

Dental caries among the elderly in Norway

Birgitte Moesgaard Henriksen, Eirik Ambjørnsen and Tony Axéll

Department of Geriatric Medicine, Ullevaal University Hospital, University of Oslo, Oslo, Norway; Resource Centre for Oral Health in Rare Medical Conditions, Oslo, Norway; Oral and Maxillofacial Unit, Halmstad Hospital, Halmstad, Sweden

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Objectives: To describe the occurrence of decayed teeth (DT), missing teeth (MT), filled teeth (FT), and the total sum score DMFT in elderly Norwegian pensioners, 67 years or more. **Basic procedures:** A representative sample of 582 elderly Norwegians (12.5% receiving social care) participated in a nationwide study (46% men and 54% women). In all, 394 (68%) still had some of their own teeth. A standardized clinical examination was performed by one of the authors (BMH) using well-defined criteria. **Main findings:** Mean DT was 0.46, FT was 8.4, and DMFT was 25.4. Mean number of root remnants was 0.11. Mean DT, FT, DMFT, and root remnants for the dentate participants were 0.67, 12.4, 24.1, and 0.17, respectively. Men had significantly higher DT than women. DT decreased with increasing age. Only small differences were found in the prevalence of dentate individuals with caries between gender, age groups, geographical regions, and residence in areas of varying population density. **Conclusion:** It seems that caries is a minor problem in the Norwegian elderly population. Age and the number of remaining teeth do not have a decisive role in the development of caries. Further, there are no differences in these respects between geographical areas in Norway. □ *Caries; DMFT; epidemiology; pensioners*

Birgitte Moesgaard Henriksen, Department of Geriatric Medicine, Ullevaal University Hospital, NO-0407 Oslo, Norway. Tel. +47 22 11 87 02, fax. +47 22 11 87 01, e-mail. bhenriks@odont.uio.no

In Scandinavian and in most Western countries the number of elderly people is steadily increasing (1). Studies on groups of elderly people indicate that the number of teeth the elderly people retain is increasing and the prevalence of dentures is decreasing (2–4).

In old age, the prevalence of chronic disease and the use of medicines increase and are believed to have a negative impact on oral health (5, 6). Difficulties in performing oral hygiene procedures and prolonged sugar elimination time may be a consequence of poor general health and hyposalivation, and this may have a strong influence on the development of caries (see review by Fitzpatrick; 7). In addition, with increasing age, root surfaces often become exposed and susceptible to decay. This contributes to caries or other oral problems for older dentate patients (8). Some Scandinavian studies show a high prevalence of root caries and that this is an increasing problem with advancing age (8–10).

Studies of elderly populations implicate dental caries as a significant risk factor for tooth loss (11–14), and some studies among groups of elderly people have reported that loss of teeth significantly reduces chewing ability (15, 16).

Dental caries has usually been investigated in institutionalized groups and only occasionally in non-institutionalized elderly individuals (8, 13, 17–20). Many report a trend towards a higher incidence of caries (18, 21–23). The prevalence of dental caries seems particularly high among institutionalized individuals (24).

In Norway, one study has shown a low prevalence of untreated caries in a group of healthy non-institutionalized old-age pensioners (25), but another Norwegian study found a high prevalence of root caries (9).

The aim of the present study was to describe the occurrence of decayed teeth (DT), missing teeth (MT), filled teeth (FT), and the total sum score DMFT in elderly Norwegian pensioners aged 67 years or more.

Materials and methods

This report is part of a nationwide study which took place in 1996–99 aimed at providing a description of the oral health of elderly Norwegians (26, 27). The sampling procedure was directed by Statistics Norway and was carried out with the objective of obtaining a sample that was representative both nationally and regionally (26–28).

From a random sample of 1152 urban and rural elderly Norwegians aged 67 years or more (age defined as the difference between the year of examination and the year of birth), 582 (12.5% receiving social care) could participate in the study (265 (46%) men and 317 (54%) women). The identification of DMFT could not be undertaken for two individuals, and they are excluded from the analysis in this report.

In all, 394 individuals (68%, 194 men and 200 women) had remaining teeth (29 individuals receiving social care). One-hundred-and-eighty-six individuals (32%) were edentulous.

A tooth was registered if at least 2 mm remained above the gingival margin. Less than 2 mm was defined as a root remnant (RR).

The mean age of the study group was 75.4 ± 5.5 years (for men 74.1 ± 4.9 years and for women 75.7 ± 5.9 years) and the age range was 67–99 years.

In a previous report, analysis of the same study group revealed three different regions in Norway with respect to the occurrence of teeth and dental/denture status. Significant differences existed between the regions and non-significant differences were found within them. Region A comprised the South-East counties, including the capital Oslo; region B comprised the West-Central counties; and region C comprised the Northern counties (26, 27).

Comparison of the participants and non-participants in that study sample with respect to age, gender, dental status, dental visits, and oral symptoms showed no statistically significant differences between the two groups (27).

The examining dentist was calibrated and standardized with an experienced cariologist from the Faculty of Dentistry in Oslo. After calibration procedures, 18 elderly individuals with a total of 177 teeth at an institution were examined at a random order by the two examiners.

A standardized clinical examination was performed by the author (BMH), usually in dental clinics, but to some extent also in hospitals/institutions for the elderly or in the participant's home. The participant was lying in bed or sitting in a chair/wheelchair. Light was provided by a dental unit lamp or a headlamp/torch.

The oral inspection was carried out with the aid of a dental mirror and a dental probe. Dentures were removed before the examination. No scaling was performed when calculus (tartar) was present.

No radiographic examination was undertaken for practical reasons, given the limited time and resources available.

DT, MT, and FT were recorded as described by Ambjornsen (25) and defined in accordance with criteria suggested by the World Health Organisation (WHO) (29). DT were defined as teeth with primary or secondary/recurrent caries; MT were so defined whatever the reason, and FT as teeth with fillings, including inlays and crowns, but without caries (30). A tooth was registered if at least 2 mm remained above the gingival margin. If less than 2 mm remained, a RR was registered and at calculation it was included among MT and also in DMFT. Third molars were excluded from the DMFT calculation. Pontics, cantilevers, and implants were not registered as teeth (only one individual had implants!).

The criteria for coronal caries were as described by Fure et al. (30); '1. a macroscopic defect which cannot be verified as hypoplasia or erosion and where an explorer enters easily and displays some resistance to withdrawal; 2. a visible decalcified spot without a macroscopic defect which has lost its normal translucence and assumes a chalk-like consistency'.

Root caries was diagnosed according to Banting et al. (31) and Fure et al. (30). The criteria were: '1. a discrete, well-defined and discoloured soft area; 2. an explorer enters easily and displays some resistance to withdrawal; 3. the lesion is located either on the cemento-enamel junction or wholly on the root surface.'

Coronal or root caries in connection with dental restoration or prosthetic crowns was recorded as second-

ary/recurrent caries. A tooth with any filling, inlay or prosthetic crown and with any carious lesion was recorded as decayed (25).

Thus, for the present study the DT, MT, FT, the total DMFT, and the RRs were recorded and served as the main outcomes.

The study was approved by the regional medical research ethics committee (RREC). Informed written consent was obtained from all study participants, next of kin, or nursing personnel before the interviews and examinations took place.

Statistical methods

The data were analysed in a standard package of SPSS 10.0 for Windows, from which prevalence figures and other data were retrieved. Differences between groups were tested with the chi-square tests. *P* values less than 0.05 were considered to be statistically significant. Inter-examiner agreement was calculated with kappa statistics (32).

Results

At inter-rater measurements, teeth with caries lesions were recorded for 21 and 22 teeth by the cariologist and the author (BMH), respectively. One-hundred-and-forty-eight teeth were considered without caries by both examiners. The kappa value calculated was 0.62 and, thus, the clinical inter-examiner agreement between the author and the cariologist registering caries lesions was 'good'.

The number of DT, MT, FT and the total DMFT from the study participants are given in Table 1. The main findings were that DT and FT were significantly more prevalent among men, while MT and the total DMFT were more prevalent among women ($P < 0.001$). With respect to age, DT and FT decreased with increasing age, while MT and DMFT increased ($P < 0.001$). Concerning the national geographical regions A–C, MT and DMFT increased from A to B and from B to C, while FT showed the opposite pattern ($P < 0.001$). DT was significantly most prevalent in region A ($P < 0.001$).

Using the definition provided by Statistics Norway of densely and thinly populated areas of residence in Norway, the results of DT, MT, FT, and DMFT recorded were compared between those areas and with the capital city Oslo. The mean number of DT and FT was significantly higher in Oslo than in densely and thinly populated living areas. The mean number of DMFT differed only by about one tooth between the areas, being somewhat lower in Oslo than in the densely and thinly populated areas, although the difference was statistically significant (Table 1).

Among the dentate participants ($n = 394$), the comparison between Oslo and the densely and thinly populated areas was similar to the one in the total study population. The mean number of DT and FT was higher, and the

Table 1. Number of decayed teeth (DT), missing teeth (MT), filled teeth (FT), decayed/missing/filled teeth (DMFT) and root remnants (RRs) among the study participants ($n = 580$) distributed by gender, age, geographical regions, and residence in densely/thinly populated areas compared to Oslo

	DT			MT			FT			DMFT			RR			Theoretical max. no. of teeth	(No. of intact teeth)
	<i>n</i>	Mean	95% CI	<i>n</i>	Mean	95% CI	<i>n</i>	Mean	95% CI	<i>n</i>	Mean	95% CI	<i>n</i>	Mean	95% CI		
Gender																	
Men ($n = 265$)	160	0.60	(0.51–0.70)***	4,098	15.5	(15.0–15.9)***	2,325	8.8	(8.4–9.1)***	6,583	24.8	(24.3–25.4)***	53	0.20	(0.15–0.25)***	7,420	(837)
Women ($n = 315$)	105	0.33	(0.27–0.40)	5,461	17.3	(16.9–17.8)	2,558	8.1	(7.8–8.4)	8,124	25.8	(25.3–26.3)	13	0.04	(0.02–0.06)	8,820	(696)
Age group																	
67–74 ($n = 254$)	142	0.56	(0.47–0.65)***	3,422	13.5	(13.1–13.9)***	2,665	10.5	(10.1–10.9)***	6,229	24.5	(24.0–25.1)**	34	0.13	(0.09–0.18) NS	7,112	(883)
75–84 ($n = 259$)	105	0.41	(0.33–0.48)	4,680	18.1	(17.6–18.5)	1,924	7.4	(7.1–7.8)	6,709	25.9	(25.4–26.4)*	23	0.09	(0.06–0.13)	7,252	(543)
85+ ($n = 67$)	18	0.27	(0.15–0.39)	1,457	21.7	(20.8–22.7)	294	4.4	(3.9–4.9)	1,769	26.4	(25.3–27.5)	9	0.13	(0.05–0.22)	1,876	(107)
Region																	
A ($n = 234$)	139	0.59	(0.50–0.69)***	2,602	11.1	(10.7–11.5)***	2,936	12.5	(12.1–13.0)***	5,677	24.3	(23.7–24.8)***	25	0.11	(0.07–0.15) NS	6,552	(875)
B ($n = 311$)	113	0.36	(0.30–0.43) NS	6,096	19.6	(19.2–20.0)	1,883	6.1	(5.8–6.3)	8,092	26.0	(25.5–26.5)	40	0.13	(0.09–0.17)	8,708	(616)
C ($n = 35$)	13	0.37	(0.20–0.63)	861	24.6	(23.2–26.0)	64	1.8	(1.4–2.3)	938	26.8	(25.3–28.3)	1	0.03	(0.01–0.17)	980	(42)
Residence																	
Oslo ($n = 84$)	67	0.78	(0.59–0.97)***	793	9.2	(8.6–9.8)***	1,201	14.0	(13.2–14.7)***	2,061	24.0	(23.1–24.9)***	6	0.07	(0.01–0.13)*	2,352	(291)
Densely ($n = 244$)	102	0.42	(0.34–0.50) NS	3,665	15.1	(14.7–15.6)	2,256	9.3	(9.0–9.7)	6,023	24.9	(24.3–25.4)	38	0.16	(0.11–0.21)	6,832	(809)
Thinly ($n = 252$)	96	0.38	(0.31–0.46)	5,101	20.2	(19.7–20.7)	1,426	5.7	(5.4–5.9)	6,623	26.3	(25.7–26.8)	22	0.09	(0.06–0.12)	7,056	(433)
Total ($n = 580$)	265	0.46	(0.40–0.51)	9,559	16.5	(16.2–16.8)	4,883	8.4	(8.2–8.6)	14,707	25.4	(25.0–25.7)	66	0.11	(0.09–0.14)	16,240	(1533)

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$. NS = not significant.

Table 2. Number of decayed teeth (DT), missing teeth (MT), filled teeth (FT), decayed/missing/filled teeth (DMFT), and root remnants (RRs) among the dentate participants ($n = 394$) resident in densely/thinly populated living areas compared to the capital, Oslo

Residence	DT				MT				FT				DMFT				RR				Theoretical max. no. of teeth	(No. of intact teeth)
	<i>n</i>	Mean	95% CI		<i>n</i>	Mean	95% CI		<i>n</i>	Mean	95% CI		<i>n</i>	Mean	95% CI		<i>n</i>	Mean	95% CI			
Oslo ($n = 80$)	67	0.84	(0.64–1.04)	NS	625	7.8	(7.2–8.4)***		1,201	15.0	(14.2–15.8)***		1,893	23.7	(22.7–24.6)	NS	6	0.08	(0.02–0.14)*		2,240	(347)
Densely ($n = 178$)	102	0.57	(0.46–0.68)***		1,873	10.5	(10.1–11.0)		2,256	12.7	(12.2–13.2)		4,231	23.8	(23.1–24.4)***		38	0.21	(0.15–0.28)		4,984	(753)
Thinly ($n = 136$)	96	0.71	(0.57–0.85)	NS	1,853	13.6	(13.0–14.2)		1,426	10.6	(10.0–11.1)		3,375	24.8	(24.1–25.5)		22	0.16	(0.09–0.23)		3,808	(433)
Total ($n = 394$)	265	0.67	(0.59–0.75)		4,351	11.0	(10.7–11.4)		4,883	12.4	(12.1–12.7)		9,499	24.1	(23.7–24.5)		66	0.17	(0.13–0.21)		11,032	(1533)

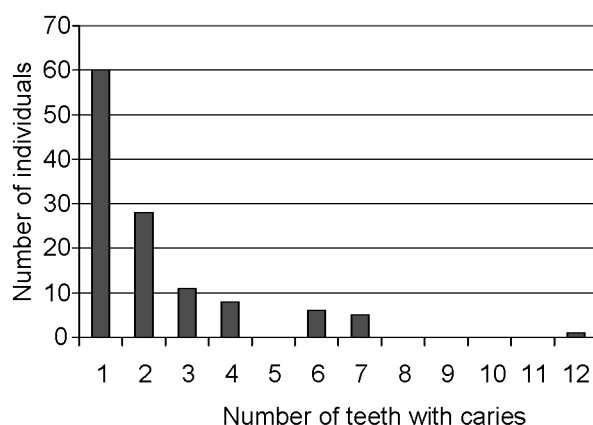
* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$. NS = non significant.

Fig. 1. Number of decayed teeth distributed by individuals with caries.

mean number of MT and DMFT was lower in Oslo than in densely and thinly populated areas, but the differences between the mean numbers were smaller. However, it should be observed that the mean occurrence of caries (DT) did not differ significantly between Oslo and the thinly populated areas (Table 2).

The prevalence of RRs was low in all subgroups, with the highest values among men and among those living in densely populated areas.

Of the total study population ($n = 580$), 119 participants (20.5%) had dental caries (11 participants receiving social care). Of the total number of teeth recorded ($n = 6681$), 4% were decayed (DT). The total number of decayed teeth ($n = 265$) distributed between individuals with caries ($n = 119$) is illustrated in Fig. 1. Out of the 119 individuals with caries, 88 (74%) had only one or two decayed teeth. One individual had 12 decayed teeth (Fig. 1). The proportion of decayed teeth in these 119 individuals decreased with an increasing number of remaining teeth (Fig. 2). The occurrence of caries in teeth identified by their position is shown in Fig. 3. First molars and canines were most often affected by caries in both jaws. The premolars and lower jaw incisors were less affected.

Proportion of teeth with caries, %

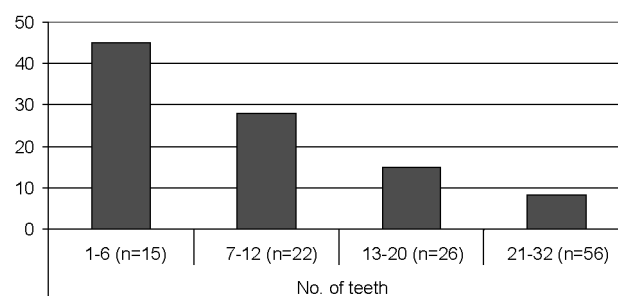


Fig. 2. Proportion of decayed teeth in individuals with caries distributed by number of remaining teeth.

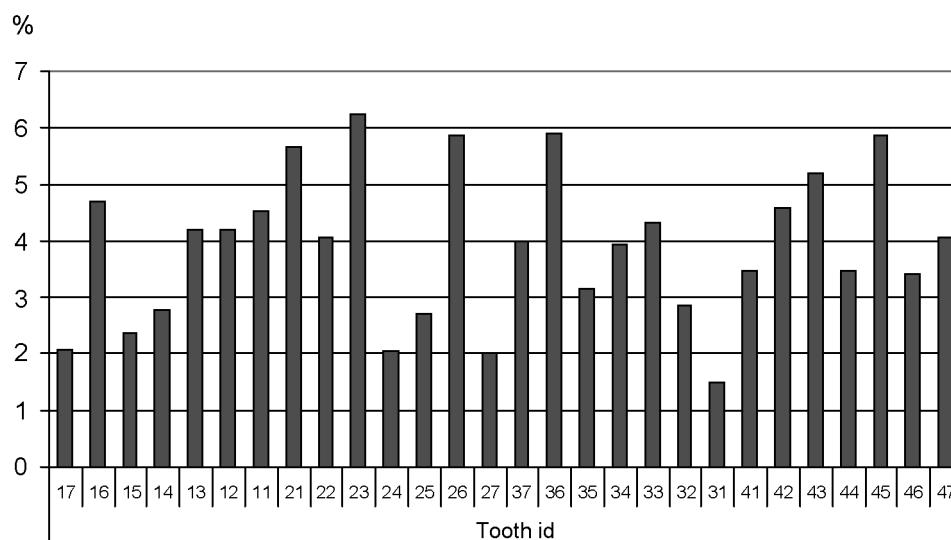


Fig. 3. Proportion of identified teeth affected by caries.

Table 3 gives the number and prevalence of individuals with caries distributed by gender, age group, and geographical region. Among the dentate participants 30.2% had caries (37.9% of 29 dentate participants receiving social care had caries). Caries was more prevalent among men, but the difference between men and women was not statistically significant ($P > 0.05$). Coronal caries was significantly more prevalent than root surface caries ($P < 0.001$) and secondary caries was more prevalent than primary caries, although the difference was not statistically different ($P > 0.05$). The prevalence of the different types of caries did not differ significantly by gender, age group, or residence in the different geographical regions A, B, and C (Table 3).

Discussion

The overall impression of this study is that dental caries is a relatively limited problem for the old age pensioners in Norway. The mean number of decayed teeth (DT) was 0.46 in the total population and 0.67 in the dentate population. This is a decisively lower DT figure than in a previous Norwegian study from a municipality near Oslo undertaken in 1979–80 which showed DT = 1.1 in a dentate non-institutionalized population (25). In the present study in Oslo the mean number of MT was 9.2 and of FT 14.0. These figures differ considerably from the previous figures, which were 14.1 and 8.8, respectively (25). This points at a considerable change in the DMFT

Table 3. Number and prevalence of individuals with caries among the dentate participants distributed by gender, age, and geographical region

	Caries, total			Primary caries			Secondary caries			Coronal caries			Root surface caries		
	<i>n</i>	%	95% CI	<i>n</i>	%	95% CI	<i>n</i>	%	95% CI	<i>n</i>	%	95% CI	<i>n</i>	%	95% CI
Gender															
Men (<i>n</i> = 194)	65	33.5	26.9–40.1	37	19.1	13.5–24.6	49	25.3	19.1–31.4	55	28.4	22.0–34.7	30	15.5	10.4–20.6
Women (<i>n</i> = 200)	54	27.0	20.8–33.2	32	16.0	10.9–21.1	35	17.5	12.2–22.8	43	21.5	15.8–27.2	26	13.0	8.3–17.7
Age group															
67–74 (<i>n</i> = 198)	63	31.8	25.3–38.3	34	17.2	11.9–22.4	50	25.3	19.2–31.3*	54	27.3	21.1–33.5	28	14.1	9.3–19.0
75–84 (<i>n</i> = 168)	46	27.4	20.6–34.1	31	18.5	12.6–24.3	26	15.5	10.0–20.9	36	21.4	15.2–27.6	24	14.3	9.0–19.6
85+ (<i>n</i> = 28)	10	35.7	18.6–55.9	4	14.3	4.0–32.7	8	28.6	13.2–48.7	8	28.6	13.2–48.7	4	14.3	4.0–32.7
Region															
A (<i>n</i> = 207)	64	30.9	24.6–37.2	36	17.4	12.2–22.6	47	22.7	17.0–28.4	53	25.6	19.7–31.5	27	13.0	8.5–17.6
B (<i>n</i> = 176)	50	28.4	21.7–35.1	29	16.5	11.0–22.0	33	18.8	13.0–24.5	41	23.3	17.1–29.5	26	14.8	9.5–20.0
C (<i>n</i> = 11)	5	45.5	16.8–76.6	4	36.4	10.9–69.2	4	36.4	10.9–69.2	4	36.4	10.9–69.2	3	27.3	6.0–61.0
Total (<i>n</i> = 394)	119	30.2	25.7–34.7	69	17.5	13.8–21.3	84	21.3	17.3–25.4	98	24.9	20.6–29.1	54	13.7	10.3–17.1

* $P < 0.05$.

situation among the elderly in Norway and might partly be explained by the fact that previously missing teeth because of caries now have been restored by fillings (33).

In the total study population the sum score DMFT was 25.4 (90.7% of the total number of teeth). This figure is in agreement with reports from other countries. For instance, similar figures are reported from Germany, the UK, the USA, New Zealand, Japan, and Malaysia, while lower figures have been reported from Hong Kong and Singapore. Information from these countries, and others, can be found in a recently published thesis (34). Even though men more often had caries experience (DFT) (Table 1), the prevalence of men having untreated caries was not higher than for women (Table 3). It has previously been found that men and women have different attitudes and behavior regarding dental health and the use of dental services (35). This concurs with the finding in our study that men have more DT and RR than women (Table 1).

Caries experience (DFT) decreased significantly with increasing age (Table 1). However, the prevalence of individuals with caries among the dentate participants did not differ significantly between the different age groups (Table 3).

In the present study, DMFT has been registered. For a more accurate registration of caries, DMFS would have been preferred. However, in the present project the use of simplified indices for an array of parameters was made because of feasibility related to available resources. Also DMFT is an acknowledged index widely used and also supported by WHO (see ref. no. 29). The prevalence of decayed and filled teeth in a population will not change whether DMFS is used or not. It should be observed, however, that DMFS measurements should serve the purpose of for example follow-up studies more accurately than DMFT registrations.

Compared to two Swedish studies on caries in the elderly from a densely populated area (22, 36), the present study shows considerably lower caries prevalence figures. Also comparisons with studies outside Scandinavia, e.g. Australia and the UK (37, 38), indicate that the present figures are comparatively low.

Interestingly, individuals with many remaining teeth had a low number of caries lesions (Fig. 2) and the caries lesions were fairly evenly distributed in their position in the mouth (Fig. 3). This result, showing the association between the number of remaining teeth and number of caries lesions, should be interpreted with some caution. These dentate individuals still had premolars and molars, making the detection of caries lesions in the contact junction more difficult. However, the differences between groups by number of remaining teeth at analysis (Fig. 2) were considerable and our results may therefore be considered as correct.

The recording of caries was based on a clinical examination. No radiographic examination was carried out, so some caries lesions may have been overlooked, leading to an under-registration of caries. However, about 40% of the teeth were missing (MT) in the dentate popu-

lation, mostly premolars and molars (27), possibly leading to a decreased number of teeth with approximal contacts. It thus seems unlikely that the number of undiscovered caries could have affected the result significantly. It should also be noted that the Kappa value of the inter-examiner test with an experienced cariologist and without the use of X-rays was as high as 0.62.

The occurrence of coronal caries proved significantly more prevalent than root surface caries ($P < 0.001$). This is in contrast to findings in some other studies (22, 39, 40). In the present study the root surface caries prevalence is fairly low, 13.7% in the dentate population, compared to other findings reported from Scandinavia (10, 41). Our findings do not support the statement by Jallaludin (34) that 'root caries is considered a significant oral health problem of the elderly', referring to Beck et al. (42). Our findings do not support a previous statement that root surface caries increases with increasing age (21) (Table 3). It should be emphasized that different factors, including the criteria, influence the prevalence figures for caries and perhaps most importantly for root surface caries (43).

The prevalence of old age pensioners with caries in Norway has thus been shown to be independent of gender, age, residence by geographical region and population density (Table 1).

Many factors may contribute to the development of caries in old age. Data have been collected on an array of possible independent variables such as oral hygiene, dry mouth, mental and physical disabilities, and socio-economic factors. These factors will be the subject of future analyses.

In conclusion, it seems that caries is a minor problem in the Norwegian elderly population. Age and the number of remaining teeth do not have a decisive role in the development of caries. Further, there are no differences in these respects between geographical regions in Norway.

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