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Changes in caries experience among 35-year-old Oslo citizens, 1973–2003

RASA SKUDUTYTE-RYSSTAD[1] & HARALD M. ERIKSEN[2]

[1]*Faculty of Dentistry, University of Oslo, Oslo, Norway and* [2]*Faculty of Medicine, University of Tromsø, Norway*

Abstract

Objective. The aims of the present study were to describe caries experience among 35-year-olds in Oslo in 2003 and to assess changes in caries experience during the past 30 years using data from cross-sectional studies performed in 1973, 1984, and 1993. ***Material and Methods.*** The dental status of 149 randomly selected 35-year-olds in Oslo was examined in 2003 (response rate 64%) and the data were compared with available data from earlier studies. Dental caries was registered clinically and radiographically at the surface level, applying the same criteria as used in previous studies, and recorded as DMFS/T. ***Results.*** The results indicate a gradual decrease in the mean DMFS scores by 62% from 68.2 in 1973 to 26.1 in 2003. There was an 83% decrease in the mean number of DS, a 73% decrease in the mean number of MS, and a 56% decrease in the mean number of FS during this 30-year period. The proportion of individuals with DS = 0 gradually increased from 5% in 1973 to 54% in 2003. There was also a significant decrease in the prevalence of recurrent caries from 2.8% in 1984 to 1.2% in 2003. While a statistically significant reduction in the number of decayed, missing, and filled surfaces was observed during the period 1984–1993, in the past decade (1993–2003) a significant decrease appeared only in the case of the filled surfaces. ***Conclusions.*** The results indicate that dental health among 35-year-olds in Oslo, measured as a reduction in caries experience, has improved substantially from 1973 to 2003.

Key Words: *Adults, dental caries, epidemiology*

Introduction

The improvement in dental health among children and adolescents in industrialized countries has been extensively documented [1–3]. Based on data from Public Dental Services in Norway, this improvement was first observed and documented in the 1960s [4–6]. However, there is less information on trends in caries experience among adults. Available epidemiological studies demonstrate improvements in adult dental health in Sweden [7], Denmark [8], the United States [9–11], the United Kingdom [12,13], and the Netherlands [14]. In Norway, an improvement in adult dental health from 1973 to 1993 has been documented by two repetitive cross-sectional studies performed in the county of Trøndelag [15] and in Oslo [16–18]. In general, available epidemiological studies on caries in adults reveal similar trends, i.e. a reduced number of decayed and missing teeth, an increased number of filled teeth for older cohorts, and a decrease in the total caries experience for younger adults. It seems that the caries reduction observed among adolescents may be maintained as a permanent reduction into adulthood [19].

Adult dental health status reflects the long-term cumulative impact of prevention and treatment policy. The documented decline in caries among children in Norway has become evident during the past 40 years [4], and the earliest birth cohorts of children who experienced caries reduction are now adults. In order to follow the trends in dental caries among Norwegian adults, a new repetitive cross-sectional study on dental health among 35-year-olds was carried out in 2003. The aims of the present study were to describe caries experience among 35-year-olds in Oslo in 2003 and to assess changes in caries experience during the past 30 years using data from cross-sectional studies in 1973, 1984, and 1993.

Material and methods

Changes in the prevalence of caries among 35-year-olds in Oslo have been described and published

Correspondence: Rasa Skudutyte-Rysstad, Institute of Clinical Dentistry, Faculty of Dentistry, University of Oslo, P.O. Box 1109 Blindern, NO-0317 Oslo, Norway. Tel: +47 22852128. Fax: +47 22852344. E-mail: rasas@odont.uio.no

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previously (from 1973 to 1993) [16–18]. The material for these repetitive, cross-sectional epidemiological studies constituted samples of 35-year-olds randomly selected and examined using similar examination methods in all three studies.

A new random sample of 35-year-olds (250) from Oslo was drawn from the National Bureau of Statistics Recordings in 2003. After adjusting for 18 of the individuals, who had to be excluded because of a change of address or temporary residence abroad, the final sample comprised 232 participants. Approval to carry out the study was obtained from the Regional Ethics Committee.

The selected individuals were invited to participate by way of a letter giving general information about the survey. In order to increase response rate and to collect information about the non-responders, a further letter and a telephone interview were used where possible.

Data-collection included self-administered questionnaires and clinical and radiographic examination of participants at the Faculty of Dentistry, University of Oslo. Dental caries was registered clinically and radiographically at the surface level and recorded as DMFS/T. Clinically visible caries was registered at the cavitation level following the World Health Organisation criteria for caries diagnosis [18,20]. Four surfaces were assigned to a front tooth and five to a premolar or molar. Third molars were not included in the registrations. All missing teeth, independently of the reason for not being present, were included in the DMF index.

Four bitewing radiographs, one for the premolar and one for the molar area, were taken using Kwik-bite film holders (Hawe Neos Dental, Switzerland), Insight film (Eastman-Kodak Co., Rochester, N.Y., USA), and a Siemens X-ray unit (Siemens AG, Erlangen, Germany), from all but three study participants (because of pregnancy or lack of time). Caries registration from bitewing radiographs was done independently by three examiners using standardized conditions and a method used in previous studies [21]. All the lesions seen on the proximal tooth surfaces radiographically were registered and recorded as enamel caries, enamel and dentine caries, or recurrent caries. Caries was registered as present only if it was recorded by at least two examiners.

Clinical examination was performed by one examiner (R.S.R.) in the period October 2003 to February 2004. Before the main investigation, a calibration session regarding the diagnostic criteria was performed with the examiner from the 1973 investigation, who participated in the calibrations in all previous studies. In addition, double examination of 738 surfaces in 6 individuals was performed in order to control intra-examiner consistency for clinical caries registration. The kappa value for intra-observer agreement was 0.97. Inter-examiner agreements for caries scoring from radiographs resulted in kappa values from 0.67 to 0.76.

The data were computed and analyzed using the SPSS statistical program package (SPSS for Windows 13.0, SPSS Inc., Chicago, Ill., USA). Both published [16–18] and raw data from earlier studies, available as SPSS files, were used for comparisons. Student's t-test and ANOVA with Tukey adjustment were used to compare differences in caries experience. Differences in the number of restored surfaces on the basis of materials used and differences in prevalence of recurrent caries were assessed using the chi-square test. The significance level was set at 0.05.

Results

Study population

Of the 232 individuals selected for the study, 149 attended the clinical examination (response rate 64%). When the study participants were compared to the population data for 35-year-olds in Oslo, the present study sample had an over-representation of men, participants with higher education (>14 years), and a slight under-representation of non-Western immigrants. Thirty-eight (25%) of the participants in the study population were born outside Norway; 23 (15%) of them in non-Western and 15 (10%) in Western countries.

Non-attendance

Fifty-six individuals (68%) of the 83 non-attenders were contacted by telephone and asked about the reason for non-attendance. The main reasons reported among men ($n=20$) were lack of time (60%) and lack of interest (30%). Women ($n=36$) mentioned pregnancy/maternity (31%), lack of time (31%), and dental fear (11%) as the main reasons. Forty-four (53%) of the non-attenders who were contacted agreed to be briefly interviewed about their education, dentist visiting, toothbrushing, and smoking habits.

A comparison of the interviewed non-attenders with the study participants (Table I) demonstrated that there was a higher proportion of women and twice as many smokers among the non-attenders. A slightly higher proportion of the study participants visited their dentist regularly; however, there were more non-attenders who had visited their dentist during the previous year.

Changes in dental caries

The caries experience among Oslo citizens in 2003 is presented in Table II. It is apparent that substantial differences in caries and treatment experience exist in relation to country of origin. Since non-Western immigrants (mean residence time in Oslo 10 years

Table I. Comparison of the study participants and non-attenders

	Study participants ($n=149$)	Non-attenders ($n=44$)
Gender		
Women	60 (40%)	29 (66%)
Men	89 (60%)	15 (34%)
Education		
≤9 years	11 (7%)	3 (7%)
10–14 years	46 (31%)	14 (32%)
>14 years	92 (62%)	27 (61%)
Regular dental visits		
Yes	108 (73%)	29 (66%)
No	41 (27%)	15 (34%)
Last dental visit		
<1 year ago	84 (56%)	32 (73%)
Toothbrushing		
Twice a day	121 (81%)	41 (93%)
Smokers	32 (22%)	18 (41%)

(SD = 7)) had a significantly lower mean DMFS and FS scores compared to the rest of the sample, in 2003 this group was excluded from the comparisons with the previous studies.

Caries status in 1973 to 2003 is presented in Table III and indicates a 62% decrease in caries experience measured as the mean DMFS during this 30-year period. The mean DS score decreased by 83% from DS 6.5 in 1973 to DS 1.1 in 2003. The mean FS increased during the period 1973–1984, but then gradually decreased from 54.4 in 1984 to 21.4 in 2003, a 56% decrease during the 30-year period. There was also a 73% reduction in the mean MS scores from 13.3 in 1973 to 3.6 in 2003. Despite this general improvement, only 2 individuals (2%) had no registered caries or fillings (DMFS = 0) in 2003.

The pattern of change in the distribution of separate DMFS components varied during the 30-year period. From 1973 to 1984 there was a significant decrease in the mean number of decayed and missing surfaces and a slight, although non-significant, increase in the mean number of filled surfaces. During the next decade, from 1984 to 1993, a substantial decline in caries experience was documented and the mean numbers of DS, MS, and FS were significantly reduced. A further reduction in total caries experience was observed in 2003. However, this was mainly due to a decrease in the mean number of filled surfaces, since no significant reduction in the mean number of DS and MS was noticed between 1993 and 2003.

Cumulative percentage distributions for DS and FS scores (Figures 1 and 2) show trends of change in caries experience. The proportion of individuals with DS = 0 gradually increased from 5% in 1973 to 54% in 2003. The distribution curves of DS scores from the 1993 and 2003 surveys are almost identical in shape, except for a further increase in the proportion of individuals with DS = 0 from 41% in 1993 to 54% in 2003. In 2003, 5% of all participants had 4 or more DS compared to 73% in 1973. Cumulative percentage distributions of FS scores (Figure 2) gradually moved to the left and became more skewed in 1993 and 2003. While in 1973 50% of the participants had 49 or fewer filled surfaces, this number was 18 or fewer FS in 2003.

Changes in the proportions of decayed, filled, and sound approximal surfaces are shown in Figure 3. There was a 44% increase in the proportion of sound approximal surfaces from 1973 to 2003 and the proportion of decayed approximal surfaces decreased from 9% to 2%. There was also an increase in proportions of sound occlusal (Figure 4) and buccal/lingual surfaces during this period, but to a lesser extent.

The number of restored surfaces and the prevalence of recurrent caries (D_FS) in relation to filling material are presented in Table IV. There was a significant increase in the proportion of surfaces restored with composites in 2003 compared to earlier studies ($p < 0.001$). The overall prevalence of recurrent caries decreased significantly from 2.8% in 1984 to 1.2% in 2003. When the type of filling material was considered, there was a significant decrease in the prevalence of recurrent caries in relation to amalgam restorations in 2003 compared to 1993; however, the prevalence of recurrent caries in relation to composite restorations remained unchanged from 1993 to 2003.

Discussion

In the present study, a decrease in caries experience among 35-year-olds in Oslo has been demonstrated using data from four cross-sectional surveys

Table II. Caries experience in relation to country of origin of the participants, 2003

	DS	MS	FS*	DMFS*
Country of birth	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Norway ($n=111$)	1.2 (2.7)	3.9 (6.6)	21.8 (15.1)	26.7 (17.8)
Non-Western ($n=23$)	3.6 (7.5)	6.2 (8.6)	6.4 (6.9)	16.0 (17.7)
Western ($n=15$)	0.9 (1.1)	1.3 (3.0)	18.9 (11.5)	21.0 (12.6)
Total ($n=149$)	1.5 (3.8)	4.0 (6.7)	19.1 (14.8)	24.6 (17.7)

*Indicates statistically significant differences between the groups.

Table III. Caries experience among 35-year-olds in Oslo, 1973–2003

	1973 ($n=117$)	1984 ($n=156$)	1993 ($n=121$)	2003 ($n=126$)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
DMFT	21.6 (5.2)	19.9 (5.5)	14.8 (5.2)	11.7 (5.2)
DT	3.2 (2.7)	1.8 (2.7)	0.7 (1.3)	0.9 (1.3)
MT	2.8 (4.6)	1.8 (2.4)	1.0 (1.5)	0.7 (1.3)
FT	15.7 (4.5)	16.3 (5.8)	13.1 (5.1)	10.1 (4.8)
DMFS	68.2 (16.4	66.5 (18.3)	40.9 (15.8)	26.1 (17.3)
DS	6.5 (5.5)	3.3 (4.9)	1.5 (2.1)	1.1 (2.5)
MS	13.3 (21.2)	8.8 (11.7)	5.3 (7.5)	3.6 (6.3)
FS	48.4 (13.9)	54.4 (19.3)	34.1 (14.3)	21.4 (14.7)

performed during the period 1973–2003. The randomly selected study populations and similar registration methods used made it possible to describe changes in adult dental caries during the past 30 years. However, some methodological aspects of the study are important to consider when interpreting the results.

The response rate in the 2003 study was 64% compared to 66–80% reported in previous Oslo studies. Comparisons of the participants and the non-attenders in relation to available background characteristics revealed differences in relation to gender, smoking, and dentist visiting habits. There was a higher proportion of irregular dental users among the non-attenders; they were also more likely to have visited their dentist during the previous year. Among the study participants, no differences in caries experience in relation to gender or smoking habits were detected, but variables on dental visiting habits were associated with differences in caries experience. Irregular dental attenders had higher mean numbers of decayed surfaces. On the other hand, participants who visited their dentist during the previous year had lower mean number of DS and therefore no clear direction and magnitude of bias due to the non-response on dental health estimates could be shown. Compared to the general population of 35-year-olds in Oslo, there was an over-representation of participants with higher education, which has often been related to better dental health [22,23]. Also in the present study, participants with higher education had a significantly lower mean number of decayed surfaces. Owing to the fact that participants with higher education were overrepresented in this study, there is a possibility that the real caries prevalence might be underestimated.

Substantial changes in the demographic composition of 35-year-olds in Oslo have occurred during this 30-year period. The proportion of non-Western immigrants increased from 1% in 1973 to 15% in 2003. The data from both earlier Oslo studies and the present study showed that caries and treatment experience among non-Western immigrants was different from the rest of participants [17,18]. In order to minimize the possible effect of demographic composition on time-lag differences in caries, this group was excluded from the comparisons in 2003.

Caries registrations in the four investigations were performed by four different examiners and, as such, one cannot rule out the possibility of variation in

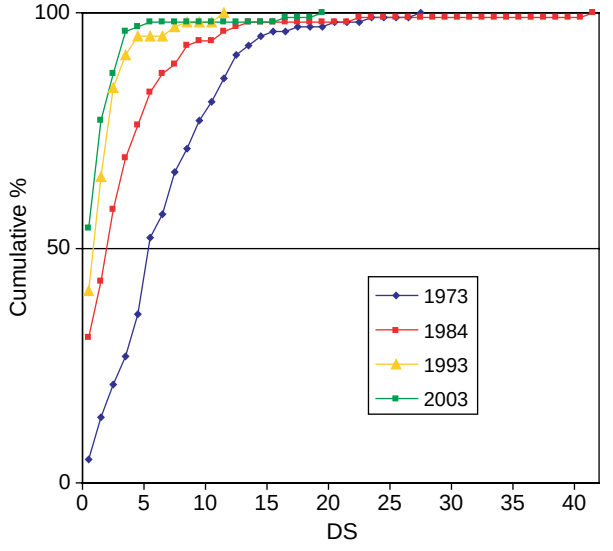

Figure 1. Cumulative frequency distributions of DS scores according to year of survey.

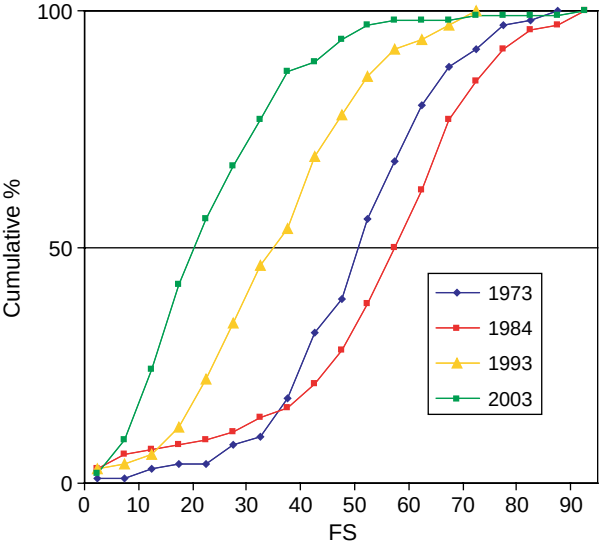

Figure 2. Cumulative frequency distributions of FS scores according to year of survey.

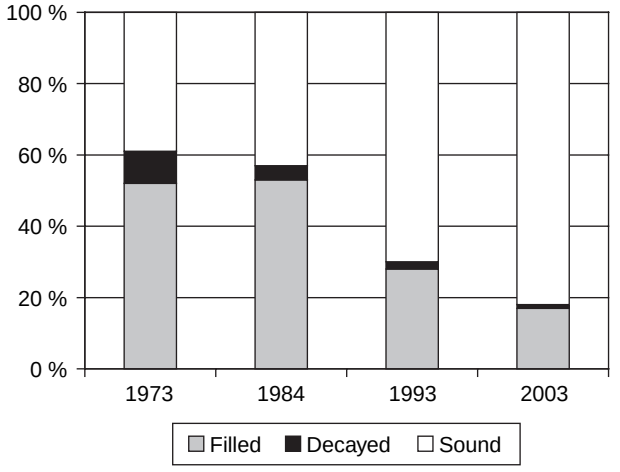

Figure 3. Proportions of sound, decayed, and filled proximal surfaces 1973–2003.

clinical diagnosis. In order to minimize this possibility, the examiner in the 1973 investigation was involved in the calibration sessions regarding the diagnostic criteria in all the following investigations.

When interpreting the findings, the methodological limitations of the DMF index as a measure for caries experience in adults should be considered [24]. The F-component, which dominated the total DMF score, is greatly influenced by the dentists' restorative treatment decisions, and it has been shown that restorative treatment decisions are subject to variation [25]. There has also been a shift towards a less interventional treatment strategy among the dentists around the 1980s [26,27], which could have some impact on the observed reduction in number of filled surfaces.

In the 1973 and 2003 surveys, the D component included all surfaces with primary and recurrent caries and the F component only satisfactory fillings. In the 1984 and 1993 surveys, filled surfaces with recurrent caries were included in both the D and the F component of the DMF index. The mean numbers of filled surfaces reported in 1984 and in 1993

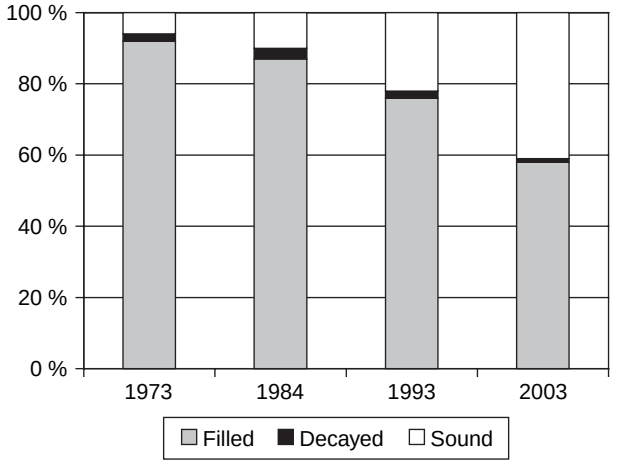

Figure 4. Proportions of sound, decayed, and filled occlusal surfaces 1973–2003.

Table IV. Number of restored surfaces and recurrent caries (D_FS) according to filling material among 35-year-olds in Oslo, 1984–2003*

	Restored surfaces	D_FS	$D_FS/FS\%$
1984 ($n=156$)			
Amalgam	6477 (77%)	170	2.6
Composite	1225 (15%)	59	4.8
Gold	703 (8%)	9	1.3
Total	8405 (100%)	238	2.8
1993 ($n=121$)			
Amalgam	3313 (80%)	73	2.2
Composite	564 (14%)	12	2.1
Gold	246 (6%)	4	1.6
Total	4123 (100%)	89	2.2
2003 ($n=126$)			
Amalgam	1892 (69%)	17	0.9
Composite	684 (25%)	15	2.2
Gold	160 (6%)	2	1.3
Total	2736 (100%)	34	1.2

*Data from 1973 not available.

are therefore higher due to this calculation difference. However, because of the low mean number of filled surfaces with decay ($D_FS = 1.5$ in 1984 and 0.7 in 1993), this had a minor influence on DS and a negligible influence on FS counts in 1984 and 1993, the latter being 54.4 and 34.1, respectively. The DMFT counts (Table III) confirmed an increase in FT from 1973 to 1984 and the latter a consistent reduction.

The results indicate that caries prevalence in 35-year-olds in Oslo decreased considerably during this 30-year period. The significant decline in the mean DMFS scores observed in 1993 continued further in 2003. However, when comparing separate components of the DMF index, the pattern of this decline seemed to be different in the two decades. While there was a significant decrease in the mean DS, MS, and FS during 1984–1993, only the mean number of FS decreased during the last decade. Similar findings were reported in Jönköping, Sweden [7], where a decrease in caries experience in 30- and 40-year-olds during 1993–2003 was due to a reduction of the mean FS, while the mean DS increased during the same period.

Despite this, there was a 13% increase in the proportion of individuals with no carious surfaces registered ($DS = 0$) from 1993 to 2003 among the 35-year-olds in Oslo, which may indicate a further caries reduction.

The 35-year-olds in the 2003 investigation have been exposed to fluoride from an early age, compared to the cohorts investigated earlier. Nevertheless, there were only two individuals (2%) with $DMFS = 0$. In addition, cumulative frequency distributions of DS and FS scores revealed that a small fraction of the population still have had a high disease level.

The latest results indicate that caries experience among 35-year-olds in Oslo has continued to decrease. One can hypothesize that the majority of the 35-year-olds from the 2003 survey will probably maintain a lower disease rate and treatment experience throughout their adult life with a reduced need for complex restorative care. Despite this general improvement, there is still a fraction of the population with poor dental health and in great need of dental care.

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