|
| 0.0 through 0.2----- | 14.5 | 21.2 |
| 0.1 through 1.0----- | 17.7 | 19.7 |
| 0.5 through 1.9----- | 13.8 | 12.4 |
| 1.5 through 5.0----- | 10.4 | 7.9 |
| 4.0 through 8.0----- | 4.2 | 2.7 |

Age and Sex

A majority of men and women within each of the various age groups had some form of periodontal disease (table 1). Moreover, the proportion with disease grew increasingly larger with advancing age. Although at ages 18-24 years, for example, 70.9 percent of men and 63.2 percent of women already had either gingivitis or destructive disease, by ages 75-79 years the group with disease included as many as 93.7 percent of men and 89.1 percent of women.

The increase in severity with age was even more striking, with destructive disease far more likely to be encountered in older persons than in younger ones (table 1). Among both men and women 18-24 years of age who had periodontal disease, only about 15 percent had periodontitis. By ages 75-79 years, however, the percentage with obvious pocket formation had risen to 64.0 and 60.4 for men and women, respectively. Reflecting the sharp increase in both prevalence and severity with age, the mean Periodontal Index rose from 0.62 for men and 0.48 for women in the youngest age group to 2.91 and 2.94 for the oldest group of men and women, respectively (table 3).

The mean score for men was half again as large as the mean score for women—1.34 as compared with 0.93. This difference by sex occurred at every age except 75-79 years and arose because, as a rule, relatively more men than women had periodontal disease and relatively more of those having periodontal disease had destructive disease.

Race

Substantial differences by race were found in the prevalence and severity of periodontal disease. Negro adults not only were more likely to have disease (table 4), but also were more likely to have destructive disease when disease was present. As a result, the average Periodontal Index was 50 percent greater for Negro adults than for white adults—1.60 as against only 1.06. Of those persons with some periodontal disease, the following percentage (by race and sex) had one or more pockets:

| | <i>Men</i> | <i>Women</i> |
|-------------|------------|--------------|
| White ----- | 37.2 | 28.6 |
| Negro----- | 44.3 | 41.2 |

In both white and Negro populations a strong rise in mean scores occurred with advancing age (table 3). From a low of 0.58 for men and 0.46 for women in the youngest age group of white adults, scores climbed consistently throughout the various ages to reach a high of 3.01 and 2.41,

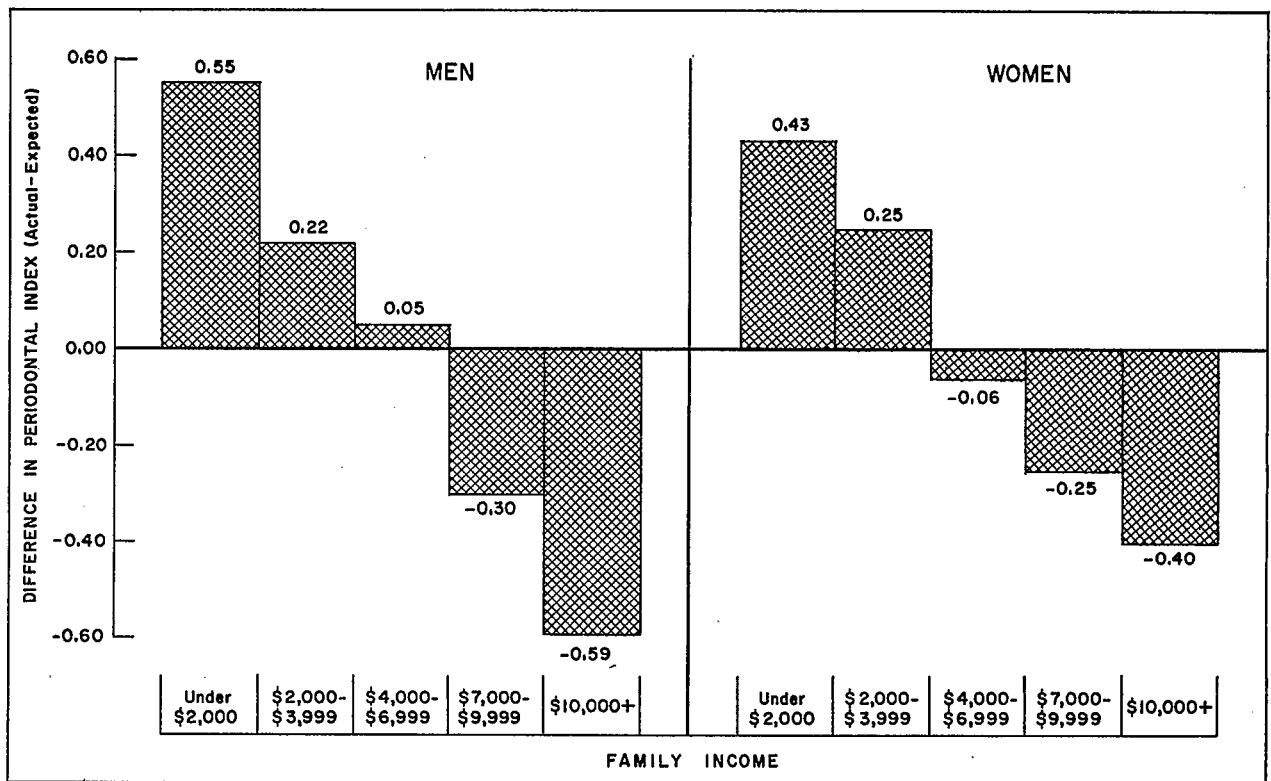


Figure 4. Difference between actual and expected mean Periodontal Index in men and women, by family income.

respectively, for persons 75-79 years of age. In the same trend within the Negro population, mean scores increased from a minimum of 0.78 for the youngest men and 0.62 for the youngest women to a maximum of 3.13 for men 55-64 years old and 5.53 for women 75-79 years old. With the exception of men 75 years and older, the mean Periodontal Index within the various age-sex groups was significantly higher for Negroes than for white persons.

Other Demographic Variables

In the discussion that follows, the U.S. population was subdivided into groups characterized by differences in income, education, and place of residence. The occurrence of periodontal disease within the various groups, as expressed by the mean Periodontal Index, was then compared. For example, mean periodontal scores for persons

grouped by five levels of income were examined to determine whether the amount of periodontal disease was different in one income group than in another. In making these comparisons, allowance was made for differences in the age and sex distribution of persons who composed the various groups, for periodontal disease in the adult population has already been shown to vary importantly by both of these characteristics.

Because of the comparatively small sample population, the sampling variability for specific age and sex groups was usually very large. As a result, summary comparisons of the actual and expected Periodontal Index by sex and race were preferable to a comparison of mean scores that were specific for age.

The expected values that are shown were obtained by weighting age- and sex-specific mean scores for the total U.S. population by age-sex distribution for respective groups. A positive

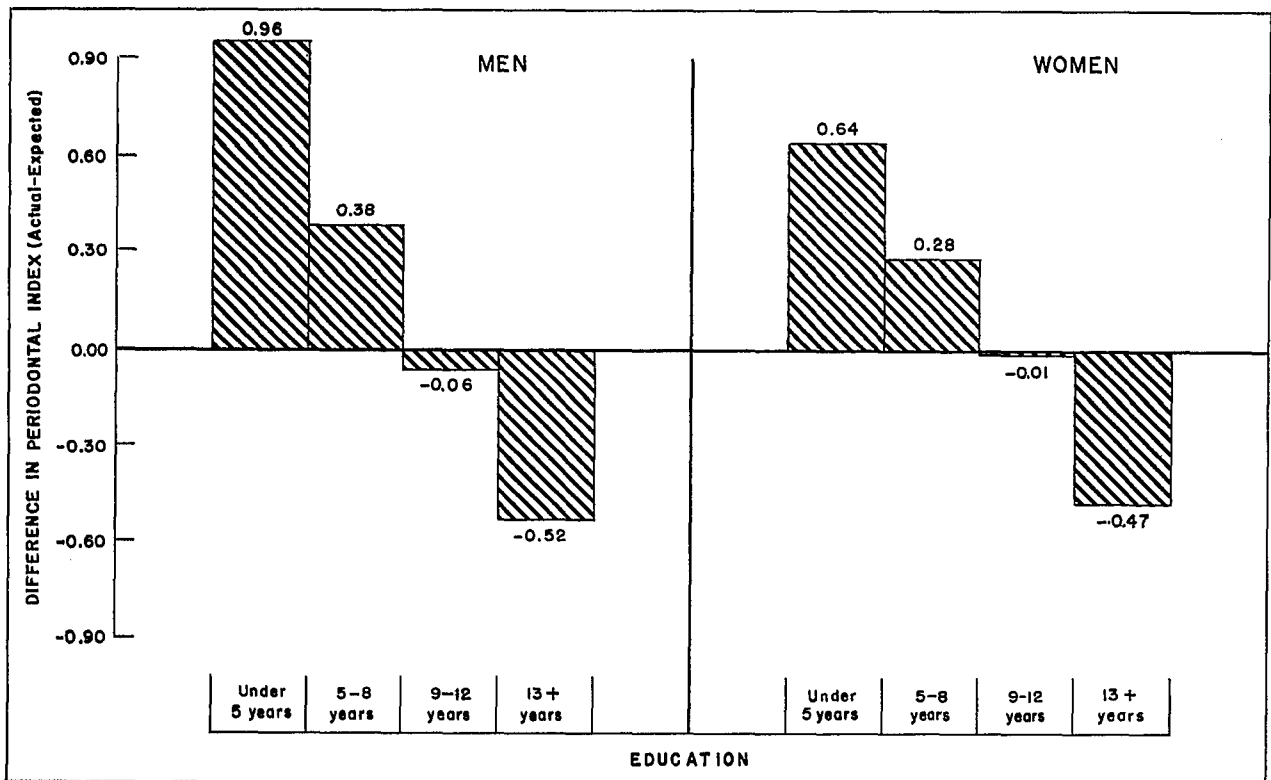


Figure 5. Difference between actual and expected mean Periodontal Index in men and women, by education.

difference between the actual and expected values for a group indicates that the mean Periodontal Index was higher than expected, and a negative difference indicates that it was lower than expected. Differences between actual and expected values may sometimes, of course, arise by chance. When the difference between actual and expected values for any one group is not statistically significant, it may generally be assumed that the differences between mean periodontal scores for individual age-sex groups exhibited only random fluctuations.

Income and Education

Periodontal disease varied inversely with family income (tables 5 and 6 and fig. 4). Persons whose families had high yearly incomes had significantly lower scores than persons from poorer families. This means that, in general, the lower the family income, the greater the amount of

periodontal disease likely to be encountered. For example, while the mean score for white men from families with yearly incomes of \$10,000 or more was only 0.81, the corresponding score for men with family incomes at the low extreme—under \$2,000 per year—was 2.21, or more than twice as great. Even after allowance was made for differences in age and sex distributions of the six income groupings, substantial differences in mean scores continued to persist.

Periodontal scores for men and women and the percentages of men and women with destructive disease, by the number of years of school completed, are shown in tables 7 and 8 and in figure 5. The strong association of periodontal disease and education is immediately apparent. As the level of educational attainment rose, periodontal scores became progressively lower, dropping sharply at each level. However, education was more strongly associated with periodontal disease in men than in women.

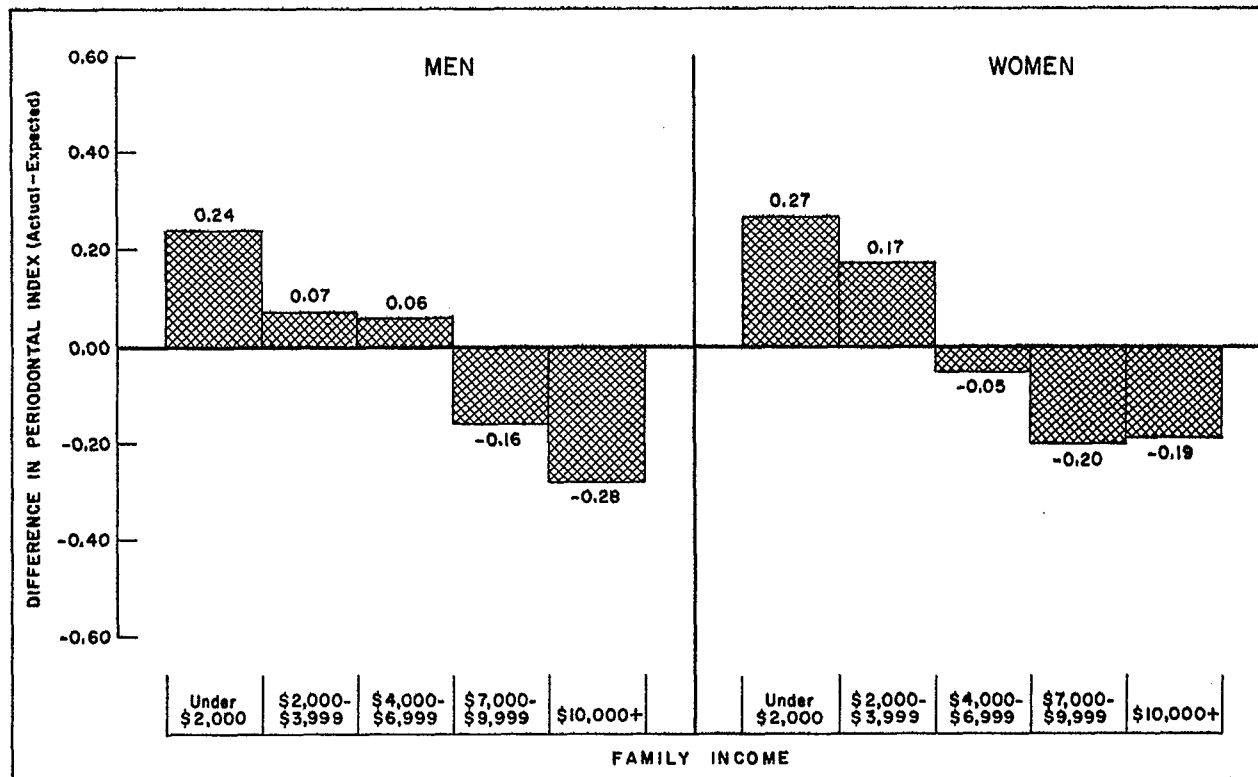


Figure 6. Difference between actual and expected mean Periodontal Index in men and women, by family income adjusted for education.

While education and income in the adult population are closely correlated, the two variables do not mean the same thing. Income implies, for example, the ability to purchase dental care, whereas education implies a greater awareness of what appropriate dental care is. It seems pertinent to inquire whether income was independently associated with periodontal disease or whether the association was merely an indirect expression of the evidently stronger one that existed between education and income.

The definite trend toward lower scores with rising income remained even after education had been eliminated as variable (fig. 6). The gradient, although substantially reduced, was nonetheless distinct. Adjustment for education, however, reduced the variance in the mean scores attributable to income to roughly a quarter of their former value.

Race by Income and Education

A significant part of the difference observed in periodontal disease by race was explained by differences in income and education. Differences in mean scores for white and Negro men, after their age distributions were standardized, were largely accounted for by one of the two variables (table 9). The adjusted index still was higher for Negro men who had incomes ranging from \$4,000 to \$6,999 per year, but differences by race virtually disappeared at the lower levels. With education constant, however, mean periodontal scores for white and Negro men were almost the same at every level.

Adjusted periodontal scores for Negro women, on the other hand, were higher than those for white women. The differences, although present at every level of income and education, were

relatively less with lower incomes. Because proportionately few Negro adults had family incomes exceeding \$7,000 per year or education beyond high school, average scores could not be meaningfully compared at these levels.

Residence

As noted in Appendix I, there may have been appreciable examiner differences in scoring periodontal disease. Since examiners were not assigned to examining locations at random, examiner differences were impossible to distinguish from regional differences. Data by geographic region were therefore omitted from this report.

Mean periodontal scores for persons whose place of residence was described by other methods less subject to possible examiner bias are presented in tables 10-12. Actual and expected scores did not differ greatly enough to indicate that periodontal disease was associated either with population density or with place description. This does not mean categorically that there were no differences, but it suggests that if they did exist they were either very small or they had too large a sampling variability to be found significant. Moreover, since the tabulated variances in Appendix II include examiner variability as well as sampling variability, any minor differences associated with place of residence would be especially difficult to demonstrate.

Tooth Loss and Periodontal Disease

The estimates of the prevalence and severity of periodontal disease presented in this report can properly be described as conservative. Clinical examination with X-rays and probing for pockets, for example, would doubtless have resulted in appreciably higher estimates. Moreover, in quite another sense the lifetime experience of individuals with periodontal disease is also underestimated because periodontal scores cannot be assigned to missing teeth. It is true that individuals who have already lost teeth because of destructive disease very likely will show extensive disease involving their remaining teeth. However, the past experience of persons who have lost all their teeth is not reflected in the Perio-

dontal Index, and information about reasons for previous extractions was not obtained in the Survey.

The periodontal condition of the estimated 9.5 million persons with one edentulous jaw is especially interesting because of the implications for tooth loss in edentulous persons. As a group they had a periodontal score (2.34) which was more than twice as great as the mean score for all other persons (0.98). Even after the age distributions of the two groups were standardized, differences in periodontal scores were still substantial.

| | Average Periodontal Index | |
|---|------------------------------|-------|
| | Men | Women |
| One jaw edentulous ----- | 2.91 | 1.93 |
| Neither jaw edentulous ¹ --- | 1.66 | 1.09 |

¹Adjusted to age distribution of persons with one edentulous jaw.

Persons with one edentulous jaw resembled edentulous persons in having lost a large number of teeth. Moreover, about 90 percent of the former and about 95 percent of the latter were over 34 years old, the age at which periodontal disease reportedly becomes the leading cause for the extraction of teeth.²⁴ These circumstances strongly suggest that the impact of periodontal disease on the dental health of the American people is far more serious than is indicated by morbidity estimates alone.

SUMMARY

Periodontal disease is an ailment of major proportions in the adult population of the United States. About 3 out of 4 of the entire adult population at risk—the 90 million men and women who had at least one permanent tooth—had periodontal disease, and about 1 out of 4 had destructive periodontal disease. Two out of four had gingivitis ranging from mild inflammation involving

a few teeth to severe inflammation involving all their teeth.

The estimates were based upon examinations conducted in 1960-62 by the Health Examination Survey on 6,672 persons—a probability sample of the civilian, noninstitutional population 18-79 years of age. The prevalence and severity of periodontal disease were measured by the Periodontal Index.

Destructive disease, although present at all ages, was strongly associated with age. Only about 10 percent of persons 18-24 years old had one or more overt periodontal pockets, but by ages 75-79 years the proportion with destructive disease had increased fivefold.

The mean periodontal score for men was half again as large as the mean score for women—1.34 as compared with 0.93. This difference by sex occurred at every age except 75-79 years, and it arose from the fact that men not only were more likely than women to have periodontal disease, but also were more likely to have destructive disease.

Both the prevalence and severity of periodontal disease varied substantially by race. Negro men and women were more likely to have periodontal disease than were white persons of comparable age; in addition, proportionately more

Negroes had destructive disease. As a result, the mean Periodontal Index was 50 percent greater for Negro adults than for white adults—1.60 as compared with only 1.06.

The occurrence of periodontal disease, as expressed by the mean Periodontal Index, varied inversely with both family income and education. Both variables were independently associated with periodontal disease, but the correlation was higher with education.

Much of the difference in the occurrence of periodontal disease by race was "explained" by differences in income and to an even greater extent by differences in education. The occurrence of periodontal disease in white and Negro men with comparable educational attainment did not differ significantly. However, differences in education between white and Negro women only partly "explained" the higher mean scores for Negro women.

The prevalence and severity of periodontal disease in the U.S. population were conservatively estimated. Moreover, since many of the approximately 20 million edentulous adults in the population may at one time have had severe destructive disease, periodontal disease has a graver effect on dental health than morbidity estimates can indicate.

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Table 1. Percent distribution of adults, by status of periodontal disease according to sex and age: United States, 1960-62

| Sex and age | Status of periodontal disease | | | | |
|-------------------------|-------------------------------|-----------------------------|--------------------------|--------------|--|
| | Total | Without periodontal disease | With periodontal disease | | |
| | | | Without pockets | With pockets | |
| <u>Both sexes</u> | | Percent distribution | | | |
| Total, 18-79 years----- | 100.0 | 26.1 | 48.5 | 25.4 | |
| <u>Men</u> | | | | | |
| Total, 18-79 years----- | 100.0 | 20.9 | 49.0 | 30.1 | |
| 18-24 years----- | 100.0 | 29.0 | 60.6 | 10.3 | |
| 25-34 years----- | 100.0 | 26.3 | 51.7 | 22.0 | |
| 35-44 years----- | 100.0 | 22.1 | 48.1 | 29.7 | |
| 45-54 years----- | 100.0 | 15.0 | 48.1 | 36.9 | |
| 55-64 years----- | 100.0 | 15.3 | 39.1 | 45.6 | |
| 65-74 years----- | 100.0 | 5.6 | 36.0 | 58.4 | |
| 75-79 years----- | 100.0 | 6.2 | 33.7 | 60.0 | |
| <u>Women</u> | | | | | |
| Total, 18-79 years----- | 100.0 | 31.0 | 47.9 | 21.0 | |
| 18-24 years----- | 100.0 | 36.8 | 53.6 | 9.6 | |
| 25-34 years----- | 100.0 | 37.6 | 50.2 | 12.3 | |
| 35-44 years----- | 100.0 | 33.3 | 46.2 | 20.5 | |
| 45-54 years----- | 100.0 | 26.6 | 43.7 | 29.6 | |
| 55-64 years----- | 100.0 | 20.8 | 43.6 | 35.5 | |
| 65-74 years----- | 100.0 | 15.2 | 52.0 | 32.8 | |
| 75-79 years----- | 100.0 | 11.0 | 35.3 | 53.8 | |

Table 2. Number of adults, by Periodontal Index and sex: United States, 1960-62

| Periodontal Index | Men | Women | Periodontal Index | Men | Women |
|-------------------|---------------------|--------|-------------------|---------------------|-------|
| | Number in thousands | | | Number in thousands | |
| All scores----- | 43,655 | 46,439 | 4.0----- | 149 | 131 |
| 0.0----- | 9,126 | 14,406 | 4.1----- | 41 | 94 |
| 0.1----- | 2,523 | 3,609 | 4.2----- | 88 | 62 |
| 0.2----- | 2,874 | 3,175 | 4.3----- | 216 | 66 |
| 0.3----- | 2,703 | 3,042 | 4.4----- | 72 | 25 |
| 0.4----- | 1,763 | 2,237 | 4.5----- | 132 | 104 |
| 0.5----- | 1,437 | 1,840 | 4.6----- | 106 | 44 |
| 0.6----- | 1,644 | 1,557 | 4.7----- | 84 | 26 |
| 0.7----- | 1,221 | 962 | 4.8----- | 149 | 121 |
| 0.8----- | 1,225 | 999 | 4.9----- | 114 | 68 |
| 0.9----- | 1,076 | 926 | 5.0----- | 115 | 72 |
| 1.0----- | 1,214 | 1,318 | 5.1----- | 22 | 78 |
| 1.1----- | 734 | 694 | 5.2----- | 78 | 30 |
| 1.2----- | 863 | 728 | 5.3----- | 62 | 122 |
| 1.3----- | 821 | 680 | 5.4----- | 83 | 49 |
| 1.4----- | 1,037 | 475 | 5.5----- | 55 | 27 |
| 1.5----- | 686 | 586 | 5.6----- | 8 | 32 |
| 1.6----- | 639 | 489 | 5.7----- | 33 | 36 |
| 1.7----- | 454 | 410 | 5.8----- | 65 | 47 |
| 1.8----- | 433 | 370 | 5.9----- | 31 | 25 |
| 1.9----- | 351 | 342 | 6.0----- | 1,218 | 646 |
| 2.0----- | 1,445 | 1,470 | 6.1----- | 74 | 89 |
| 2.1----- | 425 | 246 | 6.2----- | 85 | 31 |
| 2.2----- | 481 | 119 | 6.3----- | 108 | 102 |
| 2.3----- | 586 | 227 | 6.4----- | 139 | 79 |
| 2.4----- | 372 | 164 | 6.5----- | 173 | 20 |
| 2.5----- | 179 | 260 | 6.6----- | 86 | 40 |
| 2.6----- | 384 | 233 | 6.7----- | 44 | 53 |
| 2.7----- | 208 | 328 | 6.8----- | 71 | 21 |
| 2.8----- | 420 | 258 | 6.9----- | 52 | 48 |
| 2.9----- | 226 | 207 | 7.0----- | 28 | 90 |
| 3.0----- | 240 | 183 | 7.1----- | 29 | 64 |
| 3.1----- | 145 | 108 | 7.2----- | 15 | - |
| 3.2----- | 162 | 73 | 7.3----- | 36 | 36 |
| 3.3----- | 215 | 195 | 7.4----- | 44 | 18 |
| 3.4----- | 109 | 177 | 7.5----- | 47 | 27 |
| 3.5----- | 431 | 210 | 7.6----- | 22 | 11 |
| 3.6----- | 140 | 175 | 7.7----- | 12 | - |
| 3.7----- | 182 | 98 | 7.8----- | 19 | - |
| 3.8----- | 175 | 107 | 7.9----- | - | 8 |
| 3.9----- | 34 | 57 | 8.0----- | 266 | 61 |

Table 3. Average Periodontal Index of white and Negro adults, by sex and age: United States, 1960-62

| Sex and age | All races | White | Negro |
|-------------------------|-----------|---------------------------|-------|
| <u>Both sexes</u> | | Average Periodontal Index | |
| Total, 18-79 years----- | 1.13 | 1.06 | 1.60 |
| <u>Men</u> | | | |
| Total, 18-79 years----- | 1.34 | 1.28 | 1.79 |
| 18-24 years----- | 0.62 | 0.58 | 0.78 |
| 25-34 years----- | 0.92 | 0.87 | 1.30 |
| 35-44 years----- | 1.27 | 1.22 | 1.67 |
| 45-54 years----- | 1.62 | 1.55 | 2.06 |
| 55-64 years----- | 2.15 | 2.00 | 3.13 |
| 65-74 years----- | 2.50 | 2.47 | 2.83 |
| 75-79 years----- | 2.91 | 3.01 | 2.16 |
| <u>Women</u> | | | |
| Total, 18-79 years----- | 0.93 | 0.85 | 1.43 |
| 18-24 years----- | 0.48 | 0.46 | 0.62 |
| 25-34 years----- | 0.60 | 0.53 | 0.95 |
| 35-44 years----- | 0.82 | 0.74 | 1.30 |
| 45-54 years----- | 1.23 | 1.11 | 1.92 |
| 55-64 years----- | 1.56 | 1.39 | 2.90 |
| 65-74 years----- | 1.62 | 1.51 | 2.03 |
| 75-79 years----- | 2.94 | 2.41 | 5.53 |

Table 4. Percent distribution of adults, by status of periodontal disease according to race and sex: United States, 1960-62

| Race and sex | Status of periodontal disease | | | |
|-----------------|-------------------------------|-----------------------------|--------------------------|--------------|
| | Total | Without periodontal disease | With periodontal disease | |
| | | | Without pockets | With pockets |
| <u>White</u> | | | | |
| Both sexes----- | 100.0 | 27.8 | 48.3 | 23.9 |
| Men----- | 100.0 | 22.4 | 48.7 | 28.9 |
| Women----- | 100.0 | 33.0 | 47.8 | 19.2 |
| <u>Negro</u> | | | | |
| Both sexes----- | 100.0 | 15.8 | 48.2 | 36.0 |
| Men----- | 100.0 | 12.2 | 48.9 | 38.9 |
| Women----- | 100.0 | 19.1 | 47.6 | 33.3 |

Table 5. Actual and expected mean Periodontal Index for adults, by sex, race, and family income: United States, 1960-62

| Race and family income | Men | | | Women | | |
|------------------------|--------|----------|------------|--------|----------|------------|
| | Actual | Expected | Difference | Actual | Expected | Difference |
| <u>All races</u> | | | | | | |
| Mean Periodontal Index | | | | | | |
| Under \$2,000----- | 2.11 | 1.56 | 0.55 | 1.47 | 1.04 | 0.43 |
| \$2,000-\$3,999----- | 1.59 | 1.37 | 0.22 | 1.18 | 0.93 | 0.25 |
| \$4,000-\$6,999----- | 1.31 | 1.26 | 0.05 | 0.79 | 0.85 | -0.06 |
| \$7,000-\$9,999----- | 0.96 | 1.26 | -0.30 | 0.63 | 0.88 | -0.25 |
| \$10,000+----- | 0.82 | 1.41 | -0.59 | 0.57 | 0.97 | -0.40 |
| Unknown----- | 1.66 | 1.38 | 0.28 | 1.14 | 1.04 | 0.10 |
| <u>White</u> | | | | | | |
| Under \$2,000----- | 2.21 | 1.60 | 0.61 | 1.34 | 0.99 | 0.35 |
| \$2,000-\$3,999----- | 1.59 | 1.31 | 0.28 | 1.14 | 0.87 | 0.27 |
| \$4,000-\$6,999----- | 1.29 | 1.20 | 0.09 | 0.75 | 0.77 | -0.02 |
| \$7,000-\$9,999----- | 0.93 | 1.20 | -0.27 | 0.62 | 0.80 | -0.18 |
| \$10,000+----- | 0.81 | 1.35 | -0.54 | 0.57 | 0.88 | -0.31 |
| Unknown----- | 1.62 | 1.32 | 0.30 | 0.96 | 0.94 | 0.02 |
| <u>Negro</u> | | | | | | |
| Under \$2,000----- | 2.03 | 1.89 | 0.14 | 1.66 | 1.60 | 0.06 |
| \$2,000-\$3,999----- | 1.61 | 1.81 | -0.20 | 1.33 | 1.31 | 0.02 |
| \$4,000-\$6,999----- | 1.70 | 1.67 | 0.03 | 1.26 | 1.29 | -0.03 |
| \$7,000-\$9,999----- | 2.01 | 1.48 | 0.53 | 0.80 | 1.23 | -0.43 |
| \$10,000+----- | 1.50 | 1.57 | -0.07 | 0.65 | 0.76 | -0.11 |
| Unknown----- | 1.81 | 1.92 | -0.11 | 1.53 | 1.48 | 0.05 |

Table 6. Percent distribution of adults, by sex and status of periodontal disease according to race and family income: United States, 1960-62

| Race and family income | Men | | | | Women | | | |
|------------------------|-------|-----------------------------|--------------------------|--------------|-------|-----------------------------|--------------------------|--------------|
| | Total | Without periodontal disease | With periodontal disease | | Total | Without periodontal disease | With periodontal disease | |
| | | | Without pockets | With pockets | | | Without pockets | With pockets |
| <u>All races</u> | | | | | | | | |
| Percent distribution | | | | | | | | |
| Under \$2,000----- | 100.0 | 10.0 | 51.0 | 39.0 | 100.0 | 22.3 | 46.4 | 31.3 |
| \$2,000-\$3,999----- | 100.0 | 15.2 | 48.7 | 36.1 | 100.0 | 23.6 | 50.2 | 26.2 |
| \$4,000-\$6,999----- | 100.0 | 19.9 | 51.1 | 29.0 | 100.0 | 33.6 | 48.6 | 17.8 |
| \$7,000-\$9,999----- | 100.0 | 32.1 | 43.5 | 24.4 | 100.0 | 39.4 | 45.7 | 14.9 |
| \$10,000+----- | 100.0 | 28.2 | 50.6 | 21.2 | 100.0 | 38.0 | 47.1 | 15.0 |
| Unknown----- | 100.0 | 13.8 | 48.2 | 38.0 | 100.0 | 26.3 | 48.5 | 25.2 |
| <u>White</u> | | | | | | | | |
| Under \$2,000----- | 100.0 | 11.5 | 47.0 | 41.5 | 100.0 | 26.3 | 44.4 | 29.3 |
| \$2,000-\$3,999----- | 100.0 | 16.2 | 48.9 | 34.9 | 100.0 | 25.4 | 49.8 | 24.8 |
| \$4,000-\$6,999----- | 100.0 | 20.2 | 51.2 | 28.5 | 100.0 | 34.2 | 48.8 | 17.0 |
| \$7,000-\$9,999----- | 100.0 | 33.1 | 43.8 | 23.1 | 100.0 | 40.2 | 44.7 | 15.1 |
| \$10,000+----- | 100.0 | 29.1 | 50.1 | 20.9 | 100.0 | 38.4 | 46.6 | 14.9 |
| Unknown----- | 100.0 | 13.6 | 48.7 | 37.7 | 100.0 | 27.9 | 51.8 | 20.3 |
| <u>Negro</u> | | | | | | | | |
| Under \$2,000----- | 100.0 | 9.3 | 56.7 | 34.0 | 100.0 | 15.6 | 48.0 | 36.5 |
| \$2,000-\$3,999----- | 100.0 | 12.4 | 46.4 | 41.1 | 100.0 | 15.7 | 51.4 | 32.9 |
| \$4,000-\$6,999----- | 100.0 | 16.3 | 45.6 | 38.1 | 100.0 | 29.6 | 41.9 | 28.5 |
| \$7,000-\$9,999----- | 100.0 | 6.0 | 32.9 | 61.1 | 100.0 | 24.0 | 66.1 | 9.9 |
| \$10,000+----- | 100.0 | - | 52.9 | 47.1 | 100.0 | 13.9 | 63.7 | 22.5 |
| Unknown----- | 100.0 | 18.4 | 47.9 | 33.7 | 100.0 | 22.2 | 31.9 | 45.9 |

Table 7. Actual and expected mean Periodontal Index for adults, by sex, race, and education: United States, 1960-62

| Race and education | Men | | | Women | | |
|------------------------|--------|----------|------------|--------|----------|------------|
| | Actual | Expected | Difference | Actual | Expected | Difference |
| <u>All races</u> | | | | | | |
| Mean Periodontal Index | | | | | | |
| Under 5 years----- | 2.69 | 1.73 | 0.96 | 1.81 | 1.17 | 0.64 |
| 5-8 years----- | 1.99 | 1.61 | 0.38 | 1.38 | 1.10 | 0.28 |
| 9-12 years----- | 1.14 | 1.20 | -0.06 | 0.83 | 0.84 | -0.01 |
| 13+ years----- | 0.72 | 1.24 | -0.52 | 0.44 | 0.91 | -0.47 |
| Unknown----- | 2.15 | 1.77 | 0.38 | 1.87 | 1.32 | 0.55 |
| <u>White</u> | | | | | | |
| Under 5 years----- | 2.82 | 1.77 | 1.05 | 1.68 | 1.07 | 0.61 |
| 5-8 years----- | 2.04 | 1.58 | 0.46 | 1.28 | 1.02 | 0.26 |
| 9-12 years----- | 1.13 | 1.16 | -0.03 | 0.78 | 0.77 | 0.01 |
| 13+ years----- | 0.68 | 1.18 | -0.50 | 0.43 | 0.83 | -0.40 |
| Unknown----- | 2.17 | 1.80 | 0.37 | 1.56 | 1.15 | 0.41 |
| <u>Negro</u> | | | | | | |
| Under 5 years----- | 2.71 | 2.25 | 0.46 | 1.82 | 1.98 | -0.16 |
| 5-8 years----- | 1.80 | 1.91 | -0.11 | 1.76 | 1.66 | 0.10 |
| 9-12 years----- | 1.17 | 1.45 | -0.28 | 1.22 | 1.12 | 0.10 |
| 13+ years----- | 2.70 | 1.74 | 0.96 | 0.67 | 1.30 | -0.63 |
| Unknown----- | 2.30 | 2.00 | 0.30 | 2.18 | 2.25 | -0.07 |

Table 8. Percent distribution of adults, by sex and status of periodontal disease according to race and education: United States, 1960-62

| Race and education | Men | | | | Women | | | |
|-----------------------------|-------|-----------------------------|--------------------------|--------------|-------|-----------------------------|--------------------------|--------------|
| | Total | Without periodontal disease | With periodontal disease | | Total | Without periodontal disease | With periodontal disease | |
| | | | Without pockets | With pockets | | | Without pockets | With pockets |
| Percent distribution | | | | | | | | |
| <u>All races</u> | | | | | | | | |
| Under 5 years----- | 100.0 | 4.8 | 44.6 | 50.7 | 100.0 | 10.6 | 53.8 | 35.6 |
| 5-8 years----- | 100.0 | 11.6 | 44.7 | 43.7 | 100.0 | 21.2 | 47.6 | 31.1 |
| 9-12 years----- | 100.0 | 21.6 | 52.0 | 26.4 | 100.0 | 32.4 | 48.6 | 19.1 |
| 13+ years----- | 100.0 | 33.8 | 48.3 | 17.9 | 100.0 | 44.7 | 45.2 | 10.1 |
| Unknown----- | 100.0 | 10.7 | 46.5 | 42.8 | 100.0 | 10.4 | 42.9 | 46.7 |
| <u>White</u> | | | | | | | | |
| Under 5 years----- | 100.0 | 5.6 | 37.6 | 56.8 | 100.0 | 10.7 | 55.6 | 33.7 |
| 5-8 years----- | 100.0 | 12.2 | 44.3 | 43.5 | 100.0 | 22.0 | 48.5 | 29.5 |
| 9-12 years----- | 100.0 | 22.1 | 51.6 | 26.3 | 100.0 | 33.8 | 48.4 | 17.8 |
| 13+ years----- | 100.0 | 34.5 | 48.3 | 17.2 | 100.0 | 45.9 | 44.4 | 9.7 |
| Unknown----- | 100.0 | 10.8 | 45.5 | 43.7 | 100.0 | 12.6 | 44.9 | 42.5 |
| <u>Negro</u> | | | | | | | | |
| Under 5 years----- | 100.0 | 5.1 | 51.8 | 43.1 | 100.0 | 11.0 | 48.9 | 40.0 |
| 5-8 years----- | 100.0 | 9.7 | 45.0 | 45.3 | 100.0 | 18.6 | 41.8 | 39.7 |
| 9-12 years----- | 100.0 | 18.5 | 53.8 | 27.7 | 100.0 | 20.6 | 49.3 | 30.1 |
| 13+ years----- | 100.0 | 7.9 | 30.0 | 62.1 | 100.0 | 27.3 | 56.7 | 16.0 |
| Unknown----- | 100.0 | 11.9 | 42.8 | 45.2 | 100.0 | - | 47.9 | 52.1 |

Table 9. Mean Periodontal Index, by sex, race, family income, and education: United States, 1960-62

| Family income and education | Men | | Women | |
|-------------------------------|--------------------|-------|--------------------|-------|
| | White ¹ | Negro | White ¹ | Negro |
| Family income | | | | |
| Mean Periodontal Index | | | | |
| Under \$2,000----- | 1.99 | 2.03 | 1.27 | 1.66 |
| \$2,000-\$3,999----- | 1.66 | 1.61 | 1.10 | 1.33 |
| \$4,000-\$6,999----- | 1.25 | 1.70 | 0.76 | 1.26 |
| Education | | | | |
| Under 5 years----- | 2.89 | 2.71 | 1.79 | 1.82 |
| 5-8 years----- | 1.91 | 1.80 | 1.20 | 1.76 |
| 9-12 years----- | 1.04 | 1.17 | 0.67 | 1.22 |

¹Adjusted to the age distribution of Negro men or women in the same income or educational group.

NOTE: Because proportionately few Negro adults had family incomes exceeding \$7,000 per year or education beyond high school, these groups have not been included.

Table 10. Actual and expected mean Periodontal Index for adults, by sex, race, and place description: United States, 1960-62

| Race and place description | Men | | | Women | | |
|--------------------------------|--------|----------|------------|--------|----------|------------|
| | Actual | Expected | Difference | Actual | Expected | Difference |
| <u>All races</u> | | | | | | |
| Mean Periodontal Index | | | | | | |
| SMSA-in central city----- | 1.42 | 1.38 | 0.04 | 0.99 | 0.96 | 0.03 |
| SMSA-outside central city----- | 1.14 | 1.31 | -0.17 | 0.79 | 0.93 | -0.14 |
| Urban-not SMSA----- | 1.35 | 1.30 | 0.05 | 0.81 | 0.88 | -0.07 |
| Rural farm----- | 1.52 | 1.45 | 0.07 | 1.25 | 0.93 | 0.32 |
| Rural nonfarm----- | 1.57 | 1.33 | 0.24 | 1.13 | 0.91 | 0.22 |
| <u>White</u> | | | | | | |
| SMSA-in central city----- | 1.37 | 1.33 | 0.04 | 0.91 | 0.88 | 0.03 |
| SMSA-outside central city----- | 1.12 | 1.26 | -0.14 | 0.77 | 0.85 | -0.08 |
| Urban-not SMSA----- | 1.29 | 1.22 | 0.07 | 0.76 | 0.80 | -0.04 |
| Rural farm----- | 1.42 | 1.42 | - | 1.17 | 0.88 | 0.29 |
| Rural nonfarm----- | 1.49 | 1.26 | 0.23 | 0.89 | 0.80 | 0.09 |
| <u>Negro</u> | | | | | | |
| SMSA-in central city----- | 1.73 | 1.75 | -0.02 | 1.35 | 1.43 | -0.08 |
| SMSA-outside central city----- | 1.71 | 1.66 | 0.05 | 1.30 | 1.34 | -0.04 |
| Urban-not SMSA----- | 1.90 | 1.98 | -0.08 | 1.21 | 1.38 | -0.17 |
| Rural farm----- | 1.90 | 1.76 | 0.14 | 1.34 | 1.18 | 0.16 |
| Rural nonfarm----- | 1.86 | 1.85 | 0.01 | 1.98 | 1.62 | 0.36 |

Table 11. Actual and expected mean Periodontal Index for adults, by sex, race, and population-size group: United States, 1960-62

| Race and population-size group | Men | | | Women | | |
|--|--------|----------|------------|--------|----------|------------|
| | Actual | Expected | Difference | Actual | Expected | Difference |
| <u>All races</u> | | | | | | |
| Mean Periodontal Index | | | | | | |
| Giant metropolitan areas----- | 1.44 | 1.38 | 0.06 | 1.08 | 0.96 | 0.12 |
| Other very large metropolitan areas----- | 1.05 | 1.34 | -0.29 | 0.74 | 0.93 | -0.19 |
| Other standard metropolitan statistical areas----- | 1.15 | 1.32 | -0.17 | 0.78 | 0.94 | -0.16 |
| Other urban areas----- | 1.53 | 1.30 | 0.23 | 0.84 | 0.86 | -0.02 |
| Rural areas----- | 1.49 | 1.35 | 0.14 | 1.17 | 0.93 | 0.24 |
| <u>White</u> | | | | | | |
| Giant metropolitan areas----- | 1.40 | 1.34 | 0.06 | 1.07 | 0.88 | 0.19 |
| Other very large metropolitan areas----- | 1.03 | 1.30 | -0.27 | 0.69 | 0.85 | -0.16 |
| Other standard metropolitan statistical areas----- | 1.11 | 1.25 | -0.14 | 0.71 | 0.85 | -0.14 |
| Other urban areas----- | 1.45 | 1.22 | 0.23 | 0.81 | 0.78 | 0.03 |
| Rural areas----- | 1.41 | 1.30 | 0.11 | 0.92 | 0.84 | 0.08 |
| <u>Negro</u> | | | | | | |
| Giant metropolitan areas----- | 1.87 | 1.63 | 0.24 | 1.19 | 1.37 | -0.18 |
| Other very large metropolitan areas----- | 1.34 | 1.64 | -0.30 | 1.30 | 1.39 | -0.09 |
| Other standard metropolitan statistical areas----- | 1.83 | 1.91 | -0.08 | 1.73 | 1.54 | 0.19 |
| Other urban areas----- | 1.97 | 1.94 | 0.03 | 1.08 | 1.34 | -0.26 |
| Rural areas----- | 1.74 | 1.80 | -0.06 | 1.87 | 1.49 | 0.38 |

Table 12. Actual and expected mean Periodontal Index for adults, by sex, race, and urban-rural residence: United States, 1960-62

| Race and urban-rural residence | Men | | | Women | | |
|--------------------------------|------------------------|----------|------------|--------|----------|------------|
| | Actual | Expected | Difference | Actual | Expected | Difference |
| <u>All races</u> | | | | | | |
| | Mean Periodontal Index | | | | | |
| Urban----- | 1.31 | 1.35 | -0.04 | 0.89 | 0.94 | -0.05 |
| Rural----- | 1.41 | 1.32 | 0.09 | 1.03 | 0.91 | 0.12 |
| <u>White</u> | | | | | | |
| Urban----- | 1.26 | 1.29 | -0.03 | 0.84 | 0.86 | -0.02 |
| Rural----- | 1.34 | 1.26 | 0.08 | 0.87 | 0.81 | 0.06 |
| <u>Negro</u> | | | | | | |
| Urban----- | 1.76 | 1.78 | -0.02 | 1.29 | 1.41 | -0.12 |
| Rural----- | 1.87 | 1.81 | 0.06 | 1.76 | 1.46 | 0.30 |

APPENDIX I

EXAMINER VARIABILITY

Throughout the 2½ years of adult examinations, the Health Examination Survey used a total of only five dentists to obtain data from sample adults. Two of the dentists, A and B, examined for brief spans at irregular intervals over the entire period but gave relatively few examinations. The other three, who examined for longer and more continuous periods, gave relatively large numbers of examinations.

With so few examiners the reduction of observer differences was an especially important consideration. Each new examiner was trained with care and drilled at length in a uniform examination procedure before joining the examining staff. At the conclusion of his training, the new examiner and at least one of the two original examiners, A or B, independently examined approximately 150 nonsample persons. The replicate examinations provided not only a means of achieving greater uniformity in the examination procedure but also a means of measuring examiner differences.

The examination procedure and results of each set of replicate examinations are outlined in a previous report (*Vital and Health Statistics, Series 11, No. 7*). In each series of replicate examinations, differences in mean periodontal scores of the respective paired examiners were slight. However, the training exercises were conducted on groups of young persons 14-17 years of age among whom the prevalence of destructive periodontal disease was very low. The scoring of more severe periodontal disease was demonstrated on approximately 10 to 15 adults purposely chosen to illustrate more advanced stages of disease.

The prevalence and severity of periodontal disease were measured by the Periodontal Index, a system of classification which, like other morbidity indexes, measures current disease within a population at risk. The standardized criteria and scoring of the Periodontal Index are described below.⁹

A total of 5,452 sample men and women were classified by the Periodontal Index. They represented all persons within the civilian, noninstitutional population of the United States aged 18-79 years who were susceptible to periodontal disease because they had at least one natural tooth. Approximately 1 out of 3 of them was examined by Examiner D, about 1 out of 4 by C or E, and about 1 out of 10 by either A or B.

| Score | Criteria and scoring for field studies |
|-------|---|
| 0 | <i>Negative.</i> There is neither overt inflammation in the investing tissues nor loss of function due to destruction of supporting tissues. |
| 1 | <i>Mild gingivitis.</i> There is an overt area of inflammation in the free gingivae, but the area does not circumscribe the tooth. |
| 2 | <i>Gingivitis.</i> Inflammation completely circumscribes the tooth, but there is no apparent break in the epithelial attachment. |
| 6 | <i>Gingivitis with pocket formation.</i> 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 | <i>Advanced destruction with loss of masticatory function.</i> 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.

Differences between examiners in the prevalence and severity of periodontal disease reported for sample persons were relatively large. The highest mean score, 1.59, was recorded by Examiner A and was more than twice as large as that recorded by Examiner E (table I). The mean scores obtained by the other examiners ranged from a low of 0.99 to a high of 1.45.

Examinations were not assigned on a random basis. At most locations all examinations were performed by a single examiner. Thus, it is impossible to judge from the survey experience whether differences between examiner findings arose from differences in technique or from differences between the persons examined. The confounding of examiner and place differences is especially serious in comparing findings for different

regions. It is probably trivial for other geographic variables, and negligible for variables such as income and education.

The number and percent of sample persons with scores of zero, with gingivitis, and with destructive disease are shown for each examiner in table I. Conspicuous differences include the low percent of persons with zero scores and the high percent with periodontal pockets seen by A, the high percent of zero scores recorded by B, and the high percent of persons with

gingivitis—as well as the low percent with destructive disease—observed by E. These differences were not accounted for by differences in the age, sex, or race distribution of the different groups of persons examined by the five examiners. They could, although it seems unlikely, reflect important regional differences in the distribution of periodontal disease, since some examiners saw a disproportionately large or small number of persons from one or another of the regions.

Table I. Selected periodontal data by examiner, Health Examination Survey, 1960-62

| Item | All examinees | Examiner | | | | |
|------------------------|---------------|----------|-------|-------|-------|-------|
| | | A | B | C | D | E |
| Number of examinees | | | | | | |
| Total----- | 5,452 | 495 | 467 | 1,476 | 1,799 | 1,215 |
| Percent distribution | | | | | | |
| Total----- | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Zero scores----- | 26.2 | 11.3 | 36.6 | 27.2 | 25.6 | 27.8 |
| Gingivitis----- | 47.9 | 44.6 | 29.6 | 47.3 | 47.4 | 57.7 |
| Pockets----- | 26.0 | 44.0 | 33.8 | 25.5 | 27.1 | 14.5 |
| Mean Periodontal Index | | | | | | |
| Total----- | 1.17 | 1.59 | 1.26 | 0.99 | 1.45 | 0.75 |

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APPENDIX II

STATISTICAL NOTES

The Survey Design

The Health Examination Survey is designed as a highly stratified multistage sampling of the civilian, noninstitutional population, aged 18-79 years, of the conterminous United States. The first stage of the plan is a sample of the 42 primary sampling units (PSU's) from 1,900 geographic units into which the United States has been divided. A PSU is a county, two or three contiguous counties, or a standard metropolitan statistical area. Later stages result in the random selection of clusters of about four persons from a small neighborhood within the PSU. The total sample included 7,710 persons in the 42 PSU's in 29 different States. The detailed structure of the design and the conduct of the Survey have been described in previous reports.^{22 25}

Reliability in Probability Surveys

The methodological strength of the Survey derives especially from its use of scientific probability sampling techniques and of highly standardized and closely controlled measurement processes. This does not imply that statistics from the Survey are exact or without error. Data presented are imperfect for three important 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 process itself is inexact, even when standardized and con-

trolled. The faithfulness with which the study design was carried out has been analyzed in a previous report.²⁵

Of the total of 7,710 sample persons, 86 percent, or 6,672 persons, were examined. Analysis indicates that the examined persons are a highly representative sample of the adult civilian, noninstitutional population of the United States. Imputation for the nonrespondents was accomplished by attributing to nonexamined persons the characteristics of comparable examined persons. The specific procedure used²⁵ consisted of inflating the sampling weight for each examined person to compensate for nonexamined sample persons at the same stand and of the same age-sex group. It is impossible, of course, to be certain that the extent of periodontal disease is the same for the examined and the nonexamined groups.

There were 6,672 persons who came in for examination. Of these, 19 did not receive a dental examination. Another 1,170 did not receive a periodontal score because they were edentulous, and 31 did not receive a periodontal score for other reasons. Thus a total of 5,452 persons received a periodontal score. The distribution of these persons by age and sex is given in table II.

Sampling and Measurement Error

In this report and its appendixes, several references have been made to efforts to evaluate both bias and

Table II. Number of persons examined and number on whom periodontal scores are available: Health Examination Survey, 1960-62

| Age | Number examined | | Number with periodontal scores | |
|-------------------------|-----------------|-------|--------------------------------|-------|
| | Men | Women | Men | Women |
| Total, 18-79 years----- | 3,091 | 3,581 | 2,572 | 2,880 |
| 18-24 years----- | 411 | 534 | 402 | 522 |
| 25-34 years----- | 675 | 746 | 661 | 693 |
| 35-44 years----- | 703 | 784 | 654 | 701 |
| 45-54 years----- | 547 | 705 | 429 | 549 |
| 55-64 years----- | 418 | 443 | 257 | 265 |
| 65-74 years----- | 265 | 299 | 138 | 128 |
| 75-79 years----- | 72 | 70 | 31 | 22 |

variability of the measurement techniques. The probability design of the Survey makes possible the calculation of sampling errors. Traditionally the role of the sampling error has been the determination of how imprecise the survey results may be because they come from a sample rather than from measurement of all elements in the universe.

The task of presenting sampling errors for a study of the type of the Health Examination Survey is complicated by at least three factors: (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 calculation of variances, and (3) thousands of statistics come from the Survey, many for subclasses of the population for which there are small numbers of sample 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.

In the present report, estimates of approximate sampling variability for selected statistics are presented in tables III-VI. 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.

In accordance with usual practice the interval estimate for any statistic may be considered the range within one standard error of the tabulated statistic, with 68 percent confidence, or the range within two standard errors of the tabulated statistic, with 95 percent confidence.

Expected Values

In tables 3, 7, and 10-12, the actual mean Periodontal Index for each of the selected demographic variables is compared with the expected. The computation of expected rates was done as follows:

Suppose that in a subgroup the Health Examination Survey estimates that there are N_1 persons in the

Table III. Standard errors in percent distribution of adults, by status of periodontal disease, sex, and age: United States, 1960-62

| Sex and age | Status of periodontal disease | | |
|-------------------------|-------------------------------|--------------------------|--------------|
| | Without periodontal disease | With periodontal disease | |
| | | Without pockets | With pockets |
| <u>Both sexes</u> | | | |
| Total, 18-79 years----- | 1.30 | 2.17 | 1.27 |
| <u>Men</u> | | | |
| Total, 18-79 years----- | 1.24 | 2.45 | 1.65 |
| 18-24 years----- | 2.83 | 4.29 | 2.07 |
| 25-34 years----- | 2.27 | 3.47 | 2.09 |
| 35-44 years----- | 2.04 | 3.23 | 2.40 |
| 45-54 years----- | 1.83 | 3.40 | 3.09 |
| 55-64 years----- | 3.24 | 3.91 | 4.33 |
| 65-74 years----- | 2.16 | 5.70 | 5.84 |
| 75-79 years----- | 3.94 | 16.86 | 23.25 |
| <u>Women</u> | | | |
| Total, 18-79 years----- | 1.70 | 2.40 | 1.15 |
| 18-24 years----- | 2.96 | 3.60 | 2.03 |
| 25-34 years----- | 2.66 | 3.17 | 1.50 |
| 35-44 years----- | 2.47 | 3.10 | 1.94 |
| 45-54 years----- | 2.45 | 3.24 | 2.57 |
| 55-64 years----- | 2.94 | 4.25 | 3.55 |
| 65-74 years----- | 4.29 | 6.37 | 6.14 |
| 75-79 years----- | 6.94 | 17.75 | 20.82 |

Table IV. Standard errors in average Periodontal Index of white and Negro adults, by sex and age: United States, 1960-62

| Sex and age | All races | White | Negro |
|---------------------------|-----------|-------|-------|
| Average Periodontal Index | | | |
| <u>Both sexes</u> | | | |
| Total, 18-79 years-- | 0.04 | 0.04 | 0.19 |
| <u>Men</u> | | | |
| Total, 18-79 years-- | 0.05 | 0.05 | 0.08 |
| 18-24 years----- | 0.06 | 0.05 | 0.13 |
| 25-34 years----- | 0.06 | 0.07 | 0.22 |
| 35-44 years----- | 0.08 | 0.08 | 0.16 |
| 45-54 years----- | 0.10 | 0.10 | 0.20 |
| 55-64 years----- | 0.15 | 0.15 | 0.31 |
| 65-74 years----- | 0.20 | 0.21 | 0.74 |
| 75-79 years----- | 0.50 | 0.52 | 0.57 |
| <u>Women</u> | | | |
| Total, 18-79 years-- | 0.04 | 0.04 | 0.10 |
| 18-24 years----- | 0.04 | 0.05 | 0.10 |
| 25-34 years----- | 0.05 | 0.05 | 0.13 |
| 35-44 years----- | 0.06 | 0.06 | 0.18 |
| 45-54 years----- | 0.08 | 0.08 | 0.19 |
| 55-64 years----- | 0.12 | 0.12 | 0.41 |
| 65-74 years----- | 0.15 | 0.15 | 0.53 |
| 75-79 years----- | 0.55 | 0.70 | 0.55 |

i^{th} age group ($i=1, 2, \dots, 7$; sum of $N_i=N$). Suppose the Health Examination Survey estimates that the mean Periodontal Index for the United States in the i^{th} age-sex group is X_i . Then the expected mean Periodontal Index for the subgroup is

$$\frac{1}{N} \sum_i N_i X_i$$

Comparison of an actual value for, say, a region 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 persons in the region. This may or may not be true. The specified region may have higher values for young persons and lower values for old persons than are found in other regions. In that case, an average comparison will obliterate one or both of these differentials. A similar remark may be made with respect to values computed for all races together, since relationships found in one race may be found in another. 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 (table VI).

Aside from tables 5, 7, and 10-12, expected values are computed for figure 4. The computation of D_k , the mean deviation adjusted for education of the Periodontal Index for sex-income group k was done as follows:

Let X_{ijk} be the estimated mean Periodontal Index for persons in sex-income group k who are in the i^{th} age group and the j^{th} education group. Let n_{ijk} be the estimated number of people in that group.

$$\text{Let } x_{ij} = \frac{\sum_k n_{ijk} x_{ijk}}{\sum_k n_{ijk}}$$

$$\text{Let } n_{jk} = \sum_i n_{ijk}$$

$$\text{Then } D_k = \frac{\sum_i n_{jk} d_{jk}}{\sum_i n_{jk}} \quad \text{where}$$

$$d_{jk} = \frac{\sum_i n_{ijk}(X_{ijk} - X_{ij})}{n_{jk}}$$

Small Numbers

In some tables magnitudes are shown for cells for which 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 to convey an impression of the overall story of the table.

Tests of Significance

Tests of significance for demographic values are performed in two ways. The first is to determine if the difference between the actual and expected value is greater than 2 times its standard error. For example, for men with less than \$2,000 income, the difference between the actual and expected value is 0.55 and the standard error is 0.16. Since the difference is 3.5 times its standard error, it may be deemed statistically significant.

The second method is to examine the age-specific differences (not published) between the prevalence for the specified group and the prevalence for all persons. Thus for men with incomes of \$10,000 or more the mean PI for all age groups is less than the overall prevalence for these age groups. The probability of such an occurrence is less than 0.01, and the difference is considered statistically significant. In general where a difference is not statistically significant on the first test, the age-sex specific mean will fail the second test.

Table V. Standard errors in percent distribution of adults, by status of periodontal disease, race, and sex: United States, 1960-62

| Race and sex | Status of periodontal disease | | |
|-----------------|-------------------------------|--------------------------|--------------|
| | Without periodontal disease | With periodontal disease | |
| | | Without pockets | With pockets |
| <u>White</u> | | | |
| Both sexes----- | 1.39 | 2.16 | 1.20 |
| Men----- | 1.32 | 2.44 | 1.58 |
| Women----- | 1.81 | 2.39 | 1.13 |
| <u>Negro</u> | | | |
| Both sexes----- | 1.77 | 3.23 | 2.66 |
| Men----- | 2.99 | 4.64 | 4.26 |
| Women----- | 2.70 | 4.12 | 3.65 |

Table VI. Standard errors in average Periodontal Index, by race, sex and specified characteristics: United States, 1960-62

| Characteristic | All races | | White | | Negro | |
|--|-----------|-------|-------|-------|-------|-------|
| | Men | Women | Men | Women | Men | Women |
| <u>Family income</u> | | | | | | |
| Average Periodontal Index | | | | | | |
| Under \$2,000----- | 0.14 | 0.11 | 0.19 | 0.13 | 0.24 | 0.18 |
| \$2,000-\$3,999----- | 0.09 | 0.08 | 0.13 | 0.08 | 0.19 | 0.16 |
| \$4,000-\$6,999----- | 0.07 | 0.04 | 0.07 | 0.04 | 0.36 | 0.28 |
| \$7,000-\$9,999----- | 0.07 | 0.04 | 0.06 | 0.04 | 0.34 | 0.36 |
| \$10,000+----- | 0.06 | 0.04 | 0.06 | 0.04 | 0.32 | 0.29 |
| Unknown----- | 0.14 | 0.11 | 0.14 | 0.11 | 0.38 | 0.32 |
| <u>Education</u> | | | | | | |
| Under 5 years----- | 0.17 | 0.20 | 0.28 | 0.20 | 0.45 | 0.38 |
| 5-8 years----- | 0.10 | 0.09 | 0.12 | 0.09 | 0.22 | 0.21 |
| 9-12 years----- | 0.06 | 0.04 | 0.06 | 0.04 | 0.14 | 0.13 |
| 13+ years----- | 0.05 | 0.03 | 0.05 | 0.03 | 0.45 | 0.30 |
| Unknown----- | 0.26 | 0.39 | 0.37 | 0.33 | 0.39 | 0.37 |
| <u>Place description</u> | | | | | | |
| SMSA-in central city----- | 0.10 | 0.08 | 0.09 | 0.08 | 0.17 | 0.21 |
| SMSA-outside central city----- | 0.08 | 0.07 | 0.07 | 0.06 | 0.38 | 0.29 |
| Urban-not SMSA----- | 0.19 | 0.11 | 0.18 | 0.10 | 0.42 | 0.27 |
| Rural farm----- | 0.15 | 0.19 | 0.22 | 0.23 | 0.42 | 0.29 |
| Rural nonfarm----- | 0.15 | 0.15 | 0.21 | 0.12 | 0.32 | 0.44 |
| <u>Population-size group</u> | | | | | | |
| Giant metropolitan areas----- | 0.10 | 0.07 | 0.14 | 0.10 | 0.26 | 0.26 |
| Other very large metropolitan areas----- | 0.14 | 0.09 | 0.16 | 0.09 | 0.43 | 0.41 |
| Other standard metropolitan statistical areas----- | 0.11 | 0.05 | 0.12 | 0.07 | 0.36 | 0.34 |
| Other urban areas----- | 0.18 | 0.10 | 0.20 | 0.11 | 0.27 | 0.24 |
| Rural areas----- | 0.18 | 0.14 | 0.19 | 0.13 | 0.24 | 0.26 |
| <u>Urban-rural residence</u> | | | | | | |
| Urban----- | 0.06 | 0.04 | 0.06 | 0.04 | 0.21 | 0.24 |
| Rural----- | 0.07 | 0.05 | 0.07 | 0.04 | 0.26 | 0.24 |

APPENDIX III

DEMOGRAPHIC TERMS

Age.—The age recorded for each person is the age at last birthday. Age is recorded in single years.

Race.—Race is recorded as "white," "Negro," or "other." "Other" includes American Indian, Chinese, Japanese, and so forth. Mexican persons are included with "white" unless definitely known to be Indian or other nonwhite race.

Income of family or unrelated individuals.—Each member of a family is classified according to the total income of the family of which he is a member. Within the household all persons related to each other by blood, marriage, or adoption constitute a family. Unrelated individuals are classified according to their own income.

The income recorded is the total of all income received by members of the family in the 12-month period prior to the week of the interview. Income from all sources is included, e.g., wages, salaries, rents from properties, pensions, and help from relatives.

Education.—Each person is classified by education in terms of the highest grade of school completed. Only grades completed in regular schools, where persons are given a formal education, are included. A "regular" school is one which advances a person toward an elementary or high school diploma or a college, university, or professional school degree. Thus, education in vocational, trade, or business schools outside the regular school system is not counted in determining the highest grade of school completed.

Place description.—In this Survey the urban population is classified as living "in the central city" or "outside the central city" of a standard metropolitan statistical area (SMSA). The remaining urban population is classified as "not in SMSA."

The definitions and titles of standard metropolitan statistical areas are established by the U.S. Bureau of the Budget with the advice of the Federal Committee on Standard Metropolitan Statistical Areas.

The definition of an individual standard metropolitan statistical area involves two considerations: first, a city or cities of specified population to constitute the central city and to identify the county in which it is located as the central county; and, second, economic and social relationships with contiguous counties which are metropolitan in character, so that the periphery of the specific metropolitan area may be determined.

Persons "in the central city" of an SMSA are therefore defined as those whose residence is in the city appearing in the title of the standard metropolitan statistical area. Persons residing in an SMSA but not in the city appearing in the SMSA title are considered to reside "outside the central city."

The remaining population is allocated into rural-farm and rural-nonfarm groups. The farm population includes all persons living in rural territory on places of 10 or more acres from which sales of farm products amounted to \$50 or more during the previous 12 months or on places of less than 10 acres from which sales of farm products amounted to \$250 or more during the preceding 12 months. Other persons living in rural territory were classified as nonfarm. Persons were also classified as nonfarm if their household paid rent for the house but their rent did not include any land used for farming.

Population-size group.—The five classes comprising this group were derived from the design of the sample, which accomplished a stratification of the primary sampling units by population-size group in each of three broad geographic locations. Because the survey was started in 1960, the primary sampling units within each of the five population-size-group classes were necessarily based on populations and definitions of the 1950 census. The name of each selected primary sampling unit within each population-size-group class and geographic location, along with other selected sample data, are presented in an earlier report.²⁵

The definitions for each of the five population-size-group classes are as follows:

Giant metropolitan areas include nine primary sampling units defined in the 1950 census as standard metropolitan statistical areas and having populations of 3,000,000 persons or more.

Other very large metropolitan areas include six standard metropolitan statistical areas with populations of 500,000 to 3,000,000 as defined by the 1950 census.

Other standard metropolitan statistical areas include nine other SMSA's selected as primary sam-

pling units. With one exception—Providence, R.I.—all had less than 500,000 population.

Other urban areas include eight primary sampling units which were highly urban in composition but were not defined in 1950 as standard metropolitan areas.

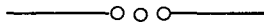
Rural areas include 10 primary sampling units which were primarily rural in composition according to 1950 census definitions.

Location of residence.—This term refers to urban or rural place of residence of the sample persons. For the first six primary sampling units at which examinations were conducted, the definition of urban and rural was the same as that used in the 1950 census. These locations were Philadelphia, Pa., Valdosta, Ga., Akron, Ohio, Muskegon, Mich., Chicago, Ill., and Butler, Mo. For the remainder of the sampling units, the 1960 census definitions were used.

The change from 1950 to 1960 definitions is of small consequence in the Survey since only six locations were

affected, and the major difference is the designation in 1960 of urban towns in New England and of urban townships in New Jersey and Pennsylvania.

According to the 1960 definition, the urban population comprises all persons living in (a) places of 2,500 inhabitants or more incorporated as cities, boroughs, villages, and towns (except towns in New England, New York, and Wisconsin); (b) the densely settled urban fringe, whether incorporated or unincorporated, of urbanized areas; (c) towns in New England and townships in New Jersey and Pennsylvania which contain no incorporated municipalities as subdivisions and which have either 25,000 inhabitants or more or a population of 2,500-25,000 and a density of 1,500 persons or more per square mile; (d) counties in States other than the New England States, New Jersey, and Pennsylvania that have no incorporated municipalities within their boundaries and have a density of 1,500 persons or more per square mile; and (e) unincorporated places of 2,500 inhabitants or more not included in any urban fringe. The remaining population is classified as rural.



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