THE PERIODONTAL INDEX AS AFFECTED BY SAMPLE SELECTION

by
EVA HELMINEN-PAKKALA

INTRODUCTION

It is commonly held that the selection of material occurring in investigations concerned with teeth in situ influences the results of periodontal studies (*Miller & Seidler*, 1940; *Marshall Day & Shourie*, 1949; *Belting et al.*, 1953; *Marshall-Day et al.*, 1955; *Kelly & van Kirk*, 1965; *Tóth & Gyulavári*, 1967). The need for consideration of this problem has been pointed out (*Marshall Day & Shourie*, 1949; *Marshall-Day et al.*, 1955; *Waerhaug*, 1962; *Kelly & van Kirk*, 1965; *Tóth & Gyulavári*, 1967). Further analysis has, however, been hindered by the difficulty of assessing the periodontal status of missing teeth (*Marshall Day & Shourie*, 1949; *Marshall-Day et al.*, 1955; *Kelly & van Kirk*, 1965). Nevertheless, information on the effect of selection may be found in studies reporting frequencies of periodontal disease and other dental particulars as comprehensive entities (*Belting et al.*, 1953; *Bossert & Marks*, 1956; *Tóth & Gyulavári*, 1967; *Sutton*, 1968).

In an investigation on periodontal conditions in »normal» subjects (*Helminen-Pakkala*, 1968) it was also realized that the data obtained might be affected by the unavoidable selection of material which had taken place on account of lost teeth and prosthetic replacement. For various reasons it was desired to study the effect of this selection.

Received for publication, December 4, 1970.

The periodontal index (PDI-M), a modification of the PDI by *Ramfjord* (1959), was regarded as the most suitable object of study.

MATERIALS AND METHODS

The material available for the study consisted of one hundred and twenty-four males[1]), aged 15—64 years, and one hundred and twenty-nine females[2]), aged 15—64 years, investigated for the PDI-M (Material I), and three hundred and fifty-five males[3]) and six hundred and seventy-seven females[3]), aged 15—64 years, from which the former had originated (Material II). Since the subjects of Material I were required to have natural teeth only (*Helminen-Pakkala*, 1968), the subjects of Material II had been surveyed for general dental conditions according to a scheme presented in Table 1.

For the purpose of the study two mathematical approaches were decided upon: median analysis and probit analysis (*Finney*, 1952).

Median analysis

The median analysis involved the observation of the age and sex development of the median scores for PDI-M in Materials I and II.

For the purpose of the median analysis the following hypotheses were formulated:

1. In Material II, for subjects with natural teeth only, the PDI-M observations in the various age groups would be on the same level as in Material I.

2. In Material II, for subjects with partial prosthesis as supplement to the natural dentition or with total prosthesis/being edentulous in one or both jaws, all PDI-M observations in a given age group would be above the median of this group.

The analyses were carried out for five-year age groups. Table II shows the distribution of males and females of Materials I and II within these groups, together with the absolute figures and percentages for subjects in Material II with any form of prosthesis/being edentulous without prosthesis.

Determination of the median scores of PDI-M in age groups of Material II was undertaken using for the ordinal number of the median ($=R_{\frac{1}{2}}$) the general formula

$$R_{\frac{1}{2}} = \frac{N}{2} + \frac{1}{2}$$

[1]) Group reported in *Helminen-Pakkala* (1968) and 5 subjects aged 61—64 years.
[2]) Group reported in *Helminen-Pakkala* (1968) and one subject aged 63 years.
[3]) Taken from the initial material reported in *Helminen-Pakkala* (1968).

Table I. *Criteria used for screening of subjects for periodontal investigation*

Acceptable situation	Natural teeth only in both jaws. Single crowns and/or single small fixed bridges are allowed. Periodontal conditions should, however, not be investigated for teeth restored as above.
Rejectable situations	1. Removable partial prosthesis as a supplement to natural dentition in one or both jaws. 2. Total prosthesis/edentulous without prosthesis in one jaw, natural teeth with/without supplement of partial prosthesis in the other jaw. 3. Total prosthesis/totally edentulous without prosthesis.

(N = total number of subjects in Material II),
and for the interpolation of the final value of the median the formula

$$F(x) = F(x_0) + \frac{x - x_0}{x_1 - x_0} \cdot [F(x_1) - F(x_0)]$$

[$x_0 < x < x_1$ = observed quantities and $F(x_0)$, $F(x)$, $F(x_1)$ = corresponding function values. In the present case x_0 and x_1 were the ordinal numbers closest to $R_{\frac{1}{2}}$ (= x) and $F(x_0)$, $F(x)$ and $F(x_1)$ the PDI-M observations corresponding to x_0, x and x_1].

Probit analysis

The probit analysis involved the determination of ages at which fifty per cent of the subjects of Materials I and II reached/exceeded given limit values of PDI-M.

Probit analysis is an analytical smoothing procedure, which in its main features resembles regression analysis. The aim of probit analysis is to find for the object of concern the most efficient estimate of the independent variable (impact) at various percentile levels of the dependent variable (percentage affected). In general, the optimal information is secured close to the median level (= fifty per cent affected).

For the purpose of analysis, the percentage observations are transformed into probits, which, assuming that the observed percentages increase in the same manner as the normal distribution function, may be defined as being

standardized normal distribution variables corresponding to observed cumulative percentages. As a result of the probit transformation for the percentage observations equivalent quantities are obtained, the regression of which, with regard to the independent variable, may be expressed more simply than that of the original percentages, i.e. at best by a probit regression line.

As for the analysis itself, the principal difference between probit analysis and ordinary regression analysis is that in probit analysis the weights of the observations are based, not on the number of observations, but upon the expected accuracy of the probit. This accuracy again depends on the number of observations plus the value of the probit.

For the purpose of probit analysis the following hypotheses were formulated:

1. In Material II, among subjects having natural teeth only, the percentile distribution of PDI-M scores within a given age group would be the same as in Material I.

2. In Material II, subjects with natural teeth and partial prosthesis would be in possession of a minimi PDI-M = 3. Within a given age group the percentile distribution of PDI-M scores $\geqq 4$ would be the same as in Material I.

3. In Material II, subjects with total prosthesis/being totally edentulous in one or both jaws would be in possession of a minimi PDI-M = 4.

The subjects of Material I were divided according to order of age as far as possible in groups of twenty, the subjects of Material II into groups corresponding in age to the subjects of Material I. Thus, males up to the age of 61 years and females up to the age of 54 years were included in the analysis. Table V presents the number of subjects considered in the groups of Material II in addition to the twenty dentulous subjects of Material I, and Table VI the percentages of subjects in groups of Materials I and II reaching/exceeding the given limit values of PDI-M together with corresponding primary (= first working) probits.

RESULTS

Median analysis

The results of the median analyses were as seen from Table III. Fig. 1 presents the corresponding graphs.

Development of median scores of PDI-M in Materials I and II according to age and sex. In the males, the median scores of PDI-M could be followed for subjects aged 15—54 years. Within this interval the age increase of

Table II. *Age and sex distribution of subjects in Materials I and II; ratios of subjects wearing removable prosthesis/being edentulous*

		Material II			
		Non-investigated subjects*)			
Age group	Investigated dentulous subjects (Material I)	with natural teeth only	with prosthesis/ edentulous	Total	Per cent of total with prosthesis/ edentulous
		Male			
15—19	20	26	1	47	2.1
20—24	15	37	4	56	7.2
25—29	19	31	1	51	2.0
30—34	14	19	4	37	10.8
35—39	16	11	7	34	20.6
40—44	11	12	6	29	20.7
45—49	9	12	13	34	38.2
50—54	9	7	11	27	40.8
55—59	4	3	10	17	58.7
60—64	7	4	12	23	52.2
		Female			
15—19	15	32	1	48	2.1
20—24	24	62	14	100	14.0
25—29	19	47	23	89	25.8
30—34	16	39	44	99	44.5
35—39	11	31	36	78	46.2
40—44	10	18	50	78	64.2
45—49	16	5	48	69	69.6
50—54	9	3	24	36	66.7
55—59	6	5	41	52	79.0
60—64	3	2	23	28	82.1

*) Known with regard to general dental conditions only.

the median scores of PDI-M was regular up to the 31—34 year age group, later becoming irregular in Material I but remaining regular in Material II.

In the females, however, the median analyses could not be carried on beyond the age of 35—39 years. Nevertheless, up to this point the increase of the median scores of PDI-M with age was regular in both materials.

As far as could be followed, i.e. up to the 35—39 year age group, males scored higher than females in Material I. In Material II, however, females scored higher than males beginning with the 30—34 year age group.

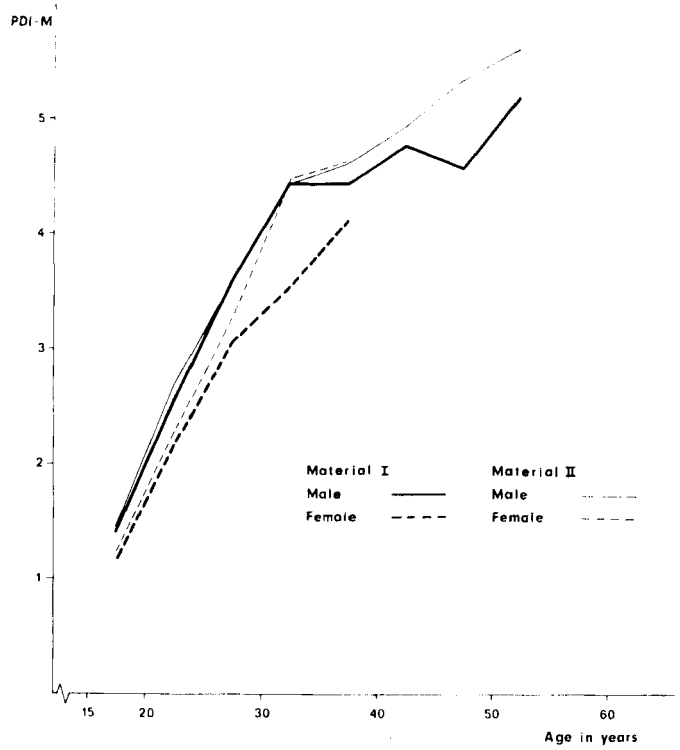


Fig. 1. Age and sex development of median scores of PDI-M in Materials I and II.

Table III. *Age and sex development of median scores of PDI-M in Materials I and II*

Age group	Male		Female	
	Material I	Material II	Material I	Material II
15—19	1.41	1.45	1.17	1.24
20—24	2.57	2.69	2.15	2.27
25—29	3.59	3.60	3.05	3.27
30—34	4.42	4.43	3.54	4.48
35—39	4.43	4.61	4.11	4.63
40—44	4.77	4.93	4.50	.*)
45—49	4.57	5.33	4.34	.
50—54	5.19	5.61	4.67	.
55—59	4.55	.*)	4.83	.
60—64	4.93	.	4.84	.

*) Analysis not possible because of loss of subjects in group > 50 % (cf. Table II).

Table IV. *Typical ages for various limit values of PDI-M in Materials I and II obtained through median analysis*

	Limit PDI-M							
	2		3		4		5	
	Male	Female	Male	Female	Male	Female	Male	Female*)
Material	Age in years							
I	20.0	21.7	24.6	27.2	29.8	36.6	51.0	. .
II	19.7	21.2	24.2	26.2	29.8	30.5	43.2	. .

*) Analysis not possible owing to limitations in material.

Relationship of typical ages for certain limit values of PDI-M in Materials I and II. Table IV shows the approximate ages at which the median scores of PDI-M reached/exceeded the limit values of PDI-M 2,3 and 4 in the analysed groups, these ages being considered as typical in the above sense. As a consequence of the hypotheses on which the analyses were based the typical ages for the given limit values of PDI-M were in Material II either the same as or lower than those in Material I.

In Material I, at all the investigated limits of PDI-M, the typical ages were lower for males than for females. This was also true for Material II since the reversed relationship between the scores of males and females, referred to above, occurred for the first time at the limit value PDI-M = 4.4, a level not reached in the females of Material I within the age range that it had been possible to investigate for the present purpose.

Table V. *Number of non-investigated*) subjects in Material II taken into account for alteration of the PDI-M observations according to hypotheses applied to probit analysis*

Group	Male	Female
1	27	32
2	55	92
3	28	83
4	19	76
5	41	148
6	50	47

*) Known with regard to general dental conditions only.

Table VI. *Observed percentages and primary probits for various limit values of PDI-M according to age in Materials I and II*

Group	Median age in years corresponding to observations	Material I*) Observed percentages for limits of PDI-M			Material I*) Value of primary probit at limit of PDI-M			Material II Observed percentages for limits of PDI-M			Material II Value of primary probit at limit of PDI-M		
		2	3	4	2	3	4	2	3	4	2	3	4
						Male							
1	17.0	25	5	0	4.48	3.60	. .**)	26.1	5.9	1.1	4.33	3.74	2.97
2	22.5	65	35	5	5.30	4.50	3.62	66.9	38.6	7.5	5.38	4.58	3.60
3	29.0	95	80	50	6.35	5.55	4.27	95.2	81.1	52.8	6.43	5.56	4.35
4	36.5	100	90	65	. .	6.52	5.03	. .	91.2	68.5	. .	6.70	5.20
5	43.0	100	100	85	. .	. .	5.68	. .	. .	88.3	. .	. .	5.96
6	53.0	100	100	85	. .	. .	6.70	. .	. .	91.5	. .	. .	7.12
						Female							
1	18.0	35	10	0	4.50	3.55	. .	36.0	11.6	. .	4.64	3.90	. .
2	22.0	50	15	5	5.05	4.10	3.07	58.8	30.2	19.2	5.22	4.48	3.90
3	28.0	90	60	5	5.90	4.90	3.84	93.3	73.3	24.8	6.10	5.35	4.55
4	33.0	90	80	30	6.60	5.58	4.45	94.0	87.9	53.2	6.80	6.08	5.08
5	42.5	100	95	85	. .	6.85	5.70	. .	98.2	93.4	. .	7.40	6.12
6	49.0	100	100	85	. .	. .	6.55	. .	. .	94.2	. .	. .	6.80

*) Groups of twenty.
**) Not used in analysis.

Differences in typical ages for given limit values of PDI-M in Materials I and II. In the males, the median scores of PDI-M reached/exceeded the limit values PDI-M = 2, 3 and 4 in Materials I and II very much at the same age, the differences in the typical ages of the two groups being less than half a year at all the above levels of PDI-M. In the males, any difference in typical ages worth consideration did not seem to occur until beyond the limit value PDI-M = 4.4, the level not observable in the females.

In the females, however, already at the limit value PDI-M = 3 a difference of approximately one year could be observed in the typical ages of Material I and Material II. At the limit value PDI-M = 4 this difference amounted to about six years. Here it also seemed that still greater differences in the typical ages of the two materials could have been encountered with the increasing limits of PDI-M, had the type of analysis used permitted further calculations.

Table VII. *Probit regression equations for relationship of PDI-M and age in Materials I and II*

Material	Limit PDI-M 2	3	4
		Male	
I	y = 5.00+0.16(x-20.6)	y = 5.00+0.15(x-25.5)	y = 5.00+0.071(x-32.9)
II	y = 5.00+0.16(x-20.2)	y = 5.00+0.15(x-25.0)	y = 5.00+0.092(x-32.3)
		Female	
I	y = 5.00+0.13(x-21.1)	y = 5.00+0.13(x-27.7)	y = 5.00+0.12(x-37.6)
II	y = 5.00+0.14(x-20.2)	y = 5.00+0.15(x-25.1)	y = 5.00+0.11(x-32.1)

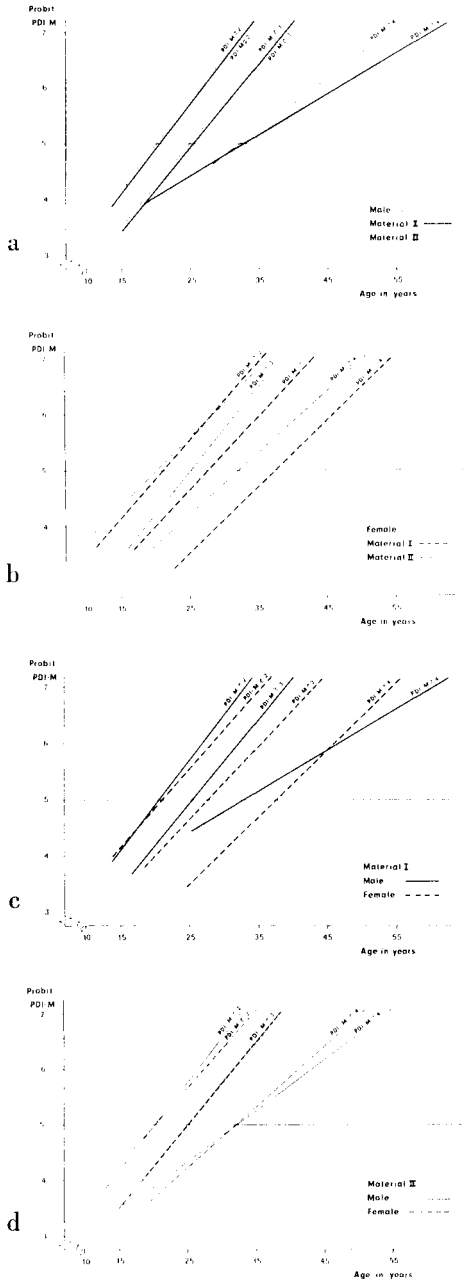
Differences in typical ages for given limit values of PDI-M in males and females. Differences in the typical ages for males and females were at the limit value PDI-M = 2 practically the same in Materials I and II, i.e. about one and a half years. At the limit value PDI-M = 3, however, the difference in the typical ages was about 2.6 years for Material I, about two years for Material II. At the limit value PDI-M = 4, the difference in the typical ages of males and females was more than six years in Material I, while in Material II it was hardly one year.

Probit analysis

Table VII shows the probit regression equations obtained for the relationship of the stipulated limit values of PDI-M and age and Figs. 2 a-d the corresponding graphs.

Development of percentages of subjects in Materials I and II reaching/exceeding given limit values of PDI-M. Within males and females, in Material I as well as in Material II, the percentages of subjects reaching/exceeding limit values of PDI-M = 2, 3 and 4 seemed to be in a linear relationship to age.

Relationship of typical ages for given limit values of PDI-M in Materials I and II. Table VIII shows approximations of ages at which the various limit values of PDI-M were reached/exceeded in Materials I and II by fifty per cent of the subjects, these ages here being considered as typical. Again, owing to the hypotheses on which the analyses were based, the typical ages for the various limit values of PDI-M were in Material II the same as or lower than those in Material I.



Figs. 2 a-d. Graphical results of the probit analyses. Probit value = 5.00 indicates 50 % of subjects reaching/exceeding limit value of PDI-M.

Table VIII. *Typical ages for various limit values of PDI-M in Materials I and II obtained through probit analysis*

	Limit PDI-M					
	2		3		4	
	Male	Female	Male	Female	Male	Female
Material	Age in years					
I	20.6	21.1	25.5	27.7	32.9	37.6
II	20.2	20.2	25.0	25.1	32.3	32.1

In Material I at all the investigated limits of PDI-M the typical ages were lower in males than in females. In Material II, however, the above relationship was present only at the limit value PDI-M = 3. In this case, the limit value PDI-M = 2 was reached/exceeded by males and females at the same approximate age, the typical ages in both sexes here being accordingly the same. At the limit value PDI-M = 4 the typical age was lower in the females than in the males.

Differences in typical ages for given limit values of PDI-M in Materials I and II. In the males, the limit values PDI-M = 2, 3 and 4 were reached/exceeded very much at the same age in Material I and in Material II. At every limit, the difference in the typical ages was less than one year.

In the females, however, a diverging development of PDI-M in Materials I and II was suggested also by this type of analysis. While the difference in typical ages at limit value PDI-M = 2 was hardly one year, at limit value PDI-M = 4 the same difference was as much as five and a half years.

Differences in typical ages for given limit values of PDI-M in males and females. In Material I, the difference in the typical ages of males and females was at the limit value PDI-M = 2 about half a year, at the limit value PDI-M = 4 more than four and a half years. In Material II, however, at the various limits of PDI-M, the differences which did occur in the typical ages of males and females were almost negligible.

DISCUSSION

In the present study, the effect of unavoidable selection of material on the periodontal index (PDI-M) caused by loss of teeth and prosthetic replace-

ment was approached mathematically, using median analysis and probit analysis (*Finney*, 1952).

For the purpose of the analyses working hypotheses had to be formulated. In so doing, it was natural to consider that the periodontal status of lost teeth might, in general, have been inferior to that of remaining teeth. This point of view was, as a matter of fact, supported by the findings of *Kelly* and *van Kirk* (1965) which indicated for subjects with one edentulous jaw, as a group, higher periodontal scores than for subjects with natural teeth in both jaws. Since several investigations had revealed a negative influence of removable partial prosthesis on the periodontal tissues (*Fenner et al.*, 1956; *Koivumaa*, 1956; *Koivumaa et al.*, 1960; *Carlsson et al.*, 1961; *Carlsson et al.*, 1962; *Seeman*, 1963), it was also natural to assume that periodontal conditions would be worse in connection with these replacements than in the absence of the same.

In the median analysis the medians obtained for the various age groups in Material II were based on the ordered observations in Material I and upon the percentages of subjects with natural teeth only and subjects with removable prosthesis/being edentulous in these groups. This procedure was rendered possible by the fact that in several age groups the ratio of subjects with removable prosthesis/being edentulous was less than fifty per cent. It should be noted that, in the analysis, no claim was made regarding the magnitude of deviation of the PDI-M scores of subjects with removable prosthesis/being edentulous in a given age group of Material II from the median score of this group.

In the probit analysis, conditions in Materials I and II were approached on the basis of limit values PDI-M = 2, 3 and 4. In Material I the development of PDI-M in age groups was determined by percentages of subjects reaching/exceeding the given limit values on the basis of their known scores. In Material II the development of PDI-M was determined, in addition, by the percentages of non-investigated subjects reaching/exceeding these values on the basis of the hypotheses describing their periodontal status.

The results of the presented analyses were accordingly rough estimates of the relationships which could have been present between the levels of PDI-M in the two materials.

Providing that the development of PDI-M in Material II could be looked upon as having been more realistic than that of Material I, the following may be inferred:

In the males the median scores of PDI-M obtained through investigation conformed with the »real» PDI-M up to early middle age, after which an underestimation of the »real» PDI-M by these scores started to take place.

This observation agreed well with the findings by *Belting et al.* (1953) and *Tóth* and *Gyulavári* (1967) on the relationship between frequencies of periodontal disease and periodontal disease plus edentulousness, and also with the findings by *Bossert* and *Marks* (1956) on the relationship between frequencies of periodontal disease and periodontal disease plus extractions owing to this disease.

In the females, however, an underestimation of the »real» PDI-M by the scores obtained through investigation seemed to have taken place already in young subjects. As far as could be followed this underestimation increased with age and increasing levels of PDI-M.

In Material I, accordingly, the selection of material had led to the occurrence of greater differences between the median scores of PDI-M in males and females than might have been present without the selection. In fact, within the ranges of age and PDI-M that had been possible to investigate, the median scores of males and females in Material II tended to be alike.

The figures obtained through the probit analysis indicated similar trends for the development of the PDI-M in Materials I and II to those arrived at through the median analysis, thus supporting the impression regarding the effect of selection obtained by means of the same.

Acknowledgements. The idea to the presend study was developed together with Mr. Erkki Järvinen, M. Sc., who also performed the statistical calculations and guided the evaluation of the results. For all the help thus afforded the author expresses her sincere gratitude.

SUMMARY

The effect of the selection of material on the periodontal index (PDI-M) obtained for 124 males and 129 females aged 15—64 years (Material I), was studied observing conditions in 355 males and 677 females aged 15—64 years (Material II), the basis of Material I.

In the study median analysis and probit analysis were employed. The PDI-M levels of those subjects of Material II, known only with regard to their general dental status, were assessed according to hypotheses formulated for the purpose. The reaction of the periodontal index to the selection of material was evaluated on the basis of ages at which limit values PDI-M = 2, 3 and 4 were reached/exceeded in the various instances, i.e. in the median analysis by the different median values of PDI-M and in the probit analysis by fifty per cent of the subjects in the groups concerned.

The results of the analyses indicated that the selection of material, having been greater in the females than in the males, had contributed to the sex

difference observed in Material II. When Material I was considered the age development of the PDI-M tended to be almost the same in both sexes.

RÉSUMÉ

INFLUENCE DU CHOIX DE L'ÉCHANTILLONNAGE SUR L'INDICE PARODONTAL

Une étude de l'action de la sélection du matériel utilisé sur l'indice parodontal (PDI-M) de 124 hommes et 129 femmes âgés de 15 à 64 ans (Matériel I) a été effectuée en relevant les observations faites sur 355 hommes et 677 femmes âgés de 15 à 64 ans (Matériel II) parmi lesquels le Matériel I avait été prélevé.

Cette étude a été faite en utilisant l'analyse de médiane et l'analyse de probit. Les valeurs du PDI-M des sujets du Matériel II dont on ne connaissait que l'état dentaire en général, ont été établies d'après des hypothèses formulées à cet effet. La réaction de l'indice parodontal à la sélection du matériel a été évaluée en se basant sur les âges auxquels les valeurs différentes de médiane de PDI-M dans l'analyse de médiane, et 50 % des sujets dans les groupes en question dans l'analyse de probit, ont atteint/dépassé les valeurs limite de PDI-M = 2, 3 et 4.

Les résultats des analyses indiquaient que la sélection du matériel, qui avait été plus grande parmi les femmes que parmi les hommes, avait ainsi contribué aux différences trouvées suivant le sexe dans le Matériel II. Lorsqu'on considérait le Matériel I, l'évolution du PDI-M avec l'âge tendait à être environ la même dans les deux sexes.

ZUSAMMENFASSUNG

DER PERIODONTALINDEX (PDI-M) UND DESSEN BEEINFLUSSUNG DURCH AUSLESE DES UNTERSUCHUNGSMATERIALS

Untersucht wurde die Einwirkung der Auslese auf den Periodontalindex (PDI-M), errechnet an 124 männlichen und 129 weiblichen Fällen im Alter von 15—64 Jahren (Material I), unter Berücksichtigung der Verhältnisse bei der Grundlage für Material I, d.h. 355 männlichen und 677 weiblichen Fällen im Alter von 15—64 Jahren (Material II).

Bei der Untersuchung bediente man sich sowohl der Median Analyse als der Probit Analyse. Die PDI-M Werte der nur in Bezug auf den allgemeinen Zustand ihrer Zähne bekannten Fälle aus Material II wurden mit Hilfe eigens für diesen Zweck aufgestellten Hypothesen eingeschätzt. Die Reaktion

des Periodontalindexes auf die Auslese des Untersuchungsmaterials wurde ausgewertet auf der Basis jener Altern, bei denen die verschiedenen Medianwerte des PDI-M (Median Analyse) bzw. 50 % der Gesamtfälle der beobachteten Gruppen (Probit Analyse) die Grenzwerte bes PDI-M = 2,3 und 4 erhielten/überschritten.

Das Ergebnis der Analysen liess erkennen, dass die Auslese des Untersuchungsmaterials, die bei den weiblichen Fällen grösser war als bei den männlichen, zur Entstehung geschlechtsbedingter, an Material II beobachteter Unterschiede beigetragen hatte. Betr. Material I erwies sich die altersbedingte Entwicklung des PDI-M bei beiden Geschlechtern als ungefähr gleich.

REFERENCES

Belting, C. M., M. Massler & I. Schour, 1953: Prevalence and incidence of alveolar bone disease in men. J. Amer. dent. Ass. *47:*190—197.

Bossert, W. A. & H. H. Marks, 1956: Prevalence and characteristics of periodontal disease in 12,800 persons under periodic dental observation. J. Amer. dent. Ass. *52:*429—442.

Carlsson, G. E., B. Hedegård & K. K. Koivumaa, 1961: Studies in partial dental prosthesis. II. An investigation of mandibular partial dentures with double extension saddles. Acta odont. scand. *19:*215—237.

Carlsson, G. E., B. Hedegård & K. K. Koivumaa, 1962: Studies in partial dental prosthesis. III. A longitudinal study of mandibular partial dentures with double extension saddles. Acta odont. scand. *20:*95—119.

Fenner, W., A. Gerber & H. R. Mühlemann, 1956: Tooth mobility changes during treatment with partial denture prosthesis. J. prosth. Dent. *6:*520—525.

Finney, D. J., 1952: Probit Analysis. 2nd Edition. Cambridge University Press. Cambridge.

Helminen-Pakkala, Eva, 1968: Periodontal conditions in rheumatoid arthritis. Part one. The control study in non-rheumatoids. Academic dissertation. Turku. Published also in: Suom. Hammaslääk. Toim. *64:*217—361.

Kelly, J. & L. E. van Kirk, 1965: Periodontal disease in adults. United States 1960—1962. National Center for Health Statistics: Series 11, Number 11. U. S. Department of Health, Education, and Welfare. U. S. Government Printing Office, Washington D. C.

Koivumaa, K. K., 1956: Changes in periodontal tissues and supporting structures connected with partial dentures. Suom. Hammaslääk. Toim. *62:* Suppl.

Koivumaa, K. K., B. Hedegård & G. E. Carlsson, 1960: Studies in partial dental prosthesis I. An investigation of dentogingivally supported partial dentures. Suom. Hammaslääk. Toim. *56:*248—306.

Marshall-Day, C. D. & K. L. Shourie, 1949: A roentgenographic survey of periodontal disease in India. J. Amer. dent. Ass. *39:*572—588.

Marshall-Day, C. D., R. G. Stephens & L. F. Quigley, Jr., 1955: Periodontal disease. Prevalence and incidence. J. Periodont. *26:*185—203.

Miller, S. C. & B. B. Seidler, 1940: A correlation between periodontal disease and caries. J. dent. Res. *19:*549—562.

Ramfjord, S. P., 1959: Indices for prevalence and incidence of periodontal disease. J. Periodont. *30*:51—59.

Seeman, Sibylle K., 1963: A study of the relationship between periodontal disease and the wearing of partial dentures. Aust. dent. J. *8*:206—208.

Sutton, P. R., 1968: A graphic method of indicating the dental condition of a population. Brit. dent. J. *125*:70—74.

Töth, A. & O. Gyulavári, 1967: Der Zustand des Zahnfleisches in einem repräsentativen Populationsquerschnitt. Dtsch. Zahnärztl. Z. *22*:1542—1545.

Waerhaug, J., 1962: Preliminary report on WHO periodontal survey in Ceylon, October-December 1960. WHO/PA/175.62.

Address:
Hämeenkatu 14 C 26,
33100 Tampere 10,
Finland