A 24-year follow-up of root filled teeth and periapical health amongst middle aged and elderly women in Göteborg, Sweden

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Abstract

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Aim To describe the endodontic status amongst middle-aged and elderly women longitudinally and cross-sectionally over 24 years.

Methodology A random sample of 1462 women 38, 46, 50, 54 and 60 years old, living in Göteborg, Sweden, were sampled in 1968 for medical and dental examinations with a participation rate of 90.1%. The same women were re-examined in 1980 and 1992 together with new 38- and 50-year-old women. The dental examination consisted of questionnaires, clinical and panoramic radiological survey (OPG). The number of teeth, number of root filled teeth (RF) and number of teeth with periapical radiolucencies (PA) were registered. The RF and PA ratios were calculated. Cross-sectional data were analysed by means of ANOVA and longitudinal data by a general linear model for repeated measures. Sample prevalences were compared and statistical inferences were made with the chi-squared test. In all analysis, the confidence interval (CI) regarded mean difference between groups (95% CI).

Results The RF and PA ratio decreased over time as well as the frequency of edentulous subjects. Cross-sectional analysis revealed a minor increase in frequency of RF and PA and loss of teeth with age. Longitudinally, loss of teeth was evident in all cohorts. In addition, there was a trend of lower number of teeth with PA, and the RF ratio increased with age.

Conclusions The prevalence of periapical disease did not increase with age, probably as a result of root canal treatment and extractions. Data showed that the prevalence of RF teeth and teeth with PA decreased for comparable age cohorts during the 24-year follow-up.

Keywords: cross-sectional, endodontic, epidemiology, longitudinal, oral health.

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Introduction

It is generally believed that oral health in Sweden has improved over the last 40 years (Hugoson *et al.* 1995, Ahlqwist *et al.* 1999). Epidemiological data demonstrate a lower prevalence of edentulous subjects and more retained teeth amongst the elderly. The incidence of caries is also decreasing in most age groups and is probably a major contributor to better oral health and the increasing number of remaining teeth (Hugoson *et al.* 1995). However, a more conservative approach towards treatment may also be an important factor, for example, root canal treatment instead of extraction.

Clinical studies show that root canal treatment of an acceptable technical quality results in a high rate of healing, 85–90% (Strindberg 1956, Sjögren *et al.*

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1990). However, these studies are usually performed in settings not representative of general dental care. Epidemiological data show that the rate of healing following root canal treatment performed by general practitioners is 65–75% (Ödesjö *et al.* 1990, Eriksen 1991). Thus, epidemiological data reflects a realistic outcome of root canal treatment whilst data from clinical studies demonstrates what can be achieved with root canal treatment (Eriksen 1991).

Most epidemiological surveys use a cross-sectional perspective. From these studies it is evident that older individuals have a lower number of remaining teeth and higher ratio of root filled teeth (RF) and teeth with periapical radiolucencies (PA) compared with younger adults (Table 1). These studies do not provide information about the temporal dynamics in oral health which is possible in longitudinal or repeated cross-sectional studies. Eckerbom *et al.* (1989) used information from 200 patients referred for full-mouth radiographic examination with a follow-up of 5–7 years. They found that, on average, the number of teeth decreased with age, but the number of root filled teeth increased. The number of teeth with PA did not change significantly during the follow-up period. Petersson (1993a) examined 345 randomly selected subjects with a follow-up of 11 years by means of clinical and radiological examination of the mandibular molar- and premolar region. Loss of teeth and an increasing sample prevalence of root filled teeth and teeth with PA were noted over time. Longitudinal studies on this issue are scarce, and the two presented have certain drawbacks. The first one used a selected and rather small sample with a short follow-up. The second study used information only from selected teeth.

In repeated cross-sectional studies, similar but not identical population samples are studied at two or more separate occasions. Eriksen *et al.* (1995) studied randomly selected samples from an urban population of 35-year olds at three time periods, 1973, 1984 and 1993 with 111, 141 and 118 subjects examined, respectively. There were only minor changes regarding number of teeth and prevalence of RF teeth and teeth with PA between 1973 and 1984, but significant changes in 1993 with a lower prevalence of RF teeth and teeth with PA. Petersson (1993b) used information from clinical and radiographic examinations of the molar and premolar region of 861 randomly selected subjects in 1974 and 586 in 1985 and found that the number of subjects with no loss of teeth was lower in 1985 for those aged 20–49 years. In addition, the number of subjects with RF teeth as well as subjects with apical periodontitis were lower in 1985 for those aged 20–39 years. Eriksen *et al.* (1995) examined only one age group, and the population yielded a rather small sample. Petersson (1993b) used information from selected teeth only.

The aim of this study was to describe the number and frequency of root filled teeth and periapical radiolucencies in an urban female population cross-sectionally at three examinations and longitudinally over 24 years, using a representative sample.

Materials and methods

The population study of women in Göteborg, Sweden was initiated in 1968 and a random sample of 1622 women 38, 46, 50, 54 and 60 years of age was selected. Of those invited, 1462 participated in the medical aspect of the study and 1417 in the dental (Bengtsson *et al.* 1973).

The same women were re-examined in 1980–81 and 1992–93 with the addition of a new group of 38-year-old women on both occasions. Due to changes in the general population and to ensure representativeness, new groups of women were added to the cohorts with women born in 1922 and 1930 in the 1992–93 and 1980–81 examinations, respectively (Fig. 1). Detailed information on sampling procedure have been published previously (Bengtsson *et al.* 1997).

The dental examination included a panoramic radiographic survey and a questionnaire. In 1968–69 and 1992–93 it also included a colour photograph of the dentition and in 1992–93 a clinical examination. Assessment of the number of teeth, the number of RF teeth and the number of teeth with PA were obtained from the panoramic radiograph. The ratio of root filled teeth (RF ratio) was defined as the ratio between number of root filled teeth and total number of teeth. The sample prevalence of root filled teeth was defined as the ratio between number of subjects with ≥1 root filled and the total number of subjects. The variables for teeth with periapical radiolucencies, PA ratio and sample prevalence of teeth with periapical radiolucencies, were defined in the same way as the corresponding variables for root filled teeth. A periapical radiolucency was defined as a widened periapical ligament space or an overt radiolucency.

Of those attending the first two examinations 68.1% took part in the 24-year follow-up. For information on characteristics of nonparticipants see Ahlqwist *et al.* (1999).

Table 1 Prevalence of remaining and rootfilled teeth as well as frequency of periapical destructions

	No. teeth	R rf (%)	R pa (%)	R rf-pa (%)	Samp rf (%)	Samp pa (%)	Details	Country
Bergenholtz *et al.* (1973)	22.8	12.7	6.1	30.5		57	$n = 240$. Patients referred to radiologist. Mean age 45 years (20 to >70)	Sweden
Lavstedt (1978)	22.6	11.1	1.2 (roots)		72.2	45	$n = 1391$. Randomized sample. Mean age 40 (18–65)	Sweden
Allard & Palmqvist (1986)	14.2	17	14	27		72	$n = 188$. Old subjects age >65, non-institutionalized. Randomized sample. Men age 73 (65 to >75)	Sweden
Bergström *et al.* (1987)	26.4	6.5	3.5	28.8 (roots)		46.8	$n = 250$. Patients with regular dental care. Age 21–60	Sweden
Eckerbom *et al.* (1987)	24.4	13	5.2	26.4	83.5	63	$n = 200$. Patients referred to radiologist. Mean age 40 (20 to >60)	Sweden
Eckerbom *et al.* (1989)	23.5	14.7			87.5	64	$n = 200$. Patients referred to radiologist. Mean age 45	Sweden
Eriksen *et al.* (1988)	26.9	3.4	1.5	18	50	30	$n = 111$. 35-year olds in Oslo 1973. Randomized sample	Norway
	27.8	3.4	1.4	25,6	53	30	$n = 141$. 35-year olds in Oslo 1984. Randomized sample	Norway
Ödesjö *et al.* (1990)	23.5	8.6	2.9	24.5		43.2	$n = 743$. Randomized sample. Age 20 to >80	Sweden
Eriksen (1991)	24.7	6	3.5	36.6	56		$n = 119$. 50-year olds in Oslo. Randomized sample	Norway
De Cleen *et al.* (1993)	22.8	2.3	6.0	39.2			$n = 184$. Patients referred to oral surgeon.	The Netherlands
Eriksen *et al.* (1995)	27.8	1.3	0.6	38.1	24	14	$n = 118$. 35-year olds in Oslo 1993. Randomized sample	Norway
Soikkonen (1995)	15.3	21		16	78	41	$n = 169$. Old subjects age ≥75. Randomized sample	Finland
Marques *et al.* (1998)	24.8	1.5	2.0	22	26	22	$n = 179$. Age 30–39 from Porto. Randomized sample	Portugal
Sidaravicius *et al.* (1999)	26.5	15	7.2	35	84	70	$n = 147$. Age 35–44 from Vilnius. Randomized sample	Lithuania
Kirkevang *et al.* (2001)	26.0	4.8	3.4	52.2	52	42.3	$n = 614$. Age 20 to >60 from Århus. Randomized sample	Denmark

No. teeth, number of teeth; R rf, ratio of root filled teeth; R pa, ratio of teeth with periapical destructions; R rf-pa, ratio of root filled teeth with periapical destructions; Samp rf, sample prevalence (ratio of subjects with ≥1 root filled tooth); Samp pa, sample prevalence (ratio of subjects with ≥1 tooth with periapical destruction); *n*, number of subjects.

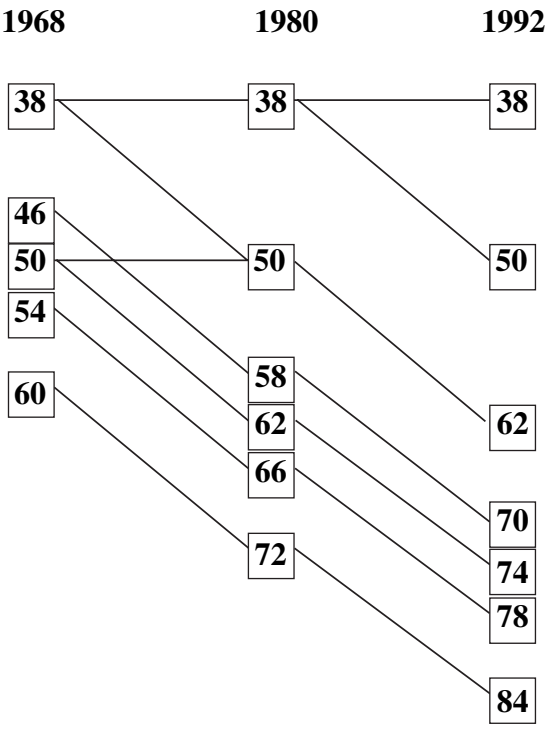

Figure 1 Design of the study. Cross-sectional examinations vertically, repeated cross-sectional examinations horizontally and longitudinal examination diagonally.

The study design according to the different cohorts and examination year is presented in Fig. 1.

In the present study edentulous women were excluded, leaving 1220 dentate subjects for the cross-sectional study in 1968–69, 1023 in 1980–81 and 867 in 1992–93. For the mean age and number of participants in each age group, see Table 2. In the longitudinal study, women born in 1908 were excluded due to the large dropout. Only nine dentate women in this cohort participated in all three examinations. Thus, 586 dentate subjects participated in the longitudinal study, constituting 48% of the dentate participants in 1968–69 (Table 3).

Statistical methods

Cross-sectional data were analysed by means of ANOVA and longitudinal data by a general linear model for repeated measures. Sample prevalences were compared and statistical inferences were made with the chi-squared test. In all analysis, the confidence interval (CI) regarded mean difference between groups (95% CI).

Table 2 Number of probands with regard to age group at the different examinations, and number and mean age of edentulous and dentate subjects compared with total sample

Year of birth	Age	Total sample (*n*)	Dentate subjects (*n*)	Edentulous subjects (*n*)
1968				
1930	38	356	342	14
1922	46	421	378	43
1918	50	390	319	71
1914	54	172	133	39
1908	60	78	48	30
Mean age (SD)		46.8 (6.2)	46.2 (6.1)	50.6 (5.7)
1980				
1942	38	108	106	2
1930	50	323	310	13
1922	58	305	261	44
1918	62	295	225	70
1914	66	125	97	28
1908	72	41	24	17
Mean age (SD)		56.3 (8.2)	55.5 (8.3)	61.4 (5.8)
1992				
1954	38	66	66	0
1942	50	98	97	1
1930	62	268	254	14
1922	70	275	233	42
1918	74	200	153	47
1914	78	70	52	18
1908	84	16	12	4
Mean age (SD)		65.3 (10.7)	64.4 (10.9)	72.0 (5.3)

Table 3 Number of participants in each age group in the longitudinal study, compared with the total sample in 1968

1908	9[a] (78)
1914	48 (172)
1918	140 (390)
1922	192 (421)
1930	206 (356)
Total	595 (1417)

[a]Excluded in the longitudinal study.

Results

Cross-sectional findings

1968

The mean number of teeth were 19.8 (SD 7.2) and 13.9% of the participants were edentulous (Table 4). The sample prevalences of PA and RF were 41.9 and 84.3%, respectively. Overall, there was a significant decrease in number of teeth with age. However, a nonsignificant difference was found between 54-year olds compared with 50-year and 46-year olds, respectively.

Table 4 Prevalence of remaining teeth, root filled teeth and teeth with periapical destructions [mean, standard deviation and confidence interval for mean and ratio (95% CI)]

		No. teeth			No. rf			No. pa			R rf (%)		Samp	R pa (%)		Samp
	n	Mean	SD	CI	Mean	SD	CI	Mean	SD	CI		CI	rf (%)		CI	pa (%)
1968																
1908	48	13.7	7.8	11.5–16	3.7	3.3	2.7–4.6	0.7	1.0	0.4–1	27.4	19.5–35.3	77.1	5.1	3–7.3	45.8
1914	133	18.2	7.2	16.9–19.4	3.8	2.9	3.3–4.3	0.7	1.0	0.5–0.9	22.4	19.3–25.4	91.7	3.6	2.7–4.7	40.6
1918	319	17.8	7.3	17–18.6	3.5	3.0	3.2–3.8	0.8	1.3	0.7–0.9	20.0	18–21.9	82.4	5.6	3.8–7.3	43.3
1922	378	19.8	7.0	19.1–20.5	3.6	2.8	3.3–3.8	0.8	1.2	0.7–0.9	18.5	17–20.1	85.7	5.0	4–5.9	45.8
1930	342	23.1	5.5	22.5–23.7	3.1	2.8	2.8–3.4	0.6	1.1	0.5–0.9	13.6	12.2–14.9	82.7	2.8	2.2–3.4	34.2
Total	1220	19.8	7.2	19.4–20.2	3.4	2.9	3.3–3.6	0.7	1.2	0.7–0.8	18.3	17.4–19.2	84.3	4.4	3.8–5	41.9
1980																
1908	24	13.4	7.6	10.2–16.57	4.4	3.5	3–5.9	0.5	0.8	0.2–0.9	34.2	21.7–46.8	79.2	3.5	0.6–6.4	33.3
1914	97	16.7	7.3	15.3–18.2	4.1	3.0	3.5–4.7	0.6	1.0	0.4–0.8	28.0	23.5–32.6	93.8	4.2	1.9–6.5	37.1
1918	225	17.7	6.7	16.8–18.5	4.1	3.2	3.7–4.5	0.5	0.8	0.4–0.6	24.1	21.5–26.8	87.5	2.9	2.2–3–5	35.6
1922	261	18.9	6.9	18.1–19.7	4.2	3.0	3.9–4.6	0.8	1.2	0.7–0.9	24.1	21.8–26.4	91.5	5.4	3.9–6.9	47.1
1930	310	21.8	5.9	21.1–22.5	3.9	3.1	3.5–4.2	0.7	0.9	0.6–0.8	19.2	17.3–21	89.3	3.7	2.9–4–5	45.5
1942	106	25.4	4.8	24.5–26.3	3.1	2.8	2.5–3.6	0.5	0.7	0.4–0.6	13.1%	10.7–15.5	84.9	2.0	1.5–2.6	38.7
Total	1023	19.8	7.0	19.4–20.3	4.0	3.1	3.8–4.2	0.6	1.0	0.6–0.7	22.1%	20.9–23.3	89.2	3.8	3.3–4.3	41.9
1992																
1908	12	13.4	6.8	9.1–17.7	3.3	3.2	1.2–5.4	0.3	0.5	−0.04–0.6	25.4	10.7–40	90.9	4.4	−1.3–10.2	27.3
1914	52	17.5	5.9	15.9–19.1	4.4	3.3	3.4–5.3	0.5	0.9	0.2–0.7	26.6	20.5–32.7	94.1	2.6	1–4.2	27.5
1918	153	16.4	7.3	15.3–17.6	4.0	3.2	3.5–4.5	0.4	0.8	0.3–0.5	26.1	22.7–29.5	86.0	3.1	2–4.3	26.7
1922	233	17.7	7.1	16.8–18.7	4.3	3.2	3.9–4.7	0.5	1.0	0.4–0.7	26.9	23.9–29.9	87.8	3.6	2.5–4.8	33.5
1930	254	21.1	6.1	20.3–21.8	4.1	3.0	3.7–4.4	0.5	0.9	0.4–0.6	20.9	18.7–23.2	87.3	2.9	2–3.7	34.9
1942	97	24.1	5.7	23–25.3	3.4	2.9	2.8–4	0.4	0.7	0.2–0.5	15.1	12.3–17.9	86.6	1.7	1–2.4	25.8
1954	66	28.1	2.2	27.5–28.6	0.9	1.4	0.6–1.3	0.3	0.6	0.1–0.4	3.3	2–4.7	45.3	1.0	0.3–1.6	17.2
Total	867	19.9	7.2	19.4–20.4	3.8	3.1	3.6–4	0.5	0.9	0.4–0.5	21.9	20.5–23.2	84.7	2.8	2.4–3.3	31.1

n, Number of subjects; No. teeth, number of teeth (mean, standard deviation, confidence interval for mean); No. rf, number of root filled teeth (mean, standard deviation, confidence interval for mean); No. pa, number of teeth with periapical destruction (mean, standard deviation, confidence interval for mean); R rf, ratio of root filled teeth (confidence interval for ratio); Samp rf, sample prevalence (ratio of subjects with ≥1 root filled tooth); R pa, ratio of teeth with periapical destruction (confidence interval for ratio); Samp pa, sample prevalence (ratio of subjects with ≥1 tooth with periapical destruction).

There were no significant differences regarding number of RF between age groups. However, for RF ratio there was a trend of increasing frequency with age, but merely a significant difference between 38-year olds and older women, and 54-year olds and 46-, 50- and 60-year-old women.

For the number of PA, no differences between age groups were noted. The PA ratio displayed a trend of increasing with age, with the only significant difference found between 38- and 50-year-old women.

1980

The mean number of teeth was 19.8 (SD 7.0) (Table 4). The edentulous subjects represented 14.5% of the sample. The sample prevalences for PA and RF were 41.9 and 89.2%, respectively.

As in 1968, the number of teeth decreased with age. The differences between age groups were significant with exceptions for 58-, 62- and 66-year-old women, and 66- and 72-year-old women.

The number of RF increased with age, however nonsignificantly with exception for differences between 38- and 58-year-old women. The same tendency was noted for RF ratio, where significant changes were identified between the youngest age groups and the oldest age groups.

Only minor changes were noted for number of PA, with a significant decrease between 58- and 62-year-old women. For PA ratio the same pattern was evident, where 38- and 62-year-old women had significantly lower frequency of PA compared with 58-year-old women.

1992

The mean number of teeth was 19.9 (SD 7.2) and 12.7% of the sample were edentulous (Table 4). The sample prevalences for PA and RF were 31.1 and 84.7%, respectively. In concordance with the earlier examinations, the number of teeth decreased with age. However, there were no significant differences between the four oldest age groups.

Only 38-year-old women differed significantly from other subjects with a lower number of RF. For the RF ratio there were no significant differences between the four oldest age groups. There were a significantly lower RF ratio in 38-year-old women than older women, which was also true for 50-year olds as compared with 70- and 74-year-old women. There was a significant increase between 62- and 70-year-old women. The number of PA did not differ significantly between age groups, nor did the PA ratio.

Repeated cross-sectional findings

38-year olds

The prevalence of edentulous women were 3.9% in 1968, 1.9% in 1980 and 0% in 1992 ($\chi^2 = 3.6; P > 0.05$). When comparing number of teeth there was a significant increase over time. In 1992, there was a significantly lower number of RF and a lower RF ratio than in 1968 and 1980, and a lower number of PA and lower PA ratio than in 1968 (Table 4).

50-year olds

In 1968, 18.2% of the women were edentulous, compared with 4% in 1980 ($\chi^2 = 34.2; P < 0.05$) The number of teeth increased significantly from 1968 to 1980. The number and ratio of RF did not change significantly, nor did the number and ratio of PA between 1968 and 1980 (Table 4).

Longitudinal findings

The participants in the longitudinal study constituted 48% of the dentate participants in the 1968 examination. The mean age in 1968 was 45 years. In all age groups there were a significant loss of teeth associated with ageing (Fig. 2). The number of RF increased significantly with age in the group of women born in 1930, 1922 and 1914 (between 1968 and 1980 only) whilst nonsignificant changes were noted for the other groups (Fig. 3). The RF ratio increased significantly with ageing in all groups (Fig. 4). The number of PA decreased with age for all women, but this change was only significant for women born in 1918 and 1922 (Fig. 5). The PA ratio did not change significantly over time, except between 1968 and 1980 for women born in 1918, for whom a significant decrease was noted.

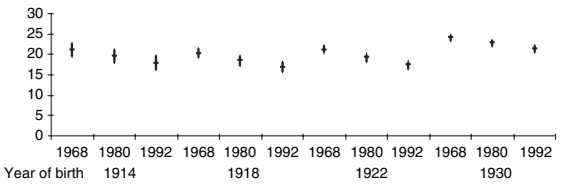

Figure 2 No of teeth. Longitudinal examination. CI for mean (95% CI).

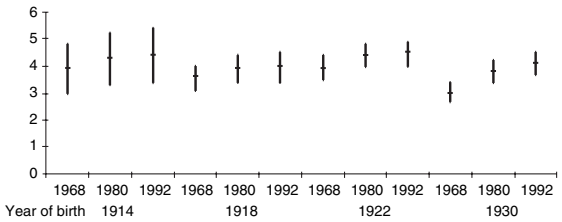

Figure 3 No of RF teeth. Longitudinal examination. CI for mean (95% CI).

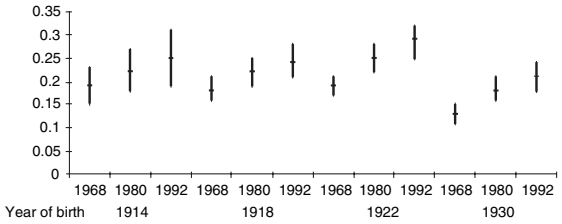

Figure 4 RF ratio. Longitudinal examination. CI for ratio (95% CI).

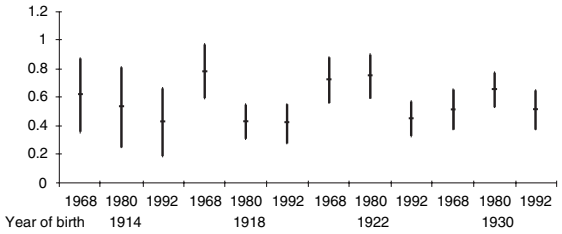

Figure 5 No of teeth with PA. Longitudinal examination. CI for mean (95% CI).

Discussion

This study reports on the changes in number of retained teeth, number and frequency of RF teeth and PA cross-sectionally and longitudinally over 24 years. The RF and PA ratio decreased over time for comparable age groups as well as the frequency of edentulous subjects. Overall, the cross-sectional analysis revealed a minor increase in frequency of RF and PA as well as

loss of teeth with age. Longitudinally, loss of teeth with ageing was evident in all cohorts. In addition, there was a trend of a lower number of teeth with PA, and the RF ratio increased with age.

With its high participation rate and method of sampling, the results from this study are representative for an urban female population. To make both cross-sectional and longitudinal analysis possible, new samples were not selected in 1980–81 and 1992–93, except for 38-year-old women. However, new random samples were added to the cohorts of 50- and 70-year-old women in 1980–81 and 1992–93, respectively. This may have implications regarding the representativity in the cross-sectional analysis. However, nonparticipation and loss to follow-up over time may always challenge representativity and generalization of results in epidemiological studies.

Several studies with gender stratification do not present any analysis of possible differences associated with gender (Bergenholtz *et al.* 1973, Ödesjö *et al.* 1990, De Cleen *et al.* 1993). Some studies have reported on a higher number of RF teeth in women, but more seldom differences regarding periapical disease (Lavstedt 1978, Allard & Palmqvist 1986, Kirkevang *et al.* 2001). Thus, the high RF ratio found in the present study, may to some extent be explained by gender and is probably not representative for the whole population.

Contrary to most studies in this field, the quality of the root fillings were not evaluated. There are reports on the difficulties in interpreting the technical quality of root fillings on intraoral radiographs (Reit & Hollender 1983). As a panoramic survey was used, it was even more difficult to make a reliable assessment of treatment quality. A few studies have used panoramic survey for quality assessment, even though the reliability could be questioned (De Cleen *et al.* 1993, Soikkonen 1995, Marques *et al.* 1998).

In 1968, there was a linear relationship between an increasing ratio of RF teeth, decreased number of teeth and a slightly increasing PA ratio and ageing, respectively. In 1992, there were only small differences between the oldest age groups, implying a steady-state in oral health development. However, in 1992 there was a low attendance rate for the oldest women, those born in 1908, 1914, 1918 and 1922 due to illness or death. Of the participants in those groups, 280 subjects (19.2%) had died before the follow-up examination in 1992. Hence, those examined were the healthiest subjects. Thus, low attendance rate and selection of healthy subjects may explain the small differences.

In all three cross-sectional examinations there was a significant increase in the ratio of RF teeth with age, but the absolute number did not differ between age groups, except for the 38-year olds in 1980 and 1992. The same pattern was evident in the longitudinal study. The explanation may be that the number of teeth decreased with age; which teeth were extracted was unknown. RF teeth are more often extracted than nonroot filled teeth (Eckerbom *et al.* 1992). That could mean, as the absolute number of RF teeth was virtually constant, but the number of teeth decreased, that several participants often had root canal treatment during ageing. The absolute number of teeth with PA was constant, and the PA ratio increased only slightly with age cross-sectionally. Longitudinally however, a decrease in the absolute number of PA was noted, but no changes in ratio over time. Thus, the prevalence of periapical disease did not increase with age which is contrary to the results from cross-sectional studies (Eriksen 1991, Kirkevang *et al.* 2001). This may mean that teeth with periapical radiolucencies, both explain part of the loss of teeth due to extraction, and part of the increasing prevalence of root filled teeth. Eckerbom *et al.* (1989) found a significant increase in the number of RF teeth with age in a longitudinal study over 5–7 years, but no significant changes in PA ratio.

The repeated cross-sectional analysis showed that the number and prevalence of root filled teeth decreased and that the periapical status improved during 24 years for comparable age groups. Eriksen *et al.* (1988) did not find significant differences in RF ratio or PA ratio in two cohorts of 35-year olds with 11 years between examinations, but found a significant decrease in RF and PA ratio after examination of a third cohort of 35-year olds, 20 years after the first examination (Eriksen *et al.* 1995). In the present study, a significant decrease in both number and ratio of RF between 38-year olds born in 1954 and 1930 and 1942, respectively, but not between 1930 and 1942 was found. For PA, a significant decrease was noted between 38-year-old women born in 1930 and 1954, regarding both absolute number and ratio.

The sample prevalence of teeth with PA was significantly lower in 1992 than 1980 and 1968. In 1968 and 1980 it was 41.9%, which is comparable with Lavstedt (1978), who used information from a randomly selected material with a sample prevalence of 45%. Bergenholtz *et al.* (1973) evaluated a selected group of 240 patients, which may explain the higher sample prevalence of 57%. In 1992, the sample

prevalence in the present study was 31.1%. Ödesjö *et al.* (1990) examined 743 randomly selected dentate subjects from a rural area and found a sample prevalence of 43.2%.

The sample prevalence of RF varied slightly. All age groups were within the range 75–95% in all three cross-sectional examinations. Only the 38-year olds in 1992 had a markedly lower sample prevalence of RF teeth where 45.3% had one or more RF tooth. Compared with other studies the sample prevalence in the present study was high. Eckerbom *et al.* (1987, 1989) reported sample prevalences between 83.5 and 87.5%, respectively, but they used a selected sample of patients referred for radiological survey. Other Scandinavian studies report sample prevalences ranging from 50 to 72.2%. However, the age of these samples varied when compared with the present sample.

The ratio of RF teeth and teeth with PA differed from other population surveys, as there were more RF teeth and fewer teeth with PA. This result is somewhat confusing, as most studies conclude that the majority of PA are found adjacent to RF teeth (Eriksen & Bjertness 1990, Kirkevang *at al.* 2001). Ahlqwist *et al.* (1986) found no differences, essential in an epidemiological context, between intraoral radiographs and panoramic survey in detecting endodontic features. Thus, the risk of underestimating the frequency of PA should be limited. However, the literature has shown that observer variation may have an impact on the results (Reit & Hollender 1983).

Conclusion

The number of teeth decreased with age cross-sectionally and longitudinally, but increased for comparable age groups in recent years. Moreover, the prevalence of edentulous individuals decreased over time. The ratio, but not the absolute number of RF teeth increased with age, but the RF ratio and PA ratio decreased for comparable age groups in recent years. Longitudinally, a significant decrease in the absolute number of PA was noted.

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