Dental caries, visible plaque, and gingival bleeding in young adult Danes in alternative dental programs

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Schwarz E. Dental caries, visible plaque, and gingival bleeding in young adult Danes in alternative dental programs. Acta Odontol Scand 1989;47:149–157. Oslo. ISSN 0001-6357.

From 16 to 19 years of age three groups of young adults received alternative dental programs on termination of the Public Child Dental Health Service (PCDHS) in different municipalities: public group, $n = 386$; mixed group, $n = 161$; and private group, $n = 261$. Dental caries status at the start of the study was assessed from the standard PCDHS records, and caries, plaque, and gingivitis were examined in an epidemiologic survey at the end. Caries experience at 16 years was 11.6 DMFS, highest in the mixed group and increased in all groups during the study. Initial placement in caries severity zones did not change. Visible plaque index (VPI) and gingival bleeding index (GBI) showed that plaque and gingival bleeding were present in most subjects, but rather few surfaces were affected. Association between gingival bleeding and non-use of dental services was found. Overall, it is concluded that none of the alternative programs differed from each other in having measurable effects on the oral health status. □ *Dental care; dental health services; periodontal diseases; public health dentistry*

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For more than a decade Danish children have been offered free, preventive and curative dental care in the Public Child Dental Health Service (PCDHS). A continuous decrease in dental caries in children has been recorded over the years by means of a uniform epidemiologic recording system (1–3). In the middle of the 1970s discussions arose on the feasibility of prolonging the child dental health program into young adulthood, to improve utilization of dental services and maintain the dental health results from the PCDHS. On termination of the PCDHS the young adults have therefore been offered dental services in the adult dental services with private dental practitioners under a special Young Adult Dental Program under the National Health Insurance (NHI) (4, 5).

The present longitudinal study was initiated to evaluate the feasibility of alternative dental programs for young adults in terms of their influence on dental health status, utilization of dental services, and amount and character of dental service items.

The purpose of the present report is to describe the dental caries status at age 16 years in terms of DMFS and caries severity zones in three young adult populations and, in a sample of these populations, to relate the initial dental caries status with status at age 19 years, and, further, to describe plaque and gingival status at age 19 years and to relate this to utilization of dental services and to self-assessment of the gingival status.

Materials and methods

Study population

On termination of the PCDHS, three groups of young men and women about 16 years old from three different municipalities in the vicinity of Copenhagen continued in different dental programs until about 19 years.

Group I ($n = 386$) continued in the framework of the accustomed PCDHS and had free preventive and curative services offered from age 16 through 18. Here this group will be termed *public*.

Group II ($n = 161$) could choose any private dentist, but the program was admin-

istered by the PCDHS, which sent out reminders for dental visits. The preventive and curative services were free of charge to the participants. The expenses were covered by the NHI and the municipality in common. This group will be termed *mixed.*

Group III ($n = 261$) entered the general countrywide Young Adult Dental Program, in which they could choose among the private dentists and have free dental examinations. For most of the services rendered they paid 25% themselves, and the NHI covered the rest. This group will be termed *private.*

To control the composition of the study populations, two conditions were determined: 1) The young adults should have attended the child dental health service in the respective municipalities during their whole school period (grade 1 through 9); and 2) The young adults should reside in their respective municipalities during the whole study period. The duration of the study was 4 years, during which time the last participant reached the age of 19 years. At this stage the public and the mixed groups entered the general Young Adult Dental Program that the private group had followed all the time.

Collection of dental health data

At the start of the study the total number of decayed, missing, and filled surfaces and surfaces at risk was obtained from the record of each individual in the PCDHS.

Simultaneously, the caries severity zone was recorded by means of the hierarchical classification described by Poulsen & Horowitz (6). In summary, the system uses six zones in accordance with the location of caries: 5 = proximal surfaces of mandibular anterior teeth (excluding distal surfaces of cuspids); 4 = labial surfaces of maxillary and mandibular incisors and cuspids; 3 = proximal surfaces of maxillary anterior teeth (excluding distal surfaces of cuspids); 2 = proximal surfaces of molars and premolars (including distal surfaces of cuspids); 1 = pit and fissure surfaces of posterior teeth; and 0 = none of the above. Every 10th record was re-examined to check the reliability of information transferral, and in less than 5% of the cases mistakes had occurred.

At the end of the study, 3 years later, it was decided to perform an epidemiologic survey of a sample of each group. About 125 individuals were randomly sampled from each group. By mail, they were asked to participate in the survey, and a date was proposed for a dental examination in their home, which was later reconfirmed by phone. Home visits took place approximately at the time when the individual was about to leave the program in question—that is, about the 19th birthday. A rather large proportion of the examinees were

Table 1. Study population in each dental program and sampling for the epidemiologic survey

	Dental program			
	Public	Mixed	Private	Total
Study population, *n*	386	161	261	808
Sample for epidemiologic survey, *n*	126	107	118	351
Moved before examination, *n*	9	8	2	19
Final sample, *n*	117	99	116	332
Not accessible	8	16	10	34
Did not want to participate	23	24	18	65
Persons examined, *n*	86	59	88	233
Percentage of final sample	73.5	59.6	75.9	70.1

visited repeatedly, until examination could take place, or a refusal was noted. Before the field survey the calibration was carried out with an experienced caries epidemiologist on a group of young adults of the same age as the study participants. One week later the same subjects were re-examined by the author. Both inter- and intra-examiner consistency was more than 95%.

Dental caries was recorded in accordance with criteria given by Møller (7) and Møller & Poulsen (8), which were also the basis for the recording system (1). Enamel caries with loss of substance (D2), dentin involvement (D3), and probable pulp complication (D4) was recorded. If caries or a filling was judged to originate from a pit or a fissure (first and second molars), this was counted as belonging to the occlusal surface of the tooth. Portable equipment was used: fiberoptic light (Guest), disposable mirrors (Mirodent), and probes (Maillefer). Third molars were excluded. Transillumination was not performed with the fiberoptic light, and the teeth were not dried. A score for caries severity zone was calculated in accordance with the criteria given above. At a later stage the recordings from the field survey were compared with the recordings from the same individuals 3 years earlier, and very few inconsistencies were noted.

Visible plaque index (VPI) and gingival bleeding index (GBI) were recorded in accordance with criteria given by Ainamo & Bay (9) and Ainamo (Personal communication). In summary, both indices are dichotomous, visible plaque and gingival bleeding being scored only if present. Unilateral examination (right and left side alternately) was used, and the facial, mesial, and lingual surfaces were examined on each tooth, resulting in a maximum of 42 potential examination sites (7 teeth × 3 examination points × 2 jaws). The WHO periodontal probe was used for the examination. VPI and GBI scores are presented as percentages, calculated in this manner:

$$\frac{N \times 100}{S}\ \%,$$

where N = number of examination sites with a positive VPI/GBI score (score 1), and S = number of sites examined.

Utilization of dental services—social background

Utilization of dental services was recorded continuously during the study, which has been described in detail elsewhere (10). For this analysis utilization was dichotomized into users and non-users. In accordance with Antoft (4), users comprise a) regular users who continue to participate in the Young Adult Dental Program directly after termination of the PCDHS and b) irregular users who alternately enroll and discontinue participation in the program. Non-users comprise a) dropouts who discontinue for good after a period of enrollment in the program and b) persons who never enroll or participate after termination of the PCDHS. Social background was assigned according to father's occupational status (5 groups) as

Table 2. Mean DMFS scores at start of study, their components, and mean number of tooth surfaces at risk in dental program

	Dental program			
	Public (n = 386)	Mixed (n = 161)	Private (n = 261)	Total (n = 808)
DMFS	11.06**	13.79**	11.06	11.59
D	0.03	0.01	0.0	0.01
M	0.30	0.31	0.10	0.23
F	10.73**	13.47**	10.95	11.35
Surfaces	124.15	124.71	125.74	125.35

** $p < 0.01$.

earlier described (10). In this analysis, social background was dichotomized into high (groups 1 + 2) and low (groups 3 + 4 + 5).

Self-assessment of gingival status

In a questionnaire mailed to the participants at the end of the study one of the questions dealt with self-assessment of gingival health. The respondents were asked whether they had any gum problems. Response categories were 1) have no problems at all; 2) have sore and swollen gums now and then; 3) have sore and swollen gums; 4) have sore/swollen gums and bleeding gums very often; and 5) suffer greatly from sore/swollen gums or bleeding gums. For the analysis responses 2 + 3 and 4 + 5 were combined. The questionnaire part of the study has been described in detail elsewhere (E. Schwarz, D. Kronborg. Unpublished observations).

Statistical analysis

The epidemiologic data were analyzed by the Statistical Analysis System and reduced to composite scores for later analysis with the Statistical Package for the Social Sciences (SPSS) at Denmark's Computing Center for Research and Education, Lyngby. We used *t* tests to show differences between mean DMFS scores and chi-square to test differences between groups. Analysis of variance was used to compare mean DMFS scores between social groups and utilization groups with regard to dental programs. Correlation between DMFS score and caries severity zone was tested by the Spearman rank correlation coefficient, rho.

Results

The study populations in the three groups are described in Table 1, which also shows the size of the groups sampled for the epidemiologic survey. Of the final sample, about 7 out of 10 were reached, but the mixed group deviated considerably from the other two groups.

Dental caries

At the start of the study the mean DMFS score was identical in the public and private groups, whereas the score in the mixed group was significantly higher (Table 2). The D and M components were negligible in all groups. A consistent strong correlation was found between mean DMFS score and severity zone (Table 3). The higher the zone, the higher the DMFS. The distribution of persons in the mixed group by severity zones differed significantly from that in the other two groups.

Table 4 shows the mean DMFS scores for the three groups in accordance with whether they were sampled and whether they were examined for the epidemiologic survey. No differences were found between those who were sampled and those who were not (A

Table 3. Mean DMFS scores at start of study in relation to caries severity zone by dental program

Severity zone	Dental program											
	Public*			Mixed†			Private‡			Total§		
	DMFS	*n*	%	DMFS	*n*	%	DMFS	*n*	%	DMFS	*n*	%
0	0.0	8	2.1	—	0	0.0	0.0	7	2.7	0.0	15	1.9
1	5.6	141	36.6	6.7	44	27.3	6.6	98	37.5	6.1	283	35.0
2	12.3	162	41.9	14.2	69	42.9	12.9	114	43.7	12.9	345	42.7
3	17.9	63	16.3	17.7	38	23.6	15.5	34	13.0	17.2	135	16.7
4 + 5	29.3	12	3.1	27.3	10	6.2	29.6	8	3.1	28.7	30	3.7
Total	11.1	386	100	13.8	161	100	11.1	261	100	11.6	808	100

Chi-square = 17.71; df = 8; $p = 0.02$.
Spearman rho = 0.73 (*); 0.65 († and ‡); 0.70 (§). For all: $p = 0.00$.

Table 4. Mean DMFS scores (± standard deviation) at the start of the study in those who were not sampled for clinical examination at the end of the study (group A), in those who were sampled but not examined (group B), and in those who were actually examined (group C) for the dental program

	Dental program			
	Public	Mixed	Private	Total
Group A				
DMFS	11.3 (8.4)	12.9 (8.4)	10.9 (8.1)	11.4 (8.3)
n	260	54	143	457
Group B				
DMFS	13.7 (10.5)	14.9 (9.7)	12.3 (8.1)	13.8 (9.6)
n	40	48	30	118
Group C				
DMFS	9.0 (4.9)**	13.8 (7.2)*	10.9 (8.0)	10.9 (7.0)
n	86	59	88	233
Total				
DMFS	11.1 (8.1)**	13.8 (8.4)**	11.1 (8.1)	11.6 (8.2)
n	386	161	261	808
t tests:				
A versus B + C	NS	NS	NS	NS
A versus B	NS	NS	NS	*
A versus C	**	NS	NS	NS
B versus C	*	NS	NS	**

* $p < 0.05$.
** $p < 0.01$.

versus B + C). The group agreeing to be examined had a lower DMFS score in all dental programs (group C). In the public group the population examined had a significantly lower DMFS score than the rest (A versus C and B versus C). This also had repercussions on the results of the total group. Significant differences between the public and the mixed groups and between the mixed and the private groups were found in group C but not in groups A and B.

Among those examined the DMFS scores increased from the start to the end of the study (Table 5). In the mixed and private groups females had higher DMFS scores, but in the public group females had the same mean DMFS scores as the males. None of the differences between sexes were significant, however. A result not tabulated was that no significant change in caries severity zone was observed from the start to the end of the study; that is, only a few persons moved from the severity zone recorded initially.

Differences in utilization did not have any impact on mean DMFS scores in any of the dental programs. Only in the public group was social background associated with DMFS (low, 12.9 DMFS; high, 8.8 DMFS; $t = -2.74$; df = 84; $p = 0.008$).

Plaque and bleeding

The VPI and GBI scores are illustrated in Table 6. Since the indices were calculated as percentages of sites with plaque/bleeding, these values might theoretically range from 0 to 100. However, as indicated in the table, few persons had scores above 20%. The distribution of VPI and GBI percentages made it appropriate to make four groups (Tables 6 and 7). Between 25% and 38% of the persons had no visible plaque, and a minority had plaque on more than 20% of the examination sites. No differences were found between the dental programs. Such differences were found with regard to gin-

Table 5. Mean DMFS scores at the start of the study and DMFS scores and FS/DMFS ratio at the end of the study for those who were actually examined, by dental program and sex (M = males; F = females)

	Dental program							
	Public		Mixed		Private		Total	
	M ($n = 39$)	F ($n = 47$)	M ($n = 36$)	F ($n = 23$)	M ($n = 36$)	F ($n = 52$)	M ($n = 111$)	F ($n = 122$)
At start	9.03	9.04	12.46	15.87	9.00	12.21	10.13	11.68
At end	12.03**	11.53	13.89**	16.91	10.42	12.38	12.11**	12.78
FS/DMFS	0.91	0.93	0.97	0.95	0.92	0.97	0.94	0.95

** $p < 0.01$.

gival bleeding, for which significantly more persons in the mixed group had a higher percentage of bleeding sites, and more from the private group were without signs of bleeding.

With regard to use of dental services, no differences were obvious in visible plaque between users and non-users (Table 7). But significantly more non-users than users had gingival bleeding. According to Table 8, respondents' own assessment of their gingival status was closely related to the number of sites with gingival bleeding in the epidemiologic survey, especially in the public and the mixed groups. Those who did not report any problems also had very little gingival bleeding in the survey (a total of 6.1%, corresponding to less than three sites), whereas those who reported suffering from bleeding also had a much higher bleeding index (a total of 24.5% corresponding to over 10 sites). It should be noted, however, that very few respondents complained of frequent gum problems (five persons).

Discussion

The Danish PCDHS recording system for dental disease has been used extensively to evaluate dental caries experience and caries development in children and young adults (2, 3, 11–15). Although it is based on recordings from several dentists, inconsistent or faulty recordings have been reported to be low (1, 16). In this study not only the summary statistics for the three delivery groups were available but also the total record for each indiviudal. Thereby, it was possible to check the caries recordings against actually recorded treatments, thus further reducing inconsistencies. Use of the recording system at the end of the study was not possible, since the mixed and the private groups had left the PCDHS, which was why an epidemiologic survey was carried out. To a certain extent, such a combined approach was used by Bille (17) in a historical prospective study on 20-year-olds in a Copenhagen suburb. The loss of subjects in the epidemiologic survey was greater than experienced in similar surveys comprising comparable age groups (18, 19). Only in the public group, however, did the population remaining for examination have significantly lower DMFS scores, thus indicating a potential underrating of caries for this group.

The use of caries severity zones as an additional description of the caries status was used because it gives a more detailed picture of the character of dental caries than the DMFS score. Although the individual zones are not related to a specific mean DMFS score, the increase in DMFS scores in accordance with increasing severity indicates the inherent logic in this hierarchical system (6). In a modified form, the severity zones have been included in the routine reports of the Danish recording system (1, 11).

In spite of the increase in DMFS, almost all individuals stayed in the same severity zone from start to end. This might indicate that most of the DMFS increase derived from extensions of already made fillings or caries of the same type as already experienced.

Table 6. Visible plaque index (VPI) and gingival bleeding index (GBI) expressed as percentages by dental program. Percentage distribution of persons examined

	Dental program			
Group %	Public (n = 86)	Mixed (n = 59)	Private (n = 88)	Total (n = 233)
VPI group*				
0	25.6	28.8	37.5	30.9
1–10	39.5	23.8	23.9	29.6
11–20	23.3	28.8	26.1	25.8
21+	11.6	18.6	12.5	13.7
Total	100	100	100	100
GBI group†				
0	36.0	20.4	56.8	39.9
1–10	31.4	42.4	31.8	34.3
11–20	24.4	16.9	6.8	15.9
21+	8.2	20.3	4.6	9.9
Total	100	100	100	100

* Chi-square = 8.48; df = 6; p = 0.21.
† Chi-square = 31.65; df = 6; p = 0.00.

Table 7. Visible plaque index (VPI) and gingival bleeding index (GBI) expressed as percentages by use of dental services. Percentage distribution of persons examined

	Use by VPI		Use by GBI	
Group %	User (n = 192)	Non-user (n = 41)	User (n = 192)	Non-user (n = 41)
0	33.3	19.5	43.7	22.0
1–10	30.7	24.4	34.4	34.1
11–20	24.0	34.1	15.6	17.1
21+	12.0	22.0	6.3	26.8
Total	100	100	100	100
	Chi-square = 6.36; df = 3; p = 0.09.		Chi-square = 18.56; df = 3; p = 0.00.	

Table 8. Mean percentage of sites with gingival bleeding (GBI %) in relation to self-assessment of gingival problems by dental program

	Dental program							
	Public		Mixed		Private		Total	
Self-assessment	GBI %	n	GBI %	n	GBI %	n	GBI %	n
No problems	6.8	63	8.9	38	3.7	65	6.1	166
Problems now and then	11.7	20	14.4	13	4.9	17	10.1	50
Often sore/ bleeding gums	21.4	1	25.2	4	—	0	24.5	5
Total	8.1	84	11.5	55	3.9	82	7.4	221*

* Twelve persons did not respond to a question: public, 2; mixed, 4; private, 6.

The proportion of FS/DMFS was high, indicating minimal treatment need. This was noted also by Bille (18) and Kirkegaard et al. (19). In an international perspective this indication of low treatment need is quite remarkable (20).

Comparisons of the DMFS scores recorded here with other studies should be made with reservation. Caries levels differ considerably in the country as a whole (11), and caries decreases so fast from year to year (2, 3) that cohorts of the same age but from different years are in fact not comparable. Unpublished data on 16-year-olds from the National Board of Health indicate that the mean DMFS was 15.1 in 1978, 15.1 in 1979, and 13.7 in 1980. Bille (18) found a mean DMFS score for 20-year-olds of 16.7 in 1976. The lack of significant associations between DMFS scores and dental service utilization and social background, respectively, might be a result of the outreaching dental care system, which all groups had initially been exposed to (21). In this respect, the social group association in the public group at the end of the study was interpreted as an artifact due to the loss of subjects in the epidemiologic survey.

The plaque and gingival indices, VPI and GBI, were proposed to make simple and reliable assessments of the plaque and gingival situation both in daily practice and in epidemiologic studies (9). The fact that the more comprehensive community periodontal index of treatment needs, CPITN, was introduced shortly after (22) may be the reason why the two indices have not been used much. The indices have been used with full-mouth and half-mouth examination and with six index teeth representing the dentition (5, 9, 23–25), making comparative attempts difficult.

Most of the persons examined had some plaque/bleeding (VPI, 69.1%; GBI, 61.1%), but more than half had less than 10% sites affected—that is, less than four sites. With regard to the association between bleeding and non-use of dental services, use as such was probably not the determining factor. Rather, the underlying attitudes bringing the users to and keeping non-users away from dentists also determined the hygiene behavior resulting in the gingival status. The positive relationship between self-assessment of gingival status and bleeding gingiva indicates that there was an awareness of the gingival condition. This might be a factor of importance in planning preventive activities for young adults.

It may be concluded that none of the alternative delivery programs had measurable dental health effects different from each other. With regard to dental caries the similarities and differences remained the same at the end as at the start of the study. Owing to the lack of data on the gingival situation at the start of the study, a final conclusion with regard to the impact of the alternative delivery programs as such is difficult. It may be established, however, that use of dental services was positively associated with less gingival bleeding. The extent to which attitudes and knowledge may influence this is being reported elsewhere (E. Schwarz, D. Kronborg. Unpublished observations). Further, it is being analyzed whether differences in dental services provided could be found (26).

Acknowledgements.—Dr. Jette Bille's assistance in the calibration exercise before the field survey is gratefully acknowledged. Thanks are due to Drs. Per Guldbæk and Lars Johansen, who as dental students endured long hours of recording during the field survey. Mr. Niels Nielsen is thanked for his extensive assistance with the data reduction. The assistance of the WHO Oral Health Unit, Geneva, in supplying the then rare periodontal probes for the survey is gratefully acknowledged. The study was supported by the Danish Medical Research Council, grant 12-7222.

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Received for publication 10 February 1988

Oral Physicians for Europe

The Association for Dental Education in Europe (ADEE) is to examine a discussion paper outlining one possibility for significant changes in dental education for the European dentist in the 21st century. The topic is to be one of the main themes for its 15th scientific meeting in Brussels on 5 and 6 September 1989. One session is to be devoted to ethics and education.

The proposals will be presented by Professor Harry Allred of the London Hospital and debated by eminent dental educationalists, including Robert Frank (France), Karin Roding (Sweden), Walter Kunzel (German Democratic Republic), David Barmes (WHO), O. Brazda (Czechoslovakia), a speaker from ADEE's sister organization in Canada, and David Mason (Glasgow). In what promises to be a significant influence on change in dental education in Europe, ADEE this year will also introduce a forum for short presentations on research in dental education.

In an age of harmonization of standards in European education, the introduction of vocational training in dentistry and consideration of radical changes in promoting oral health and care, ADEE's September meeting in Brussels could be a watershed for many dental curricula. Details of the program will be sent to member schools and are available from the President, Professor Pol Boute, Vrije Universiteit Brussel, Tandheelkundig Instituut, Laarbeeklaan 103, 1090 Brussel, Belgium, who is organizing this year's meeting.

Membership of the Association for Dental Education in Europe is open to corporate bodies such as schools or specialist organizations. Information and application forms may be obtained from the Secretary General, Dr. D. Shanley, School of Dental Science, Trinity College, 30 Westland Row, Dublin 2, Ireland.

Future meetings of ADEE include venues in Budapest (1990), Lisbon (1991), Dublin (1992) and Erfurt (1993).

Third International Interdisciplinary Research Conference on Fundamentals of Bone Growth

3–5 January 1990

The Third International Interdisciplinary Research Conference on Fundamentals of Bone Growth: Methodology and Applications will be held at the University of California Los Angeles, Schools of Dentistry and Medicine, Los Angeles, California, on 3–5 January 1990.

Emphasis will be on basic science aspects, with platform sessions and workshops on morphogenesis, molecular and cell biology, microstructure and morphanalysis. As at the previous conferences in 1982 and 1985, the primary objective is to update and integrate our understanding of the growth of bone and to offer directions for future research. Participants include leading experts: Drs. A. Boyde (U.K.), A. Dhem (Belgium), B. K. Hall (Canada), G. A. Howard (USA), D. A. N. Hoyte (U.K.), N. F. Kember (U.K.), S. C. Marks (USA), C. E. Oxnard (Australia), H. C. Slavkin (USA), and K. K. and M. R. Urist (USA). Contributions are invited, and the proceedings will be published. For more information, please write to Drs. Andrew D. Dixon or Bernard G. Sarnat, Schools of Dentistry and Medicine, 63-090 CHS, University of California Los Angeles (UCLA), Los Angeles, CA 90024, USA (tel. (213) 825-1761).