PREVALENCE OF PERIODONTAL DISEASE IN CEYLON

ASSOCIATION WITH AGE, SEX, ORAL HYGIENE, SOCIO-ECONOMIC FACTORS, VITAMIN DEFICIENCIES, MAL-NUTRITION, BETEL AND TOBACCO CONSUMPTION AND ETHNIC GROUP
FINAL REPORT

by

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INTRODUCTION

During the last 10 to 15 years a large number of epidemiological surveys have been carried out in many different countries. A summary of the main achievement from these surveys was given by Russel in a comprehensive WHO working paper.[14] For further details the reader is referred to this paper.

There is ample evidence to the effect that periodontal disease is much more prevalent in Asiatic[1, 3, 5, 7, 8, 9, 13, 15] and African[4, 10] countries than in USA[17] and some European countries.[2] Periodontal disease increases steadily with age;[15, 16, 17] there is a distinct sex difference,[16] and its prevalence and severity is associated with oral hygiene,[2, 5, 8—9, 10, 11, 12, 13, 15, 16] socio-economic factors,[2, 5, 13, 16] tobacco consumption[2] and some systemic diseases.[18] The influence of race,[16] vitamin deficiencies,[15, 17] general diseases at large,[18] and betel consumption[7] is still obscure.

The survey to be described was carried out in Ceylon during the autumn of 1960. World Health Organization sponsored the survey, and the Director of Health Services of Ceylon provided man-power and equipment and selected the populations to be

examined. The present author was in charge of epidemiology and supervised the field work.

One purpose of the survey was to assess prevalence and severity of periodontal conditions in some selected populations. Such data were wanted by the Director of Health Services in Ceylon to form basis for further planning of the Dental Health Services.

The other purpose of the survey was to collect epidemiological data from Ceylon as part of a world wide evaluation of prevalence and severity of periodontal disease as well as its association with various etiologic factors. The interest was particularly focused on the effects of Vitamin A and B deficiencies, betel consumption and racial differences. As age, sex, oral hygiene and socio-economic factors are known to be associated with variations in periodontal health, these variables had to be considered as well.

MATERIAL

All age groups from the age of 13 to 60 and over, were included.

A list of the samples, and the number of observations made in each of them, is given below:

	Males	*Females*	*Total*
Peradeniya University	745	663	1.408
Ladies College, Colombo	—	287	287
Royal college, Colombo	464	—	464
B.T.S.M., Maharagama, Colombo	137	175	312
Senior Govt. School, Wanathamulla	144	111	255
Colombo villages	321	615	936
Anuradhapura Villages	995	498	1.493
Anuradhapura Central School	130	134	264
Jaffna villages	1.214	468	1.682
Secretariat-Colombo	638	18	656
Ceylon Artillery	280	—	280
Ceylon Armoured Co.	180	—	180
	5.248	2.969	8.217

Routine of examination

The patients were first interviewed by a health inspector who reported the auxilliary information (age, sex, ethnic group, betel consumption, tobacco consumption, socio-economic status) in the form. Then the patient proceeded to the medical officers who reported clinical signs, if any, of vitamin A and B deficiencies, as well as malnutrition, in the same form. Finally, the scoring of the periodontal conditions was carried out by the dental officers. The dental officers were not familiar with the medical diagnosis or any of the other information.

As *calibration* is an important point in epidemiological studies, the present author had discussed the application of the periodontal index (PI) with its originator, Dr. A. L. Russell. In addition, the author was calibrated with dental officers who previously had been calibrated with Dr. Greene (one of Russell's coworkers) during a similar survey in Bombay in 1957.

Three Ceylon dental officers were calibrated to the author. During the first week all three of them examined the same patients (10—15 daily) and the author corrected their scores. After this period the agreement was satisfactory. For further control of the between examiners' error their scores were calculated after each days work and compared. Small differences were corrected during the first week of the survey and, for the rest of the time, regular checking of the dental officers by the author secured the highest possible agreement. The same three dental officers participated in the survey throughout and each of them examined approximately the same number of patients.

The oral examination was carried out by mouth mirror and explorer. Gauze was always available and used to dry the gingiva when the examiner was in doubt concerning the presence or absence of gingivitis. At the University of Ceylon the examination was carried out in a dental chair and in fairly good artificial light. In all other places the examination was made in good daylight. This may have led to slightly higher scores among the students. As no direct comparison will be made between the students and other groups, this will be of no practical significance.

As previously mentioned, Russell's periodontal index (PI) was

used for assessing the periodontal conditions.[14] This index and its application are considered to be known by the reader.

For the evaluation of oral hygiene, Greene and Vermillion's modified oral hygiene index (OHI'-s) was employed.[14] This index was applied in the same way as described, with the exception that only organized bacterial plaque was considered under the term "oral debris". Therefore, the name was changed to plaque index. This was done under the assumption that the firm and thin stains so commonly found in tobacco-smokers and betel-chewers are of no significance as etiological factors.

Reporting periodontosis

"Periodontosis" is considered to be a non inflammatory, degenerative destruction of the periodontium which, in pure cases, develops in the absence of local irritants. This entity is supposed to be common in Asiatic people. The three dental officers in the team were particularly interested in this type of periodontal disease and the clinical characteristics were discussed during the calibration period. They were instructed to report any case which corresponded to the above description, so that they could be examined in further detail by the present author and the medical officers.

Scoring of vitamin deficiencies and malnutrition

These conditions were diagnosed by experienced medical officers. They were requested to make a swift examination of the patients and report any clinical signs of vitamin deficiencies which were accepted to be more or less diagnostic.

Criteria for vitamin A deficiency were: Xerosis, Bitot's spots, keratitis, xerophtalmia, night blindness, total blindness and phrynoderma.

Criteria for vitamin B deficiency were: Angular stomatitis, cheilosis, erosion and fissuring of the tongue.

Gross signs of malnutrition were also diagnosed in some populations.

Classification according to income (own income and parents income) was done by well trained health inspectors. Certain criteria were agreed upon and the same three health inspectors

followed the survey throughout, so that the same yardstick was used for all.

Betel and tobacco consumption: The patients were asked by the health inspectors whether or not they used tobacco or betel (some tobacco is also included in the betel chew).

Statistical analysis

The first part of the statistical calculations were done under the supervision of Dr. Padley, WHO medical statistician in Ceylon. The last part of the calculations was done under the supervision of Miss T. Sanmugam. Significance tests were carried out only in a few associations due to lack of funds and man-power.

RESULTS

Effect of age

In the right hand column of Table I (5248 males) and Table II (2969 females) are tabulated the average PI scores of the various age groups. It may be seen that the values rise steadily in both

Table I

Average PI scores by age and oral hygiene in 5248 males

AGE in years	MALES			
	OHI GROUPS			
	0.00—1.99	2.00—3.99	4.00—6.00	TOTAL
13—19	0.50 (952)	1.16 (621)	1.89 (104)	0.83 (1677)
20—29	0.69 (906)	1.66 (671)	3.30 (245)	1.40 (1822)
30—39	1.18 (197)	2.64 (381)	4.41 (406)	3.08 (984)
40—49	1.76 (46)	3.14 (148)	5.06 (328)	4.22 (522)
50 and over	3.55 (31)	4.01 (36)	5.81 (176)	5.26 (243)
Total	0.72 (2132)	1.86 (1857)	4.35 (1259)	1.99 (5248)

Table II

Average PI scores by age and oral hygiene in 2969 females

AGE in years	FEMALES			
	OHI GROUPS			
	0.00—1.99	2.00—3.99	4.00—6.00	TOTAL
13—19	0.48 (713)	1.30 (443)	2.13 (102)	0.91 (1258)
20—29	0.71 (410)	1.99 (424)	3.58 (191)	1.77 (1025)
30—39	1.45 (55)	2.95 (163)	4.77 (215)	3.66 (433)
40—49	2.70 (10)	3.91 (34)	5.47 (114)	4.96 (158)
50 and over	4.57 (11)	4.83 (13)	6.07 (71)	5.73 (95)
Total	0.66 (1199)	1.95 (1077)	4.30 (693)	1.98 (2969)

sexes, from minima of 0.83 and 0.91 at age 13—19, to maxima of 5.26 and 5.73 at age 50 and over. Thus, it is obvious that comparisons between populations must be done within fairly narrow age groups. The present material was originally tabulated in age groups of 5 years. However, it was found that an aggregation into 10 year groups did not change the main trends, whereas the reading of the tables was made considerably easier.

Effect of sex

By comparing the right hand column of Tables I and II it becomes apparent that the average PI scores are consistently higher in females than in males, although the differences before age 20 are negligible.

Correlation between PI and OHI scores

It may be seen that the PI scores increase with increasing OHI scores in a linear fashion; this holds true for all the age groups

in both sexes (Tables I and II). Tables I and II, as well as the following tables, were first set up with 6 oral hygiene groups, all ranging over one OHI unit. However, an aggregation of the material into 3 groups did not change the overall pattern.

Correlation between sex, PI scores and OHI scores

When males and females belonging to the same oral hygiene groups are compared, it may be seen that females score higher even *within* most of these subgroups, the only exceptions being the age groups 13—29 with OHI 0.0—1.99. Inasmuch as this unquestionable sex difference might be suspected to reflect a basic difference in behaviour between the two sexes, the effect of the other factors to be studied in the following was first evaluated in males and females independently. These comparisons justified the use of combined values for males and females in the following associations (Table III).

Table III

Average PI scores by age and oral hygiene in 8217 males and females grouped together

AGE in years	MALES AND FEMALES			
	OHI GROUPS			
	0.00—1.99	2.00 - 3.99	4.00—6.00	TOTAL
13 - 19	0.49 (1665)	1.22 (1064)	2.01 (206)	0.86 (2935)
20—29	0.70 (1316)	1.79 (1095)	3.42 (436)	1.54 (2847)
30 - 39	1.24 (252)	2.73 (544)	4.54 (621)	3.26 (1417)
40—49	1.92 (56)	3.28 (182)	5.17 (442)	4.40 (680)
50 and over	3.82 (42)	4.21 (49)	5.88 (247)	5.38 (338)
Total	0.70 (3331)	1.89 (2934)	4.34 (1952)	1.99 (8217)

Table IV

Average PI scores by age, oral hygiene and income in 8217 males and females grouped together

AGE in years	INCOME GROUPS												ALL INCOME GROUPS
	POOR				MODERATE				GOOD				
	OHI-GROUPS				OHI-GROUPS				OHI-GROUPS				
	0.00 — 1.99	2.00 — 3.99	4.00 — 6.00	Total	0.00 — 1.99	2.00 — 3.99	4.00 — 6.00	Total	0.00 — 1.99	2.00 — 3.99	4.00 — 6.00	Total	
13 — 19	0.53 (802)	1.15 (805)	1.94 (165)	0.94 (1772)	0.53 (394)	1.50 (193)	2.17 (31)	0.92 (618)	0.40 (469)	1.24 (66)	2.66 (10)	0.54 (545)	0.87 (2935)
20 — 29	0.67 (734)	1.79 (718)	3.55 (328)	1.65 (1780)	0.76 (467)	1.80 (340)	3.08 (101)	1.41 (908)	0.58 (115)	1.69 (17)	2.41 (7)	0.92 (159)	1.53 (2847)
30 — 39	1.37 (158)	2.82 (436)	4.61 (539)	3.47 (1133)	1 03 (89)	2.39 (107)	4.06 (80)	2.44 (2.76)	0.77 (5)	2.64 (1)	3.63 (2)	1.72 (8)	3.26 (1417)
40 — 49	1.83 (41)	3.44 (133)	5.26 (383)	4.57 (557)	1.03 (14)	2.88 (47)	4.65 (57)	3.52 (118)	0.27 (1)	2.51 (2)	2.56 (2)	2.08 (5)	4.37 (680)
50 and over	4.00 (37)	4.23 (43)	5.90 (230)	5.44 (310)	2.49 (5)	4.17 (6)	5.59 (17)	4.73 (28)	— —	— —	— —	— —	5.38 (338)
Total	0.77 (1772)	1.91 (2135)	4.46 (1645)	2.30 (5552)	0.70 (969)	1.90 (693)	3.72 (286)	1.58 (1948)	0.44 (590)	1.43 (106)	2.66 (21)	0.65 (717)	1.99 (8217)

Table V

Average PI scores by age, oral hygiene in two upper class schools (LC and RC) and two lower class schools (SGSW and BTSM)

School	Oral Hygiene Group	0.00 – 0.99		1.00 – 1.99		2.00 – 2.99		3.00 & over		All groups	
	Age	<15	15–19	<15	15–19	<15	15–19	<15	15–19	<15	15–19
LC & RC	No. of observations	172	248	98	127	21	50	12	21	303	446
Colombo	Mean PI Score	0.21	0.32	0.60	0.71	1.09	1.11	1.42	2.45	0.45	0.62
(Upper class)	s.e. of mean	0.017	0.020	0.034	0.038	0.072	0.073	0.143	0.255	0.025	0.031
SGSW	No. of observations	14	9	55	34	53	36	30	16	152	95
Colombo	Meant PI Score	0.38	0.51	0.58	0.73	0.99	1.07	1 35	1.33	0.86	0.94
(Lower class)	s.e. of mean	0.076	0.090	0.044	0.089	0.069	0.088	0.067	0.061	0.032	0.055
BTSM	No. of observations	17	33	51	57	45	37	34	37	147	164
Colombo suburb	Mean PI Score	0.22	0.39	0.81	1.22	1.40	1.83	1.70	2.26	1.14	1.42
(Lower class)	s.e. of mean	0.051	0.032	0.061	0.099	0.118	0.141	0 123	0.189	0.063	0.082

Effect of income

Within all the age groups there is a consistent difference between the average PI scores of the *three income groups* (Table IV). When like is compared with like, as far as oral hygiene goes, the differences are small and not consistant. However, after age 30, the poor income group regularly scores higher, even within the same OHI groups.

Four schools, in—or in the neighbourhood of—Colombo, were selected particularly with the idea in mind to study the effect of socio-economic factors (Table V). Two of the schools, Royal and Ladies College (RC and LC) represent the very highest income groups in Ceylon. A third school (SGSW) was located in a slum area in Colombo, and a fourth one (BTSM) in a similar area outside Colombo. The average PI scores were 0.45 — 0.86 — 1.4 in the 13 — 14 years group and 0.62 — 0.94 — 1.42 in the 15 — 19 years group. When like is compared with like with respect to oral hygiene, most of the differences disappear. Thus, oral hygiene accounts for all the difference between the upper class schools (RC and LC) and the lower class school (SGSW) in

Table VI

Average PI scores by age and years of formal eduction. males and females

AGE in year	NO. OF YEARS SCHOOLING						TOTAL
	0—3 years	4—6 years	7—9 years	10—12 years	13—15 years	16 years and over	
13—19	1.60 (12)	0.95 (141)	0.76 (998)	0.85 (1307)	1.08 (422)	0.90 (5)	0.86 (2935)
20—29	2.44 (56)	2.19 (509)	1.73 (447)	1.41 (548)	1.12 (637)	1.34 (650)	1.54 (2847)
30—39	3.79 (67)	3.75 (412)	3.33 (367)	2.87 (217)	1.88 (115)	2.46 (39)	3.25 (1217)
40—49	5.08 (84)	4.72 (298)	4.47 (141)	3.43 (115)	2.83 (31)	3.24 (11)	4.38 (680)
50 and over	5.78 (124)	5.33 (142)	5.03 (43)	4.67 (28)	0.93 (1)	— —	5.39 (338)
Total	4.53 (343)	3.30 (1502)	1.80 (1996)	1.37 (2215)	1.22 (1256)	1.43 (705)	1.96 (8017)

Table VII

Average PI scores by age, oral hygiene, vitamin deficiency. Males and females combined

AGE in years	VITAMIN DEFICIENCY															
	NO DEFICIENCY				VIT A DEF ALONE				VIT B DEF ALONE				DEF A, B COMBINED			
	OHI-GROUPS				OHI-GROUPS				OHI-GROUPS				OHI-GROUPS			
	0.00 — 1.99	2.00 — 3.99	4.00 — 6.00	Total	0.00 — 1.99	2.00 — 3.99	4.00 — 6.00	Total	0.00 — 1.99	2.00 — 3.99	4.00 — 6.00	Total	0.00 — 1.99	2 00 — 3.99	4.00 — 6.00	Total
13 — 19	0.49	1.22	2.02	0.85	0.61	1.21	1.68	0.90	0.57	1.27	1.75	0.97	0.54	1.28	2.45	1.11
	(1531)	(953)	(193)	(2677)	(99)	(76)	(8)	(183)	(28)	(29)	(3)	(60)	(7)	(7)	(2)	(16)
20 — 29	0.71	1.77	3.48	1.56	0.62	1.77	2.77	1.26	0.78	1.96	4.19	1.99	0.82	2 02	3.16	1.63
	(990)	(842)	(355)	(2187)	(242)	(170)	(45)	(457)	(35)	(44)	(20)	(99)	(50)	(39)	(16)	(105)
30 — 39	1.23	2.75	4.48	3.22	1.50	2.31	4.93	3.29	1.40	2.78	5.23	3.85	0.57	3.01	4.76	3.46
	(227)	(473)	(537)	(1237)	(13)	(35)	(35)	(83)	(9)	(32)	(41)	(82)	(3)	(4)	(8)	(15)
40 — 49	1.87	3.29	5.19	4.38	4.74	2.90	4.93	4.27	—	3.78	5.14	4.85	—	—	4.76	4.76
	(55)	(165)	(395)	(615)	(1)	(11)	(22)	(34)	—	(6)	(22)	(28)	—	—	3)	(3)
50 and over	3.95	4.19	5.85	5.37	0.00	2.68	5.47	4.55	3.00	5.34	6.61	6.08	4.18	—	4.42	4.34
	(38)	(45)	(222)	(305)	(1)	(1)	(7)	(9)	(2)	(3)	(16)	(21)	(1)		(2)	(3)
Total	0.69	1.89	4.33	2.00	0.66	1.74	3.91	1.57	0.84	2.20	5.13	2.88	0.83	2.00	3.71	1.88
	(2841)	(2478)	(1702)	(7021)	(356)	(293)	(117)	(766)	(74)	(114)	(102)	(290)	(61)	(50)	(31)	(142)

Colombo. However, some unknown factor in addition to oral hygiene must be responsible for the very much higher PI scores in the Colombo suburb school (BTSM).

Effect of formal education

There is a strong inverse correlation between the years of schooling and the PI scores (Table VI). Thus, the scores of persons with from 0 to 3 years in school are about twice as high as those from persons with 13—15 years of formal education. The subgroup with the highest education (16 years and over) shows an unexpected deviation from the general pattern, i.e., higher values than the group with the next best education (13—15 years).

Effect of vitamin deficiencies

Clinical signs of vitamin A deficiency were found in 436 males and 338 females; signs of vitamin B deficiency were found in 174 males and 116 females; finally in 75 males and 67 females signs of both vitamin A and B deficiency were observed (Table VII). It is apparent that persons with signs of vitamin B deficiency, alone or in combination with vitamin A deficiency, consistently scored higher than those having no such signs. It schould be noted that persons with the diagnosis vitamin A deficiency as a rule returned slightly lower scores than the others, but the differences are very small.

Comparisons within subgroups of similar oral hygiene status reveal that the differences between the B deficiency and the non-deficiency groups were appreciably reduced in case the OHI values were lower than 4. Only in the OHI group 4.0—6.0 did the B deficiency group return considerably higher PI scores. There was no basic difference between males and females.

Effect of malnutrition

Clinical signs of general malnutrition were assessed in one area where such conditions were common. In Fig. 1, 118 males with evidence of malnutrition are compared with 724 males without such signs; as a rule persons with evidence of malnutrition

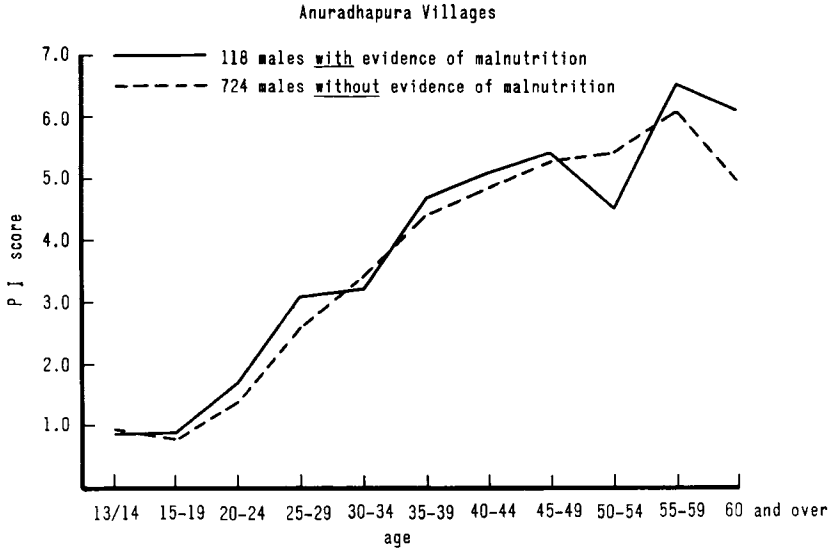

Fig. 1. Effect of malnutrition on PI scores in men.

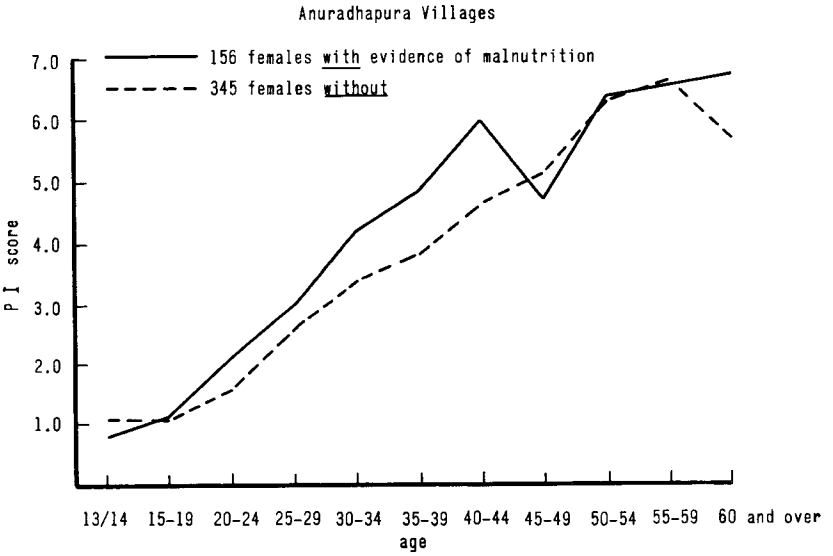

Fig. 2. Effect of malnutrition on PI scores in females.

scored higher. The difference between the 156 females *with* evidence of malnutrition and the 345 females *without* such signs is more pronounced (Fig. 2.)

Effect of betel consumption

A total of 2431 persons (1510 males and 921 females) chewed betel. After age 20 the betel consumers scored very much higher than the non-consumers (Table VIII). There is still a difference between the two categories when subgroups of equivalent oral hygienes is compared; but some of the reason for the higher values in betel consumers can be explained by poorer oral hygiene.

Effect of tobacco consumption

The 2571 tobacco consumers (2486 males and 85 females) consistently showed lower (!) PI values than the 5846 non-tobacco consumers (Table IX). This tendency was also observed within subgroups of equivalent OHI.

Table VIII

Average PI scores by age, oral hygiene and betel consumption

AGE in years	BETEL CONSUMPTION							
	YES				NO			
	OHI-GROUPS				OHI-GROUPS			
	0.00—1.99	2.00—3.99	4.00—6.00	TOTAL	0.00—1.99	2.00—3.99	4.00—6.00	TOTAL
13—19	0.52 (116)	1.04 (87)	2.25 (20)	0.88 (223)	0.48 (1569)	1.24 (977)	1.98 (186)	0.85 (2732)
20—29	0.80 (174)	1.99 (267)	3.67 (174)	2.13 (615)	0 68 (1142)	1.72 (828)	3.25 (262)	1.37 (2232)
30—39	1.43 (109)	2.90 (333)	4.69 (426)	3.59 (868)	1.10 (143)	2.47 (211)	4.21 (195)	2.73 (549)
40—49	2.53 (29)	3.24 (113)	5.28 (326)	4.62 (468)	1.27 (27)	3.35 (69)	4.87 (116)	3.92 (212)
50 and over	3.81 (34)	4.31 (41)	5.90 (182)	5.38 (257)	3.84 (8)	3.78 (8)	6.11 (65)	5.65 (81)
Total	1.21 (462)	2.53 (841)	4.86 (1128)	3.36 (2431)	0.61 (2889)	1.63 (2093)	3.64 (824)	1.41 (5806)

Effect of ethnic group

The largest ethnic group in Ceylon is made up by the Sinhaleses (represented by 5648 persons); the Tamils (2233) represent the largest minority and small minorities are Moors (212) and Europeans (114). An examination of Table X (all OHI groups) reveals that the Europeans obviously have the lowest average PI scores in all age groups. A distinct, although small difference exists between Sinhaleses and Tamils, the latter showing the better conditions, whereas the Moors fall somewhere in between the two of them.

Comparisons between subgroups of equivalent oral hygiene show that the lower average PI scores in the Europeans mostly, but not entirely, can be attributed to better oral hygiene. In the group of good oral hygiene (0.0—1.99) there is no clear cut difference between Sinhaleses and Tamils, but in the following OHI groups the Sinhaleses score consistently higher.

A comparison between a Ceylonese and a Norwegian population of about the same age was made possible because the author

Table IX

Average PI scores by age, oral hygiene and tobacco smoking

AGE in years	SMOKERS				NON-SMOKERS			
	OHI-GROUPS				OHI-GROUPS			
	0.00—1.99	2.00—3.99	4.00—6.00	TOTAL	0.00—1.99	2.00 - 3.99	4.00—6.00	TOTAL
13—19	0.46 (69)	1.07 (64)	1.78 (12)	0.83 (145)	0.49 (1596)	1.23 (1000)	2.02 (194)	0.86 (2790)
20—29	0.66 (518)	1.68 (388)	3.51 (162)	1.47 (1068)	0.72 (798)	1.84 (707)	3.37 (274)	1.57 (1779)
30 - 39	1.15 (137)	2.67 (298)	4.44 (329)	3.15 (764)	1.35 (115)	2.81 (246)	4.64 (292)	3.37 (653)
40 - 49	2.90 (33)	3.26 (115)	5.08 (256)	4.38 (404)	1.84 (23)	3.33 (67)	5.30 (186)	4.54 (276)
50 and over	4.89 (21)	4.07 (25)	5.69 (144)	5.38 (190)	2.96 (10)	4.38 (24)	6.16 (103)	5.61 (137)
Total	0.94 (778)	2.24 (890)	4.62 (903)	2.68 (2571)	0.62 (2542)	1.74 (2044)	4.09 (1049)	1.67 (5635)

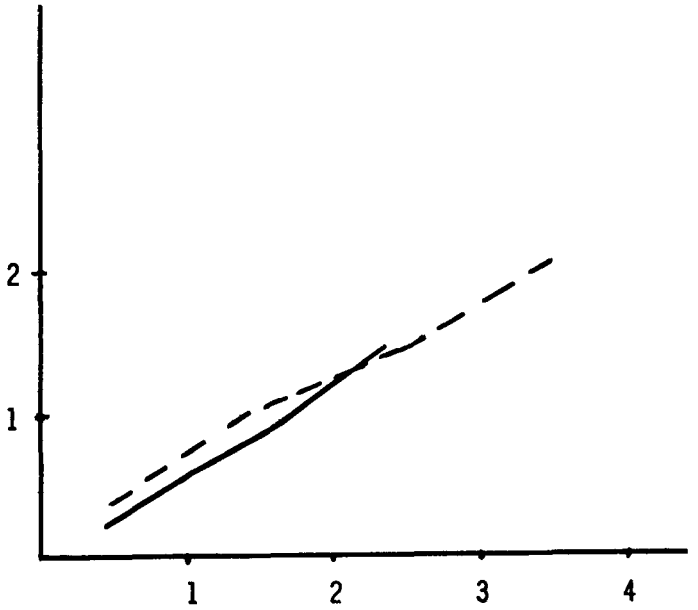

Fig. 3. *Solid line:* 206 Norwegian recruits, aged 19—21, average PI 1.14; *dotted line:* 281 Ceylonese students, aged 20—21, average PI 0.80; distributed according to PI and OHI scores.

immediately upon return from Ceylon supervised a survey[2] of 206 Norwegian recruits (age 19—21 years, average PI score 0.80). These recruits were compared with 231 Ceylonese male students (age 19/20 years, average PI 1.14). When these populations were distributed accordingly to oral hygiene, the values within equivalent OHI groups were very much the same (Fig. 3).

Prevalence of periodontosis

Formation of deep pockets in the absence of local irritants and inflammation was not found, although a few cases by first superficial examination were diagnosed as periodontosis.

DISCUSSION

Most of the recent periodontal surveys have been carried out in school children and young adults.[1, 2, 3, 5, 7, 8, 11, 12, 13] Thus, the conditions of these age groups are fairly well established. Data from the older age groups are more scarce, probably because they

are more difficult to collect.[10, 15, 16, 17, 18] Thanks to the excellent co-operation and organization by the local authorities, this was made possible in Ceylon. The old age groups were of particular interest in the present study, because the purpose was to evaluate the effect of some etiologic factors. Such an effect may not be visible in young people due to the fact that periodontitis develops slowly in most cases. Age 13 was chosen as the lower limit because, at that age, the permanent teeth have erupted, and because destructive periodontal disease *before* that age is rare.

The various populations were chosen because they were believed to be *fairly* representative samples of certain geographical areas, ethnic groups and social levels. However, it is in no way suggested that the samples are truly representative of the whole population of Ceylon. Obviously, certain professional groups, (students, soldiers) are overrepresented. Thus, nearly all the students of the University of Ceylon were included in the material. In the Colombo area the children attending two schools of very high social standard were examined and compared with the children attending two schools of very low social standard.

The observation that males in Ceylon (Table I) have better periodontal conditions than females (Table II) is interesting in view of the fact that the reverse is the case in USA and European countries. In the latter countries the superior oral hygiene practiced by women is responsible for their better periodontal conditions. In Ceylon the better periodontal health in males is not due to better oral hygiene, as the difference between males and females is the same even when subgroups of the same OHI status are compared. Thus, there must be some factor, or factors, associated with life in Ceylon, as contrasted to life in USA and Europe, that are responsible for the higher prevalence of periodontal disease in females. In that respect vitamin deficiencies, malnutrition, betel consumption and racial factors should be considered.

The strong inverse correlation between PI scores and income (Tables IV and V) as well as years of formal education (Table VI) is in agreement with findings in many other countries. Most of the differences are accounted for by the better oral hygiene which is associated with higher income and education. But the fact, that a very considerable difference still remains in sub-

Table X

Average PI scores by age, oral hygiene and ethnic group: S=Sinhalese; T=Tamil; M=Moor; O=Others (mostly Europeans and some Americans). Males and females combined

AGE in years	OHI GROUPS																Total
	0.00—1.99				2.00—3.99				4.00—6.00				ALL OHI GROUPS				
	ETHNIC GROUPS				ETHNIC GROUPS				ETHNIC GROUPS				ETHNIC GROUPS				
	S	T	M	O	S	T	M	O	S	T	M	O	S	T	M	O	
13—19	0.52	0.42	0.48	0.36	1.26	1.07	1.53	1.22	2.10	1.76	1.70	—	0.92	0.74	0.74	0.52	0.86
	(1110)	(418)	(74)	(64)	(774)	(253)	(22)	(15)	(151)	(52)	(3)	—	(2035)	(723)	(99)	(79)	(2936)
20—29	0.69	0.75	0.69	0.41	1.89	1.66	1.81	1.12	3.51	3.05	3.97	—	1.58	1.51	1.42	0.57	1.55
	(1001)	(255)	(40)	(20)	(820)	(253)	(16)	(6)	(326)	(101)	(9)	—	(2147)	(609)	(65)	(26)	(2847)
30—39	1.36	1.04	1.11	0.56	2.87	2.55	2.50	1.57	4.76	4.10	4.34	—	3.47	2.91	3.22	1.07	3.26
	(160)	(84)	(5)	(3)	(317)	(214)	(10)	(3)	(408)	(197)	(16)	—	(885)	(495)	(31)	(6)	(1417)
40—49	2.10	1.75	0.63	0.48	3.47	2.94	3.60	4.36	5.31	5.01	4.85	3.04	4.50	4.29	4.08	2.63	4.40
	(35)	(19)	(1)	(1)	(111)	(66)	(4)	(1)	(244)	(190)	(7)	(1)	(390)	(275)	(12)	(3)	(680)
50 and over	3.42	5.52	—	—	4.67	4.34	5.83	—	5.93	5.83	5.58	—	5.38	5.54	5.63	—	5.45
	(30)	(11)	—	—	(23)	(25)	(1)	—	(138)	(105)	(5)	—	(191)	(141)	(6)	—	(338)
Total	0.71	0.69	0.58	0.37	1.92	1.90	2.04	1.36	4.36	4.29	4.30	3.04	1.97	2.16	1.63	0.62	1.99
	(2336)	(787)	(120)	(88)	(2045)	(811)	(53)	(25)	(1267)	(645)	(40)	(1)	(5648)	(2243)	(213)	(114)	(8218)

groups of very poor OHI status, indicates that factors which lower the resistance to local irritants are partly responsible for the inferior conditions in very poor people.

Betel consumption may be such a factor, as betel is more used among the lower than among the upper classes, and the unfavourable effect of this habit is obvious (Table IX). A poorer standard of oral hygiene explains to some extent the higher scores in the betel consumers, but betel, apparently, also has an effect of its own, as the betel consumers have more periodontitis than non-consumers, even when like is compared with like, as far as oral hygiene is concerned. This survey does not provide any clue as to the nature of this ill-effect.

The consistently *lower* PI scores in tobacco smokers than in non-smokers is most surprising at first glance (Table IX). However, the explanation is simple: the alternative to tobacco smoking is very often betel chewing. Therefore, the group of tobacco smokers has in its control group all the betel chewers, and conversely, the control group with whom the betel consumers are compared, contains most of the tobacco smokers.

Obviously, betel consumption is a more destructive factor than is tobacco smoking (Table VIII and IX), although some of the reason for the higher average scores in betel consumers than in tobacco smokers is due to poorer oral hygiene. In view of the fact that a number of surveys have documented a significantly higher prevalence of periodontitis in tobacco smokers than in non-smokers, it becomes quite clear that the effect of betel consumption is stronger than it appears from Table XIII.

The higher PI scores in lower than in higher income groups could partly, but not entirely, be explained as being due to poorer oral hygiene in the former (Table IV). There is good reason to believe that the remainder to an appreciable degree can be attributed to betel consumption, as this habit is particularly prevalent among the lower classes.

It was surprising that clinical signs of vitamin A deficiency were not associated with a concurrent increase in PI scores. Thus, the assumption that vitamin A deficiency is involved in the etiology of periodontitis, is not supported by this study. Conversely, it may be questioned whether the clinical criteria of vitamin A deficiency used here are diagnostic.

The higher PI scores in the group of persons with clinical signs of vitamin B deficiency than in the control group indicate an untoward effect of this condition. Some of the differences between the two categories can be explained as being due to poorer oral hygiene in the B deficiency group. But the fact that the differences are exaggerated when the oral hygiene is very poor (4.0—6.0) and nearly absent when the oral hygiene is very good (0.0—1.99) suggests a real effect. It appears as if vitamin B deficiency lowers the resistance to the local bacterial irritants.

If the clinical criteria of vitamin B deficiency used here in fact reflected a real deficiency state this survey probably represents the first substantial evidence in support of the view that vitamin B deficiency is involved in the etiology of periodontitis. Two previous surveys in Asiatic countries failed to demonstrate any association between periodontal conditions and urine levels of riboflavin and niacin.[15, 17] These surveys were based on unquestionable criteria as far as the diagnosis of the two vitamin deficiencies is concerned. Thus, it must be admitted that the importance of vitamin B deficiency is still uncertain.

Usually, vitamin deficiencies are not found alone but in combination with other nutritional deficiencies, and in some of the Ceylon populations obvious signs of malnutrition were common (Fig. 1). The very high proportion of females with clinical signs of malnutrition, and the rather convincing association between malnutrition and periodontal disease, offer an attractive explanation of the higher PI scores in females than in males. This assumption becomes even more likely when it is realized that most women, living under primitive conditions alternate between pregnancies and lactation periods throughout most of their reproductive life. Malnutrition under such conditions is likely to hit women harder than men.

The distribution of the material according to ethnic groups indicates a racial difference, but most, if not all, the difference between Europeans and the three other ethnic groups disappear when like is compared with like as far as OHI goes. This conclusion is supported by the direct comparison between populations in Ceylon and Norway (Fig. 3).

Accepting, for the time being, that the better conditions in Norwegians than in Ceyloneses are due to better oral hygiene, it

requires some consideration to explain the difference between Tamils and Sinhaleses who ethnically are closer to each other than to the Europeans. This difference cannot be due to better hygiene in the Tamils than in the Sinhaleses, as the difference becomes increasingly more pronunced as the oral hygiene deteriorates. The explanation is most likely that the majority of the Tamils lived in a fishing district (Jaffna) with ample supply of sea food, whereas a large proportion of the Sinhaleses lived inland under very poor nutritional conditions, including a very low intake of proteins and vitamins. Thus, the difference between the two population groups seems to be a reflection of nutrition rather then of race.

In the evaluation of the effect of socio-economic factors, vitamin B deficiency, betel consumption and race it was observed, that these variables had no strong effect in the group of good oral hygiene, whereas the effect was correspondingly aggravated in the groups of extremely poor oral hygiene. The combined effect of betel consumption, substandard nutrition and poor oral hygiene seems to explain the extremely high prevalence of periodontal disease in Ceylon. Betel chewing and poor nutrition reduce the resistance to local bacterial irritants. If the plaque is removed, there will be no periodontitis in spite of the lowered resistance. If the plaque is allowed to accumulate freely, its component microorganisms will cause more destruction due to the lowered resistance.

CONCLUSIONS

During the autumn of 1960 a periodontal survey was carried out in Ceylon under the auspices of WHO and the Government of Ceylon. A total of 5.248 males and 2.969 females, ranging in age from 13 to 60 and over, were examined. The periodontal index (Russell) and the simplified oral hygiene index (Greene and Vermillion) were used. Presence or absence of vitamin A and B deficiencies, as well as malnutrition, was diagnosed by medical officers; other auxilliary information was provided by health inspectors. Due to lack of funds and manpower significance tests were carried out only in a few combinations. However, since most of the associations seem to be strong, and since the

number of observations is rather large, the following conclusions seem to be justified:

1) The prevalence and severity of periodontal disease increases steadily with age. This is in agreement with many previous surveys.
2) The prevalence of periodontal disease is considerably higher in females than in males after age 20. This is in contrast to observation made in USA and Europe.
3) There is a strong association between socio-economic factors and PI scores, i.e., the PI scores go down as income and years of formal education go up.
4) Some clinical symptoms which were assumed to be the consequence of vitamin A deficiency, were not associated with higher PI scores. There are two explanations: Vitamin A may be of no consequence to periodontal health or, the clinical criteria, used in the present survey, may not be diagnostic.
5) Clinical signs of vitamin B deficiency were associated with higher PI scores. If the oral hygiene was good, the effect was moderate. If the oral hygiene was very poor, the effect was aggravated. The validity of the clinical criteria of vitamin B deficiency may be argued.
6) A large proportion of persons, particularly females, showed clinical signs of malnutritions. Signs of malnutritions were associated with high PI scores, and the effect was most pronounced in women.
7) The prevalence of periodontal disease is much hiher in betel consumers than in non-consumers. If the oral hygiene is good, the influence is negligible. As the oral hygiene deteriorates, the effect becomes steadily more apparent.
8) In contrast to observations made in USA and Europe tobacco smokers showed clearly better conditions than non-smokers. The explanation of this discrepancy appears to be that most of the betel consumers were non-smokers; thus they were placed in the control group of the smokers. Taking into account that the tobacco smokers, on the other side, were included into the control group of the betel chewers, there is reason to believe that the effect of betel chewing is even stronger than what appears from Table VII.

9) The lower average PI scores in Europeans than in Ceyloneses can mostly be attributed to better oral hygiene in the former. The difference between Sinhaleses and Tamils is most likely the consequence of better nutrition in the selected sample of Tamils.
10) Although direct comparisons cannot be done, the data compiled indicate that the periodontal conditions in Ceylon are comparable with those in other Asiatic countries. Limited direct comparisons indicate that conditions are much worse than in Norway.
11) The higher prevalence of periodontitis in Ceylon than in some Western countries can to a very considerable degree be explained as the consequence of poorer oral hygiene. But oral hygiene alone does not account for the whole difference; nor does it explain all of the differences between various socio-economic groups, between betel consumers and non-consumers and between males and females. It is suggested that betel consumption and malnutrition in some form or other, is responsible for this additional effect.
12) No case corresponding to the classical criteria of periodontosis was detected.

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SUMMARY

During the atumn of 1960 a periodontal survey was carried out in Ceylon undes the auspices of WHO and the Government of Ceylon. A total of 5.248 males and 2.696 females, ranging in age from 13 to 60 and over, were examined. The periodontal index, (Russell) and the simplified oral hygiene index (Greene and Vermillion) were used. Presence and absence of vitamin A and B deficiencies, as well as malnutrition, was diagnosed by medical officers, The prevalence and severity of periodontal disease increased steadily with age. The prevalence was considerably higher in females than in males after age 20. There was a strong association between socio-economic factors and PI scores, i.e., the PI scores go down as income and years of formal education go up.

Some clinical symptoms which were assumed to be the consequence of vitamin A deficiency, were not associated with higher PI scores. Clinical signs of vitamin B deficiency were associated with higher PI scores. If the oral hygiene was good, the effect was moderate. Signs of malnutritions were associated with high PI scores, and the effect was most pronounced in women. The prevalence of periodontal disease is much higher in betel consumers than in non-consumers. If the oral hygiene is good, the influence is negligible. The lower average PI scores in Europeans than in Ceyloneses can mostly be attributed to better oral hygiene in the former. The data compiled indicate that the periodontal conditions in Ceylon are comparable with those in other Asiatic countries. Limited direct comparison indicate that conditions are much worse than in Norway. The higher prevalence of periodontitis in Ceylon than in some Western countries can to a very considerable degree be explained as the consequence of poorer oral hygiene; but betel consumption and malnutrition in some form or other may be responsible as well. No case corresponding to the classical criteria of periodontosis was detected.

RÉSUMÉ

LA FRÉQUENCE GLOBALE DES PARODONTOPATHIES A CEYLAN

Au cours de l'automne 1960, une enquête sur les parodontopathies a été faite à Ceylan sous les auspices de l'OMS et du gouvernement de Ceylan. Les examens ont été faits sur un total de 5248 sujets du sexe masculin et 2969 sujets du sexe féminin, âgés de 13 ans à 60 et plus. L'indice parodontal (PI) (Russell) et l'indice simplifié d'hygiène bucco-dentaire (Greene et Vermillion) ont été utilisés. La présence et l'absence des carences en vitamines A et B, ainsi que les états de sous-alimentation ou de déséquilibre alimentaire ont été diagnostiqués par des fonctionnaires médicaux. La fréquence globale des parodontopathies et

leur gravité augmentaient régulièrement avec l'âge. A partir de l'âge de 20 ans, cette fréquence était beaucoup plus élevée chez les femmes que chez les hommes. Il existait une forte corrélation entre les facteurs socio-économiques et les valeurs de l'indice parodontal, en ce sens que les valeurs de l'PI diminuaint lorsque le revenu et le nombre d'années consacrées à l'instruction augmentaient. Quelques symptômes cliniques considérés comme étant la conséquence d'une carence en vitamine A apparaissaient sans être associés à une augmentation d esvaleurs de l'PI. Les symptômes cliniques de carence en vitamine B étaient associés à une augmentation des valeurs de l'PI. Lorsque l'hygiène bucco-dentaire était satisfaisante, cette action était modérée. Les symptômes de sous-alimentation ou de déséquilibre alimentaire étaient associés à une augmentation des valeurs de l'PI, et cette action était particulièrement marquée chez les femmes. La fréquence globale des parodontopathies était beaucoup plus élevée chez les sujets faisant usage du bétel que chez ceux qui n'en faisaient pas usage. Lorsque l'hygiène bucco-dentaire était satisfaisante, cette influence était négligeable. Le fait que la moyenne des valeurs de l'PI était moins élevée pour les Européens que pour les Ceylanais peur surtout être attribué à la meilleure hygène bucco-dentaire des Européens. Les renseignements recueillis indiquent que les conditions parodontales à Ceylan sont comparables à celles qu'on trouve dans les autres pays d'Asie. Une comparaison directe limitée indique que les conditions sont beaucoup plus mauvaises qu'en Norvège. Le fait que la fréquence des parodontopathies est plus élevée à Ceylan que dans certains pays occidentaux peut dans une large mesure être expliqué comme la conséquence d'une hygiène bucco-dentaire plus déficiente; mais on peut également en imputer la responsabilité à l'usage du bétel et à la sous-alimentation ou aux déséquilibres alimentaires sous une forme quelconque. On n'a décelé aucun cas correspondant aux descriptions classiques de la parodontose.

ZUSAMMENFASSUNG

AUSBREITUNG DER PERIODONTALEN ERKRANKUNGEN IN CEYLON

In Herbst 1960 wurde in Ceylon eine periodontale Untersuchung unter Leitung der WHO und der Regierung von Ceylon gemacht. 5248 Männer und 2969 Frauen im Alter von 13 bis

60 Jahren und darüber wurden untersucht. Der periodontale Index (Russell) und der vereinfachte Mundhygienenindex (Oral Hygiene Index, Greene und Vermillion) wurden benutzt. A- und B-Avitaminosen, Vorhandensein bezw. Nichtvorhandensein, sowie schlechte Ernährung wurde von den Aerzten diagnosiziert. Die Ausbreitung und die Ernsthaftigkeit der periodontalen Krankheiten nehmen mit steigendem Alter zu. Die Ausbreitung war bedeutend höher bei Frauen als bei Männern über 20 Jahre. Es bestand eine starke Verbindung zwischen sozialwirtschaftlichen Faktoren und PI-Punkte, d. h., die PI-Punkte sinken, wenn Einkommen und Zeit der Ausbildung zunehmen. Einige klinische Symptome, die als Folge von A-Avitaminose angenommen wurden, waren nicht mit höheren PI-Punkten verbunden. Klinische Zeichen auf V-Avitaminose waren mit höheren PI-Punkten verbunden. War die Mundhygiene gut, war die Wirkung mittelmässig. Zeichen von Unterernährung waren mit hohen PI-Punkten verbunden, und die Wirkung war am deutlichsten bei Frauen. Die Ausbreitung von periodontalen Leiden ist viel grösser bei Leuten, die Betel kauen, als bei denen, die es nicht tun. Ist die Mundhygiene gut, ist die Wirkung von Betel ohne Bedeutung. Dass die Europäer in Durchschnitt niedrigere PI-Punkte als die Ceylonesen haben, kann von der besseren Mundhygiene der Ersten herrühren. Das gesammelte Material zeigt, dass periodontale Verhältnisse in Ceylon mit denen in anderen asiatischen Ländern verglichen werden kønnen. Begrenzte, direkte Vergleiche zeigen viel schlechteree Verhältnisse als in Norwegen. Die stärkere Ausbreitung von Parodontitis in Ceylon als in einigen westlichen Ländern, kann zu einem gewissen Grad als das Ergebnis schlechter Mundhygiene erklärt werden. Das Kauen aber, von Betel oder schlechte Ernährung in der eine oder anderen Form kann für diese zusätzliche Wirkung auch verantwortlich sein. Kein Fall, der mit den klassischen Kriterien der Paradontose übereinstimmt, wurde entdeckt.

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