A comparison of four epidemiological methods of assessing periodontal disease

I. Population Findings

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An epidemiological study of periodontal disease, using four methods of assessment of severity of periodontal disease, was conducted on a representative sample of 1,976 New Mexicans aged 18 to 44 years. Periodontal disease was assessed using PI and PDI and radiographic and mobility assessments. One objective of the study was to assess whether radiographic scores and measurements of clinical mobility added significantly to the precision of discrimination between the severity of periodontal disease in populations when using the PI and PDI. Findings indicated that the PI discriminated between population groups as efficiently as the PDI plus radiographic and mobility scores. In this study females had less severe periodontal disease than males; Anglos had less severe disease than Spanish-Americans, Mexicans, American-Indians, and Negroes; persons with a greater number of years of schooling and persons in the higher socioeconomic groups had less severe periodontal disease than persons with fewer years of schooling and in the lower socioeconomic groups respectively; urban and rural persons had a similar severity.

Introduction

In the past 13 years, two methods of assessing the prevalence and severity of periodontal disease have been widely used (Russell 1956, Ramfjord 1959). These two indices have been effective in quantifying differences in severity of periodontal disease between populations (Jamison 1963, Russell 1966). However, neither method has been compared adequately with methods commonly used in a dental office.

The present study was conducted to assess:

1. Whether information obtained from radiographs and measurements of clinical mobility of teeth added significantly to the precision of discriminating between the severity of periodontal disease in populations when using either of these two indices.
2. To compare Russell's Periodontal Index (PI) and Ramfjord's Periodontal Disease Index (PDI) with radiographic findings and measurements of clinical mobility of teeth.

This paper will deal with the comparison

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between Russell's Periodontal Index and Ramfjord's Periodontal Index plus mobility and radiographic measurements with special reference to the ability of these indices to discriminate between population groups. Further tests of the periodontal indices will be reported in another paper.

Methods

The study was conducted on a New Mexican population to see whether the indices discriminated between persons grouped by age, sex, cultural background (Anglo, Spanish-American, American-Indian, and Negroes), educational level and occupation. Details of the methods employed have been published (Guyer and Striffler 1964).

Survey Population

The investigators attempted to secure as representative a sample of the New Mexico population as possible. Sample quotas were established and field surveys were conducted throughout New Mexico.

The total sample consisted of 1,976 examinees and was aimed at representing the 18-to-44 age range of the New Mexico population. If a subject had only one tooth in his mouth he was examined.

The Clinical Examination

The clinical examinations were conducted by one examiner who had been instructed in the use of the PI and the PDI by the originators of the indices. The following conditions were assessed: total caries experience (DMF), tooth attrition (Ramfjord

1959), drift, open contact or migration; oral cleanliness (Greene and Vermillion 1960), and fluorosis (Dean 1942). Periodontal status was assessed by four methods: first by using the PDI developed by Ramfjord (1959); and, second, by the PI method described by Russell (1956). The third and fourth methods of assessment were mobility (Ramfjord 1959) and radiographic assessment, respectively.

The Periodontal Disease Index (PDI) (Ramfjord)

Gingival determinations for the buccal and lingual surfaces were recorded as follows: 0 = absence of inflammation, 1 = mild to moderate inflammatory gingival changes, extending all around the tooth, 2 = mild to moderately severe gingivitis extending all around the tooth, and 3 = severe gingivitis characterized by marked redness, bleeding tendency and ulceration.

Pocket measurements were made on the distal, buccal, mesial, and lingual aspects of each tooth except third molars and the distal of second molars.

The PDI was determined for each subject by combining the gingival score and a pocket-measurement score. If there was no pocket recording for a particular tooth, then the highest gingival score recorded for that tooth was recorded. If there was a pocket measurement for a tooth, the worst one was selected and graded as either a "5", "6", or "7". The sum of the scores was entered. This total was then divided by the number of teeth present, thereby giving a modified PDI for that particular subject.

The weighting system used to grade the severity of periodontal disease differs from the weighting system by Ramfjord (1959). Table 1 shows the weighting system used and referred to as the modified PDI and the weighting system used by Ramfjord (1959). The method of assessing the PDI was identical to the method originally de-

Table 1

Weighting system used for the modified PDI and the PDI

Modified PDI	PDI
0-3 mm = 5	0-3 mm = 4
3-6 mm = 6	3-6 mm = 5
over 6 mm = 7	over 6 mm = 6

scribed; the only modification is in the weighting system. The PDI examination was not limited to the selected teeth suggested by Ramfjord (1959): all the teeth except the third molars were scored.

The Periodontal Index (PI) (Russell 1956) and mobility (Ramfjord 1959) were assessed as outlined by the originators of the examination. The radiographic examination was carried out using a Ritter Model E radiographic unit with a long cone (cone distance 16 inches) and right angle technic with Eastman Ultra-Speed DF 57, DF 55. Sixteen intra-oral periodontal and two bitewing films were exposed for each subject and later scored by two periodontists. The following criteria were used in evaluating the radiographs (Each tooth excluding third molars was evaluated).

0 = normal

4 = lack of continuity of cortical plate at the crest of the interdental bone with possible widening of periodontal membrane.

5 = up to $\frac{1}{3}$ of supporting bone lost

6 = more than $\frac{1}{3}$ and up to $\frac{2}{3}$ of supporting bone lost

7 = more than $\frac{2}{3}$ of supporting bone lost

The radiographic index (X1) was assessed by dividing the sum of the radiographic scores by the number of teeth scored.

The following periodontal indices were assessed: PI, the modified PDI, referred to in this paper as PDI; radiographic index, X1; radiographic index plus PDI, referred to as XPDI; mobility index referred to as "M" and the complete periodontal index, MXPDI.

Table II
Comparison of group means using the MXPDI and the PI by sex, age, residence and ethnic group

Classification	Number of Subjects	MXPDI	PI	Chi-square tests for difference between group means			
				Source	Degrees of Freedom	X ² Tests MXPDI	PI
Sex							
Male	Δ 980	3.72	2.03				
Female	996	3.29	1.50	Total	1	37.2***	61.8***
Age Groups							
18-24 years	Δ 543	2.25	1.19				
25-34 years	800	3.57	1.73				
35-44 years	633	4.49	2.29	Total	2	576.6***	156.3***
Rural	724	3.42	1.72				
Urban	Δ1251	3.55	1.79				
Unclassified	1			Total	1	3.0	1.0
Ethnic Group							
Spanish American and Mexican	Δ 680	3.84	2.18	Total	3	58.8***	96.6***
American Indian	76	3.89	2.16	Anglo vs other groups	1	58.4***	96.0***
Negro	35	3.67	1.93	Remaining groups	2	0.5	0.6
Anglo and other	Δ1182	3.28	1.50				
Unclassified	3						

Δ Groups in which mean of MXPDI based on one or two fewer subjects than of PI

Asterisks follow significant values of chi-square:

*** The difference between means is significant at the 0.5 per cent level

The XPDI was assessed as follows: The PDI score and the radiographic score for each tooth was combined in such a manner that the higher of these two scores for each tooth was utilized. The total of these scores divided by the number of teeth scored produces the XPDI.

The complete periodontal clinical index (MXPDI) was obtained by assigning a tooth score of eight wherever extreme tooth mobility was found and by using the XPDI scores where severe mobility was not found; MXPDI is the mouth average of the scores assigned.

The clinical examination was conducted with the subject seated in a dental chair in a mobile dental unit. Added illumination

was obtained from a Castle Pano-Vision Examination Light. Air syringes were used for drying the teeth and gingivae and University of Michigan periodontal probes ("No. 0") were utilized for the measurement of pocket depth. A recorder was present to whom the examiner called his findings. An average examination lasted one-half hour per subject.

Analysis of Data

Comparison of Population Group Means

The group means of PI and the complete clinical index, MXPDI are compared for the different population classifications in Tables II and III. The data were tabulated

Table III
Comparison of group means using the MXPI and the PI by education and socioeconomic status

Classification	Number of Subjects	MXPDI	PI	Chi-square tests for differences between group means			
				Source	Degrees of Freedom	X ² Tests MXPDI	PI
Education (years of last grade completed)							
I) 0-4 years	80	4.42	2.83	Total	5	130.8***	231.6***
II) 5-8 years	284	4.20	2.55	I vs II	1	1.2	2.2
III) Some high school	416	3.56	2.03	III vs IV	1	2.1	19.4***
IV) High school graduate	1715	3.42	1.62	V vs VI	1	4.1*	0.5
V) Some college	1268	2.89	1.14	I + II vs V + VI	1	122.2***	209.5***
VI) College graduate	206	3.19	1.04				
Unclassified	7						
Socioeconomic Status (Duncan's scale)							
- 1 (unemployed)	94	3.61	2.20	Total	10	37.7***	105.4***
0	135	3.96	2.51	Within Low			
1	450	3.66	2.08	(-1, 0, 1, 2, 3)	4	7.5	11.9*
2	145	3.92	2.30	Within High			
3	139	3.92	1.96	(4, 5, 6, 7, 8, 9)	5	9.2	3.6
4	232	3.37	1.52	Low vs High	1	21.0***	89.9***
5	138	3.54	1.47				
6	208	3.45	1.42				
7	97	3.43	1.41				
8	33	3.41	1.19				
9	7	1.73	0.61				
Unclassified	1298						

Δ Groups in which mean of MXPDI based on one or two fewer subjects than of PI

Asterisks follow significant calculated values of chi-square.

* The difference between means is significant at the 5 per cent level

** The difference between means is significant at the 1 per cent level

*** The difference between means is significant at the 0.5 per cent level

in contingency tables using intervals of 0.3 for both indices. Means of the respective indices were analyzed by the method discussed in Yates (1948) and Cochran (1954) for partitioning contingency X^2 's from tables using groupings of quantitative characters.

The classifications of subjects by age group, sex, education, ethnic groups, and socioeconomic status are shown in the first column of Tables II and III and the number (n) of subjects in each classification in column 2. MXPDI was not obtained on two subjects so in each classification scheme n is starred for the groups or group, in which the means of MXPDI is based on one or two fewer subjects than of PI. The only criterion according to which a substantial number of subjects could not be classified was socioeconomic status; the 298 unclassified cases here include college students, highschool students whose parents' status was not determined, and unemployed dependents of members of the armed services. Duncan's Socio-Economic Index (1961) was used to discriminate the groups in this classification scheme.

A score of "0" through "9" was assigned as follows:

- 0 = Laborers except farm and mine
- 1 = Farm laborers and foremen
- 2 = Service and private household workers
- 3 = Operatives and kindred workers
- 4 = Craftsmen, foremen and kindred workers
- 5 = Salesworkers
- 6 = Clerical and kindred workers
- 7 = Managers, officials and proprietors except farm
- 8 = Farmers and farm managers
- 9 = Professional, technical and kindred workers

Findings

Comparison of PI and complete periodontal examination, MXPDI

Of the 1,976 persons aged 18 to 44 years examined, 980 were male and 996 were female. Females had less severe periodontal

disease than males. The PI for females was 1.50 compared to 2.03 for males ($P < 0.001$) and within both sexes periodontal disease as assessed by the PI and the MXPDI increased in severity with increasing age (Table II).

There was a difference in severity of periodontal disease by ethnic group. There was substantially less severe periodontal disease among Anglos than the other ethnic groups which consisted of Spanish-Americans, Mexicans, American-Indians, and Negroes; a similar severity of periodontal disease was found in the latter four ethnic groups (Table II).

The number of years of schooling was inversely related to the severity of periodontal disease as measured by the PI. However, the findings for the MXPDI were not consistent (Table III). The greatest difference for both the PI and the MXPDI was between the group which had no more than eight years of schooling (group I & II) and that with at least some college work (group V & VI) ($P < 0.001$). A very highly significant difference ($P < 0.001$) was found between the PI means for the two high school groups (II versus IV) and the reversal of trend occurring between the two college group means of MXPDI is significant at the five percent level; otherwise the agreement between the two indices is very good in this classification.

Socioeconomic factors played an important role in determining the severity of periodontal disease. Persons with a low socioeconomic index (-1 to 3) had highly significantly more severe periodontal disease than persons in the high (4 to 9) socioeconomic index groups. (Table III). The severity of periodontal disease in urban and rural New Mexican adults was similar: the PI was 1.79 and 1.72 respectively (Table II).

As shown in Table II and III, the complete periodontal index, MXPDI (which involves assessment of mobility, radiographic

Table IV

The mean and range of PI within class intervals of 0.9 of MXPDI

Class of MXPDI Interval	Mean PI	Range of PI
0.0-0.8	0.4	0.0-1.0
0.9-1.7	0.8	0.0-1.9
1.8-2.6	1.0	0.0-2.5
2.7-3.5	1.2	0.0-3.1
3.6-4.4	1.5	0.0-4.3
4.5-5.3	2.4	0.0-6.1
5.4-6.2	4.5	0.0-7.3
6.3-7.1	6.3	3.6-7.9
7.2-8.0	7.2	7.0-7.3

bone loss and clinical periodontal disease), with the exception of two comparisons (Education Group V vs VI and socioeconomic status within low) indicated the same probability of differences between groups as the PI.

PI and the MXPDI

PI has been shown to underestimate the severity of destructive periodontal disease (Jamison 1963). Therefore, an attempt was made to work out a conversion table from

Fig. 1. MXPDI scores for given scores of PI. The plotted points represent average complete clinical scores (MXPDI) within intervals of 0.3 of PI.

PI scores to overall severity of periodontal disease (Table IV, Fig. 1). The PDI method plus mobility plus radiographic findings (MXPDI) was considered to be very close to the usual examination carried out in the dental office.

It is apparent from the data presented in Table IV and Fig. 1 that an increase in PI was related to increase in MXPDI. In addition, the coefficient of correlation between PI and MXPDI was + 0.69. This value represents a dependence of 47 percent between the two indices or, in other words 47 percent of the variance among subjects is common to both indices.

Discussion

At a recent workshop on "The Periodontal Needs of the United States Population" (O'Leary 1967), Ramfjord (1967) questioned whether dental epidemiological data could be translated into data which are comparable to detailed clinical findings recorded in a dental office. Ramfjord (1967) went on to say that meaningful information on estimates of need for periodontal therapy were needed. Because most of the data on the epidemiology of periodontal disease are based on the PI and because the PI does not use routine probing of pockets, there is a need to convert PI findings into scores for clinical treatment. Russell (1967) recognizes that the PI is a "quick, visual scanning rather than an adequate clinical diagnosis..." and estimated ranges of PI which correspond with a clinical diagnosis of gingivitis, incipient destructive periodontal disease, well-established and terminal periodontal disease (Russell 1956). The ranges of PI which indicate the terminal stages of periodontal disease (4.0-8.0) and the likelihood of imminent tooth loss have been shown to be a reasonably accurate predictor of tooth loss in a large adult British population (Sheiham 1967). In the present

study of a New Mexican population the PI discriminated between population groups as efficiently as the MXPDI; the latter "index" involves assessment of tooth mobility, full mouth radiographs in addition to the PDI (Tables II and III).

The MXPDI when combined with the diagnosis of local etiological factors constitutes a complete periodontal examination as carried out in the dental office. Therefore the periodontal needs of a population may be assessed by using PI and finding out what different values of MXPDI mean in terms of periodontal needs for groups. The MXPDI scores may then be converted to PI using Fig. 1. However, it is anticipated, because of differences of approach in the treatment of periodontal disease and the lack of data on oral cleanliness, that different assessment of need will be found depending on the translation of MXPDI scores to treatment required. Based on the findings in this study, assessing the distribution of periodontal needs for given ranges of PI would be a more economical method of assessing needs than the more time-consuming MXPDI examinations.

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