

Incidence of dental caries among a group of university students in Turku

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Scheinin, U. Incidence of dental caries among a group of university students in Turku. A longitudinal study. *Acta Odont. Scand.* 32, 335—344, 1974.

The aim of the present study was to estimate the incidence of dental caries in a group of university students during a 4-year interval between registrations. Eventual differences in the periodontal and oral hygiene conditions were also examined. In addition, the reasons for high prevalence of caries in freshmen were investigated. The material consisted of 116 students, initially examined clinically and radiographically in 1967, and later in 1971. The amount of untreated caries diminished from originally 15.0 to 9.9 decayed surfaces per student. Untreated caries was constantly less frequent among females than males. The caries incidence was 1.9 surfaces per year which corresponds to previous estimations of the caries increment in Finland. An improvement in the gingival conditions, eventually due to the decrease of untreated carious lesions, was registered. The difference between mean PII-values in 1967 and 1971 was not significant. Classification in subgroups according to gingival and oral hygiene conditions showed, however, that the group possessing poor oral hygiene conditions diminished in size. The indices of GI and PII were higher among males than females.

The poor dental conditions among the freshmen could be attributed to a mean of 6.4 years since the termination of previous regular dental treatment.

Key-words: dental caries; dental plaque; gingivitis; dental records; community health services; public health dentistry

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The dental and oral conditions of 394 freshmen were examined in 1967 at the University Student Health Center in Turku (Scheinin *et al.*, 1970). Particular emphasis was placed on estimating the need and time required for comprehensive dental treatment. It was thus observed that the students had an average of 13.6 tooth surfaces requiring fillings, and an average of 0.3 teeth requiring endodontic treatment. Gingivitis ($GI \geq 0.20$) was found in 86.8 % of the students. Oral hygiene was poor or mediocre ($PII \geq 0.40$)

in 89.6 %, whilst in only 10.4 % was it estimated to be good.

The average treatment time was estimated to exceed 7 hours per student, about 5 hours being reserved for operative procedures and root canal treatments, and about 1 hour for removal of dental plaque and calculus and patient motivation. The remaining treatment time was reserved for orthodontic, surgical and prosthetic treatment procedures. The present longitudinal study was carried out as a supplement to the previous transversal investiga-

tions (Scheinin *et al.*, 1970ab). The purpose was to estimate the incidence of dental caries in a group of university students during the period from 1967 to 1971, and also to observe the eventual differences in the periodontal and oral hygiene conditions. The purpose was also to clarify the reasons for the very high prevalence of dental caries among the students at the beginning of their university studies.

MATERIAL AND METHODS

Of the 394 students examined in 1967 208 were still studying during the spring term in 1971. A questionnaire concerning the dental treatment received prior to 1967 was mailed to all the above (208) students.

A reply was received from 159 persons, of which 120 also came to a separately arranged dental examination. Of the students thus examined 116 were included in the final material. The four students excluded from the final material after coming to the re-examination had mistakenly received the invitations of participants examined in 1967 with coincidentally the same name.

An analysis performed in order to examine eventual differences between the present sample consisting of 116 students and the rest (278) of the total material (394) included in the initial phase of the study, did not reveal a significant difference between the materials in any of all variables studied. The present material comprised 63 male and 53 female students, their mean age being 24.8 years. The age distribution is shown in Table I. The examinations were carried out at the Institute of Dentistry, University of Turku. In addition to the clinical registration of dental caries and estimation of the plaque

Table I. *Distribution of the material*

Sex	Age in years					Total
	23	24	25	26	27—30	
Female	1	30	15	2	4	53
Male	2	15	15	23	9	63
Total	3	45	30	25	13	116

(PII) and gingival indices (GI), bite-wing radiographs were taken of all participants.

The indices DMF, DMFS, DS and DS_S were used as in the previous study for caries registration (Table II), DS indicating primary and DS_S secondary carious tooth surfaces. Enamel caries was registered separately. Wisdom teeth were not included in the estimations.

The Gingival Index (GI) was calculated according to *Löe & Silness* (1963) and the Plaque Index (PII) according to *Silness & Löe* (1964) from four surfaces of six teeth (16, 12, 24, 36, 32, 44). The PII and GI were calculated as individual mean values on a tooth surface bases. In cases of missing teeth other were not employed in calculating the indices.

The additional carious lesions, detected only by radiographic means, were recorded. The completed registration cards were then compared to the corresponding entries in 1967. Based on this comparison the new decayed surfaces after 1967 (C_N), the new fillings in lesions detected earlier (ΔF_{C+}), and the new fillings in lesions developed after the previous 1967 examination (ΔF_{C+}) were separately recorded. Note was made of all extractions occurring after 1967 with the exception of wisdom teeth.

The following information was requested through the questionnaire mailed to the students:

1. Regularity of dental treatment received through the community supported grammar school dental program.

2. Type and frequency of dental treatment received following the subsidized program, mentioned above.
3. Date of last treatment prior to the 1967 inspection.

Table II. *Indices used*

$\Delta DMF + \Delta Rtg^{DMF}$	Decayed, missing and filled teeth + clinically undetected radiographic findings
$\Delta DMFS + \Delta Rtg^{DMFS}$	Decayed, missing and filled teeth surfaces + clinically undetected radiographic findings
$DS + \Delta Rtg^{DS}$	Clinically diagnosed primary caries + radiographic findings
$DS_s + \Delta Rtg_s^{DS}$	Clinically diagnosed secondary caries + radiographic findings
$C_I + \Delta Rtg^{CI}$	Clinically or radiographically diagnosed incipient caries (enamel lesions)
$C_{II} + \Delta Rtg^{CII}$	Clinically or radiographically diagnosed carious lesions per surface reaching the dentin
C_N	New carious surface which has appeared since the time of the last examination
ΔF_{C+}	A restoration which replaces a primary or secondary caries positively diagnosed at the previous examination
ΔF_{C-}	A restoration placed at an area which was caries free at the previous examination
MT_N	A tooth extracted after the previous examination

In addition, at the clinical re-evaluation the dental treatment between the years 1967 and 1971 was clarified.

RESULTS

The means and the standard deviations of the caries indices are shown in Table IIIa for the total material (116) tabulated separately for 1967 and 1971. The material is also divided according to sex. The total number of decayed teeth and tooth surfaces is based on the sum of the separately recorded clinically and radiographically detected lesions. The increase of the mean DMF-index of the whole material during the 4 years between inspections was 1.3 teeth, and the corresponding increase of DMFS-index was 7.4 tooth surfaces per student. The yearly increment was thus 1.9 DMF-surfaces.

The values for the DMF- and DMFS-indices, were in the present material slightly higher for males than females, but the difference was not statistically significant.

An examination of the total caries experience ($DS + \Delta Rtg^{DS} + DS_s + Rtg_s^{DS}$) revealed that the amount of untreated caries had diminished during the inspections. (In the present material 15.0 decayed surfaces were found in 1967, whilst in 1971 9.9 carious surfaces were recorded). The decrease was 5.1 tooth surfaces, the difference being statistically highly significant (Table IIIb). Untreated caries was still less frequent among females than males; the difference between females and males in this respect was statistically significant (Table IIIb).

When subtracting the 4.1 surfaces with lesions restricted to enamel only from the total of 9.9 decayed surfaces found in 1971, it appeared that 5.8 surfaces per student unconditionally required

Table IIIa. *The mean values and standard deviation for the caries indices according to year of examination and sex*

	Males 1967*		1971		Females 1967*		1971		1967*		Total 1971		$\bar{x}_{71} - \bar{x}_{67}$
	\bar{x}	S.D.k	\bar{x}	S.D.k	\bar{x}	S.D.k	\bar{x}	S.D.k	\bar{x}	S.D.k	\bar{x}	S.D.k	
DMF + ΔRtg^{DMF}	16.65	4.15	18.32	4.0	17.11	4.32	18.02	4.56	16.86	4.21	18.18	4.23	1.32
DMFS + ΔRtg^{DMFS}	34.57	12.87	43.08	14.27	35.23	14.33	41.26	16.09	34.87	13.50	42.25	15.09	7.38
DS + ΔRtg^{DS}	14.13	7.59	9.03	7.73	10.93	5.50	6.11	4.18	12.66	6.88	7.70	6.50	-4.90
DS _s + ΔRtg_s^{DS}	2.38	2.61	2.41	3.16	2.26	2.09	1.85	2.36	2.33	2.37	2.16	2.82	-0.17
DS + ΔRtg^{DS} + DS _s + ΔRtg_s^{DS}	16.51	8.39	11.44	8.24	13.19	5.78	7.96	5.38	14.99	7.47	9.85	7.26	-5.14
DS + DS _s	12.94	7.47	7.54	6.83	10.42	5.26	5.15	4.56	11.78	6.65	6.45	6.00	-5.33
ΔRtg^{DS} + ΔRtg_s^{DS}	3.57	2.98	3.91	3.04	2.77	2.67	2.81	3.01	3.21	2.86	3.41	3.06	0.20
C _I + ΔRtg^{CI}	4.86	3.25	4.46	4.39	4.89	2.79	3.64	2.50	4.87	3.03	4.09	3.66	-0.78
C _{II} + ΔRtg^{CII}	11.65	7.84	6.98	5.69	8.30	4.99	4.32	4.27	10.12	6.87	5.77	5.24	-4.35
C _N			6.81	7.24			4.72	3.34			5.85	5.86	
ΔF_{C+}			5.76	4.53			5.17	3.32			5.49	4.02	
ΔF_{C-}			1.51	1.41			1.91	1.80			1.69	1.61	
CN + ΔF_{C-}			8.32	7.14			6.62	4.14			7.54	6.00	
ΔF_{C+} + ΔF_{C-}			7.27	5.09			7.08	3.95			7.18	4.59	
MT _N			0.29	0.85			0.13	0.34			0.22	0.67	

* The values for the 1967 examination cover only the material re-examined in 1971.

Table IIIb. *Significance level of differences between caries indices*

	Between males and females in 1971	Between total results in 1967 and 1971
DMF + Δ Rtg ^{DMF}	..	xxx
DMFS + Δ Rtg ^{DMFS}	..	xxx
DS + Δ Rtg ^{DS}	x	xxx
DS _s + Δ Rtg _s ^{DS}
DS + Δ Rtg ^{DS} + DS _s + Δ Rtg _s ^{DS}	xx	xxx
DS + DS _s	x	xxx
Δ Rtg ^{DS} + Δ Rtg _s ^{DS}
C _I + Δ Rtg ^{CI}	..	x
C _{II} + Δ Rtg ^{CII}	xx	xxx
C _N	..	
Δ F _{C+}	..	
Δ F _{C-}	..	
C _N + Δ F _{C-}	..	
Δ F _{C+} + Δ F _{C-}	..	
MT _N	..	

.. no statistical difference
 x almost significant difference ($p \leq 0.05$)
 xx significant difference ($p \leq 0.01$)
 xxx highly significant difference ($p \leq 0.001$)

filling ($C_{II} + \Delta$ Rtg^{CII}, Table IIIb). The corresponding value in 1967 for the same material was 10.1 surfaces, when counting only the dentinal lesions. The difference was statistically highly significant (Table IIIb). In 1967 enamel caries was found as an individual average on 0.8 more

surfaces than in 1971. The difference was almost significant (Table IIIb).

Table IIIa includes, according to FDI-recommendations (Baume, 1962), the new decayed surfaces (C_N), and the new fillings ($\Delta F_{C+} + \Delta F_{C-}$) recorded in 1971. The definitions of these subindices are found in the section »Material and methods».

Decayed surfaces and the number of fillings were considered as being of equal value in the combined indices.

The number of new decayed surfaces (C_N) being 5.9 per student and the number of fillings in lesions developed after 1967 (ΔF_{C-}) being 1.7, the total number of decayed surfaces developed during the 4-year interval between the two examinations was 7.6 surfaces, i.e. 1.9 surfaces per year.

The additional radiographic findings were slightly more frequent in 1971 than in 1967 (Table IIIa), but the difference was not statistically significant (Table IIIb). The ratio between caries detected only radiographically and total caries experience was clearly higher in 1971 than in 1967. Secondary caries was found less in 1971 than in 1967, but the difference was not statistically significant (Table IIIb).

The number of extracted teeth between the two examinations was 0.2 teeth per student. A total of 25 teeth were extracted, 7 of these for orthodontic reasons. The number of extracted wisdom teeth was not counted in the present study.

The indices of GI and PII are shown in Table IVa. The mean GI of the total material was lower in 1971 than in 1967, the difference being highly significant ($p \leq 0.001$). On the other hand, the slight decrease in the mean PII was only indicative ($p=0.2$). The values for GI and PII were higher among males than females. The difference between males and females was highly significant ($p < 0.001$)

Table IVa. *Gingival and plaque indices according to year of examination and sex.*

	Males				Females				Total			
	1967*		1971		1967*		1971		1967*		1971	
	\bar{x}	S.D.k	\bar{x}	S.D.k	\bar{x}	S.D.k	\bar{x}	S.D.k	\bar{x}	S.D.k	\bar{x}	S.D.k
GI	0.72	0.40	0.56	0.29	0.47	0.39	0.27	0.22	0.61	0.41	0.42	0.30
PII	0.93	0.37	0.85	0.28	0.68	0.31	0.68	0.32	0.81	0.37	0.77	0.31

* The values cover the material reexamined in 1971

× × ×¹⁾ highly significant difference between males and females

× × ×²⁾ significant difference between males and females

× × ×³⁾ highly significant difference between the results for 1967 and 1971

..⁴⁾ no statistical difference between the results for 1967 and 1971

Table IVb. *The distribution of the students according to the gingival conditions and the oral hygiene 1967* and 1971*

GI	Healthy		Gingivitis		Severe gingivitis	
	0.00—0.19		0.20—0.99		1.00—	
	1967	1971	1967	1971	1967	1971
	52 (13.2 %)	28 (24.2 %)	294 (74.6 %)	84 (72.4 %)	48 (12.2 %)	4 (3.4 %)
PII	Good		Moderate		Poor	
	0.00—0.39		0.40—0.99		1.00—	
	1967	1971	1967	1971	1967	1971
	41 (10.4 %)	14 (12.1 %)	206 (52.3 %)	78 (67.2 %)	147 (37.3 %)	24 (20.7 %)

* The numbers for the 1967 cover all material examined in 1967

with regard to GI, and significant ($p < 0.01$) for PII (Table IVa).

The material was divided into groups according to gingival and oral hygiene conditions (Table IVb). A good oral hygiene level was found in only 12.1 %. In 1967 the corresponding value for the whole material was 10.4 %.

Table V shows the correlation coefficients between the various indices. The correlation between GI and PII was highly significant ($r = 0.643$). On the

other hand no correlation was found between the GI and PII and the DMF and DMFS-indexes.

A positive correlation was found between GI and total caries ($DS + \Delta Rtg^{DS} + DS_s + \Delta Rtg_s^{DS}$), clinically detected caries ($DS + DS_s$), and particularly dentine caries ($CII + \Delta Rtg^{CII}$). These correlations were statistically significant ($P < 0.01$). The correlations between PII and the subindices for caries were stronger. The correlation to dentine caries ($C_{II} + \Delta Rtg^{CII}$) was thus

Table V. Correlation coefficients between the GI and PII and other variables

GI	DMF + ΔRtg_{DS}^{DMF}	DMFS + ΔRtg_{DS}^{DMFS}	DS + ΔRtg_{DS}	DS _s + ΔRtg_{DS_s}	CI + ΔRtg_{CI}	CII + ΔRtg_{CII}	DS + ΔRtg_{DS} DS _s + ΔRtg_{DS_s}	DS + ΔRtg_{DS} DS _s + ΔRtg_{DS_s}	DS + ΔRtg_{DS} DS _s	$\Delta Rtg_{DS}^{DS} + \Delta Rtg_{DS_s}^{DS}$	C _N
PII 0.643	-0.016	-0.046	0.224	0.211	0.127	0.303	0.282	0.220	0.238	0.269	
× × ×	×	×	..	× × ×	× ×	×	× ×	× ×	× ×
GI	0.052	0.029	0.202	0.145	0.126	0.240	0.237	0.230	0.111	0.195	
..	×	× ×	× ×	×	..	×	×

.. not significant × almost significant × × significant × × × highly significant

Table VI. Previous dental care

Grammar school care		
Regular grammar school care	91	60%
Sporadic grammar school care	47	30%
Private dental care	16	10%
	154	100%

Care following school dental program		
Regular dental care		
Twice a year	9	} 68 44%
Once a year	37	
Every other year	22	
Sporadic dental care	83	} 86 56%
No dental care	3	
	154	100%

Table VII. Student dental visits during the years between the study examinations (1967-1971)

Regular dental care			
Group A	at intervals	23	} 95 82%
	Teeth fully cared for on one occasion	72	
Group B	Sporadic acute care	15	
	No dental care	6	
		116	116 100%

highly significant ($P < 0.001$), and significant ($P < 0.01$) to additional radiographic findings ($\Delta Rtg_{DS}^{DS} + \Delta Rtg_{DS_s}^{DS}$), new caries (C_N) and total caries experience.

The completed questionnaires, 154 of which were approved, showed that regular school dental treatment was obtained by 60 %, the value for sporadic care being 30 % of the total material (Table VI). Treatment through private practitioners was obtained by 10 %. In 1967, when the first inspection in the present series was carried out, 8 to 16 years, depending on the year of birth of the examinee, had elapsed since the grammar school dental treatment mentioned above. One student had received community supported dental treatment until high school level, 5 years having elapsed since treatment. Regular

dental care following school dental treatment had been carried out in 44 %. The frequency of the treatment appears in Table VI. In 56 % of the cases no treatment or occasional procedures only were carried out. Based on the information given by the students it appears that in 1967 a mean of 6.4 years had elapsed since the termination of regular dental treatment.

The 116 students attending the re-examination in 1971 received dental treatment between 1967 and 1971 as indicated in Table VII. Six students had not visited a dentist at all and 15 had received only occasional treatment. These 21 cases formed the »untreated» group B. The »treated» group A was composed of those receiving regular treatment and those who received full treatment at least once between the inspections.

DISCUSSION

Despite the fact that the sample in 1971 was found to be unselected with regard to the initial conditions, statistically valid conclusions cannot be made concerning the development of the dental conditions in the whole previously examined student group. This is due to the loss of material, which in relation to the studies carried out in 1967 exceeded 50 per cent. The present results thus cover those 116 students attending a second series of examinations, and can only be considered as indicative with regard to the rest of the material.

The statistical calculations have been performed by using parametric tests in order to render a comparison with the previously examined material possible. The use of parametric tests also seems justified with regard to the various indices expressing dental caries, particularly as the values for the present material, due

to its homogeneity, were found to approximate a normal distribution.

Examining the results with regard to the DMFS-index, it was noted that the initial value in 1967 was 34.9 the mean age being 20.8 years. Those results verify the findings of *Ainamo & Holmberg* (1973) with regard to the number of decayed, missing and filled tooth surfaces in Finnish conscripts (DMFS \bar{x} 36.7). In their study the DMFS-index of the 18 conscripts having attended secondary school or studied at a university was even closer to the corresponding value of the student material (\bar{x} 34.1).

In the 1971 examinations of the present study the mean DMFS-index was 42.3. This means that the number of decayed, missing and filled tooth surfaces had increased by 1.9 surfaces per year and individual. It should be noted, however, that the DMFS-index does not reflect the number of secondary carious tooth surfaces.

On the other hand, carrying out the calculations on the basis of the number of the new carious surfaces (C_N) and the new fillings (ΔF_{C-}) an almost identical increase in the incidence of DF-surfaces (decayed, filled surfaces) is attained, the result differing only as to the second decimal which is not shown here. It should be noted however, that the number of extracted teeth is not considered in this calculation. Taking these in account the mean individual index on the tooth surface basis will raise by 0.22 surfaces per year. In addition, it should also be noted that the present comparison is not fully exact as the new fillings (ΔF_{C-}), but not the new filled surfaces were considered as measuring units. This was done in purpose to eliminate the larger error due to fillings appearing on intact surfaces for retentive reasons. Despite these limiting factors and partial inaccuracy the result with regard to

the incidence of dental caries in the present student sample comes close to previous estimations of an increase of 2 DMF-surfaces per person and year in a Finnish population up to the age of 40 years (*Committee of Dental Manpower, 1965*). The amount of untreated decay ($DS + \Delta Rtg^{DS} + DS_s + \Delta Rtg_s^{DS}$) decreased by roughly one third between the years 1967 and 1971. A decrease was noted particularly for dentinal caries ($C_{II} + \Delta Rtg^{CII}$), which diminished almost by one half (Table IIIa).

An improvement of the oral hygiene conditions cannot be stated to have occurred on the basis of the slight improvement of the mean value of the PII. In females the mean value of the PII remained the same (Table IVa). The distribution into subgroups shows, however, that the group possessing poor oral hygiene conditions diminished in size (Table IVb).

It does not seem justified to indicate changes in oral hygiene in studies of the present nature by only mean PII-values. More appropriately these could be described by frequency distributions on a tooth surface basis.

The statistically highly significant decrease in the mean GI-value might be attributed to the filling of untreated carious cavities which reduces the number of severe gingivitis (*Scheinin et al., 1970; Ainamo, 1971*). The same phenomenon is observed in the distribution of gingival inflammation, where the percentage of cases with severe gingivitis is decreased, and the number of healthy cases correspondingly increased.

No correlations were found between the GI- and PII-values when compared to the means of the DMF- and DMFS-values. Here it should be recognized that these indices also include fillings and tooth

extractions. Hence correlations are unexpected due to the nature of these combined indices. The indices related solely to dental caries show a positive correlation to the mean GI- and PII-values. The correlation between PII and the various caries indices were stronger than the corresponding values for the GI. This finding is at variance with the observation of the previous study (*Scheinin et al., 1970*), where stronger correlations were found between the caries indices and the GI- than the PII-values. On the other hand, the present results differ from the earlier ones with regard to a clearly lower prevalence of untreated dental caries.

For obvious reasons an attempt was made to keep the evaluation »criteria» in the 1971 examinations as similar as possible to those in 1967. Duplicate determinations were not possible in 1971 as it was difficult to persuade the students to come to even one examination. With regard to the reliability of the results it should be mentioned that the methodical error involved cannot be estimated by the ratio between clinically and only radiographically detectable lesions at the 1st and 2nd examinations particularly as the proportion of clearly detectable dentinal lesions greatly diminished during the time interval between the inspections. It should be noted, however, that the number of additional radiographic findings remained almost unchanged.

The poor dental conditions in the 1967 study might be attributed to the lack of regular dental treatment during a mean period of 6.4 years. This in turn is partly related to a shortage of dental treatment services. The improved seeking out of treatment after 1967 might be related partly to the improved services and partly to the dental examinations carried out in the beginning of the university studies.

On this occasion the students got a precise description of their dental conditions.

Interesting features for special analysis of some of the variables included in the study are seen in the group of 21 students who despite the inspection totally or almost totally neglected their dental treatment between 1967 and 1971. It was found that the negligence was not due to particularly good dental conditions. On the contrary clearly higher values with regard to the number of decayed surfaces were observed. A detailed comparison between the groups will be carried out separately.

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