Dental status of women in a 24-year longitudinal and cross-sectional study. Results from a population study of women in Göteborg

Margareta Ahlqwist, Calle Bengtsson, Magnus Hakeberg and Catharina Hägglin
Departments of Oral Diagnostic Radiology, Primary Health Care and Endodontology/Oral Diagnosis, Göteborg University, Göteborg, Sweden

Ahlqwist M, Bengtsson C, Hakeberg M, Hägglin C. Dental status of women in a 24-year longitudinal and cross-sectional study. Results from a population study of women in Göteborg. Acta Odontol Scand 1999;57:162–167. Oslo. ISSN 0001-6357.

The aim of the study was to describe dental health status among middle-aged and elderly women over a 24-year period. Because of the design of the study it was possible to make both longitudinal and cross-sectional comparisons. The study started in 1968–69 with a combined medical and dental examination of women aged between 38 and 60 years. New dental examinations of these same women were performed in 1980–81 and again in 1992–93, and included new cohorts of 38-year-old women on both occasions. In the cross-sectional perspective, it was shown that the number of edentate individuals decreased significantly during the 24-year period. Among dentate women, the number of remaining teeth and restored teeth increased significantly cross-sectionally. However, the youngest age group, women of 38 years, showed a lower number of restored teeth in the latest study (in 1992–93). There was also a lower number of crowns, root-fillings, and pontics in the latest study for the youngest age group. The two older age groups studied cross-sectionally showed similar numbers in all studies. In the longitudinal study, there was a decrease with time in incidence of edentulism. Among the dentate women in the longitudinal study the number of restored teeth related to those remaining was high (range 76–90%) and did not change much between the studies in the different age groups. There was a clear tendency during the 24-year period in all age groups for more teeth to be restored with crowns rather than different fillings. In conclusion, this population study, with a follow-up of 24 years, shows that dental status improved in that fewer individuals lost all their teeth and younger age groups have more remaining teeth and fewer restorations than previously. □ *Dental status; epidemiology; longitudinal; women*

Margareta Ahlqwist, Göteborg University, Box 100, SE-405 30 Göteborg, Sweden. Tel. +46 31 7735345, fax. +46 31 7734355, e-mail: Margareta.Ahlqwist@adm.gu.se

During recent decades, dental health has improved in the Western world. Fewer teeth are now extracted, the rates of edentulousness have decreased, and there is a lower prevalence of decayed teeth in younger people (1–7).

In a study performed in 1980–81 (8) we reported a considerably lower number of edentate individuals in comparable age groups, and among dentate individuals a higher number of remaining and restored teeth compared to 12 years earlier. Restorations with crowns rather than fillings increased significantly during the period.

As little information on dental health is available from longitudinal studies in adults, and as dental status shows big changes with time, we considered it important to prolong the study by another 12 years, i.e. to 1992–93.

Material and methods

The study began in 1968–69, when a randomized population sample of women in the age groups 38, 46, 50, 54, and 60 years participated in a combined medical and dental examination in Göteborg, Sweden (9). These same women were re-examined in 1980–81. A new group of women aged 38 years was also invited to participate in 1980–81 as well as a new group of 50-year-olds who had moved to Göteborg since the time of the baseline sampling. The new participants fulfilled the initial inclusion criteria (9, 10).

A 24-year follow-up study was performed in 1992–93. Again a new group of 38-year-old women was included. Among women who were 70 years in 1992–93 a new group of 80 women was invited; these women had moved to Göteborg during the 24-year study period but otherwise fulfilled the inclusion criteria. Table 1 shows the distribution of participants in the dental parts of the three studies. A few women participated in 1968–69 and 1992–93 but not in 1980–81.

The general design of the study makes it possible to make both cross-sectional and longitudinal comparisons (Fig. 1).

Dental examination

On all three occasions the dental examination included a panoramic radiographic survey and a questionnaire. In 1968–69 and in 1992–93 a colour photograph of the dentition was taken. In 1992–93 there was also a clinical examination of the teeth and alveolar processes.

From the panoramic surveys, the numbers of teeth, restorations, crowns, pontics, and endodontically treated teeth were assessed. The 32-teeth dentition was used as a frame of reference.

Participation and characteristics of non-participants

The non-participants in the first study differed from the

Table 1. No. of participants in the study in 1968—69, 1980—81, and 1992—93 according to age and dental status

	1968—69			1980—81			1992—93			Participants in all three studies	
Year of birth	Age	Total	Dentate	Age	Total	Dentate	Age	Total	Dentate	Total	Dentate in 1992–93
1954	—	—	—	—	—	—	38	66 (+1)†	66	66*	66*
1942	—	—	—	38	109	107	50	98	97	82**	81**
1930	38	356	342	50	323	310	62	268 (+1)†	254	217	206
1922	46	421	378	58	305	261	70	275 (+1)†	233	226	192
1918	50	390	319	62	295	225	74	201 (+2)†	154	181	140
1914	54	172	133	66	125	97	78	70	52	65	48
1908	60	78	48	72	41	24	84	16	12	13	9
Total	38–60	1417	1220	38–72	1198	1024	38—84	994 (+5)	868	850	742

* Participated only in 1992—93; ** participated in 1980—81 and in 1992—93, † participants with no radiographic examination.

participants only regarding marital status; there was an overrepresentation of single women compared to participants (11). In the initial study (1968–69), the non-participating women in the follow-up study in 1980–81 had significantly fewer teeth than those who participated in both studies, and also an absolute and relative lower number of restored teeth (10).

In the medical part of the study in 1992–93 there was a participation rate of 70.2% among those who had participated in 1968–69 and who were still alive in 1992–93 (12). Regarding the dental part of the study, 68.1% of those who participated in the first two dental studies ($n = 1031$) came back for the third one ($n = 702$).

The non-participants in the dental study in 1992–93 were 12 years earlier more often edentate ($P < 0.05$) or had an absolute lower number of teeth ($P < 0.001$) than the participants when the age groups were studied together and age was used as a background variable. However, there was no statistically significant difference regarding the relative number of restored teeth between participants and non-participants.

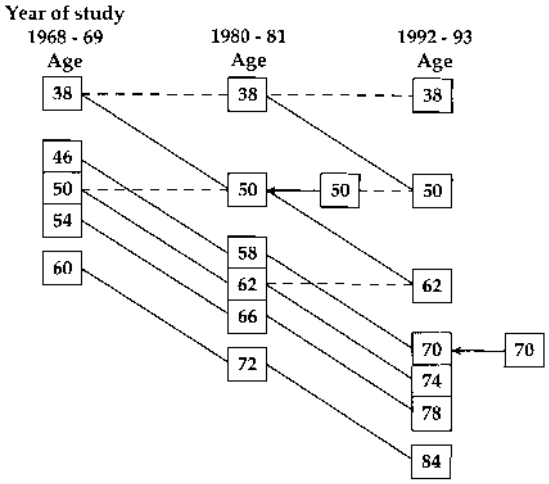

Fig. 1. General design of the population study of women.

Of the women born in 1954, 67 of 85 invited women participated in the dental part of the study in 1992–93 (78.8%).

Statistical methods.— The pairwise t test was used to test differences between two time-points. To test changes in over three time-points, a generalization of the pairwise t test was used. The technique was to compute, for each individual, the regression coefficient in a linear regression model for the three values for the different examinations. This is a measure of the average change between time-points, which is then used in a one-sample t test.

Comparisons between different groups were carried out by means of Pitman's permutation test. Differences were considered statistically significant for values of $P < 0.05$. NS means no statistically significant difference.

Results

Edentulism

Cross-sectional study.—Among the 38-year-olds, the number of edentate women decreased from 3.9% in 1968–69 to 1.8% in 1980–81, and to 0% in 1992–93 (NS) (Fig. 2). In 1968–69, 18.2% of the 50-year-old women were edentate compared to 4% in 1980–81 and to only 1% in 1992–93 ($P < 0.001$) (Fig. 2). The decrease in the number of edentate 62-year-old women between the periods 1980–81 and 1992–93 was substantial, from 23.7% to 3.9% ($P < 0.001$).

Longitudinal findings.—Altogether 40 women in the 24-year longitudinal study became edentate during the 24-year follow-up; 25 in the first 12-year interval between 1968–69 and 1980–81 and 15 between 1980–81 and 1992–93. Those who lost all their teeth in the first 12-year interval lost on average 8.9 teeth (range 1–21), whereas the 15 women who became edentate between 1980–81 and 1992–93 lost on average 5.4 teeth (range 1–14).

The percentage increase in edentulism over the 24-year study period was most marked for women born in 1914, in

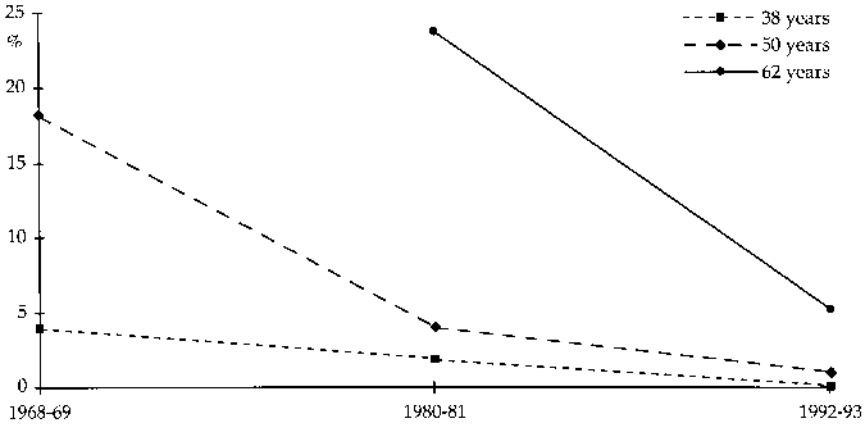

Fig. 2. Percentage of edentate women in the cross-sectional studies by year of examination.

whom 15.4% were edentate at age 54 compared to 26.2% at age 78 (Table 2). The oldest women and the youngest did not show any new edentate individuals in the longitudinal perspective.

One remarkable change during the 24-year interval is the fact that some women have had their lost teeth replaced by implants. No woman had titanium implants in the first study, but two women had at least one edentate arch rehabilitated with titanium implants in 1980–81 and 14 in 1992–93.

Dentate women

Cross-sectional findings

Remaining teeth.—In all three age groups which could be compared cross-sectionally, women aged 38, 50, and 62 years, there was a significant increase in number of remaining teeth during the follow-up period ($P < 0.001$) (Fig. 3).

Restored teeth.— The number of restored teeth was significantly higher in 1992–93 for the 50- and 62-year-olds ($P < 0.001$). For the 38-year-old women the number of restored teeth increased during the first 12-year interval but decreased between 1980–81 and 1992–93. The changes were not statistically significant over the three time-points, but the decrease between the latter two studies was statistically significant ($P < 0.01$) (Fig. 3). As for the relative number of restored teeth, there was a significant increase for the 50-year-old women ($P < 0.001$), from 74% in 1968–69 to about 80% in the latter two studies. The 38-year-olds showed a significant decrease in the relative number of restored teeth, from 75% in the first two studies to around 58% in the last one ($P < 0.001$). For the 62-year-olds, 79% of the teeth were restored in 1980–81 compared to 77% in 1992–93 (NS).

Root-filled teeth.—The absolute numbers of root-filled teeth were very similar and not statistically significantly different in the three studies for the 50- and 62-year-olds. There was a significant decrease for the 38-year-old women ($P < 0.001$) (Fig. 3). The relative number of root-filled teeth decreased significantly during the 24-year period for the 38- and 50-year-olds ($P < 0.001$ for both age groups).

Table 2. Percentage of edentate women in the longitudinal study by age and year of examination

		1968–69		1980–81		1992–93	
Year of birth	No. of women	Age	Edentate (%)	Age	Edentate (%)	Age	Edentate (%)
1954	66*	—	—	—		38	0
1942	82†	—	—	38	1.2	50	1.2
1930	217	38	2.3	50	3.2	62	5.1
1922	226	46	8.4	58	12.4	70	14.7
1918	181	50	15.5	62	21.6	74	22.7
1914	65	54	15.4	66	20.0	78	26.2
1908	13	60	30.8	72	30.8	84	30.8

* Particiapted only in 1992–93. † Participated only in 1980–81 and in 1992–93.

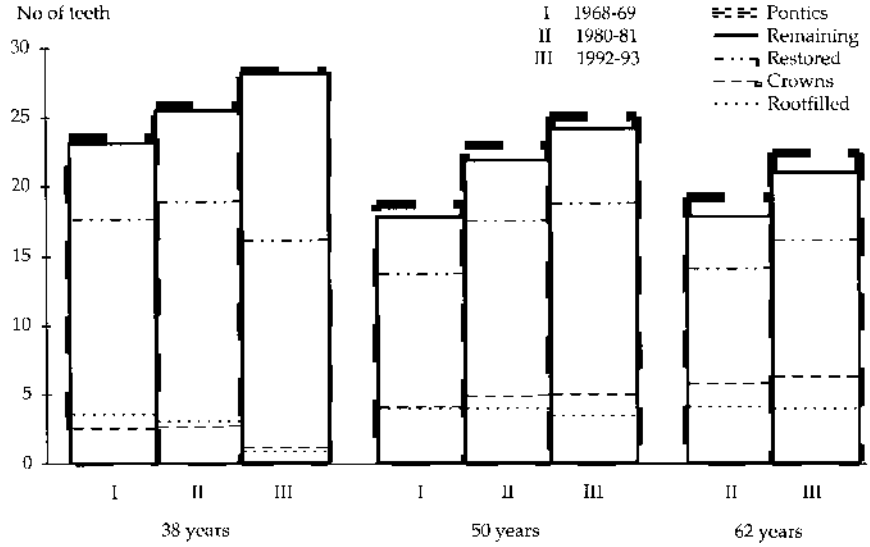

Fig. 3. No. of remaining and restored teeth, crowns, and pontics among women in the cross-sectional studies.

For 38-year-olds there was a decrease from 16% in the first study to 13% in 1980–81, and to 3% in 1992–93 and for the 50-year-olds from 22% to 19% and 15%, respectively. The 62-year-olds showed no statistically significant difference between 1980–81 and 1992–93 (24% and 21%, respectively).

Crowns.— For the 50-year-olds, there was a small but statistically significant increase between the studies regarding absolute number of crowns ($P < 0.001$), but the relative number was the same in all three studies (24%, 26%, and 24%, respectively, Fig. 3). The 38-year-olds showed a statistically significant decrease in both absolute and relative numbers ($P < 0.001$) from 12% in the first two studies to 4% in the third one (Fig. 3). For the 62-year-olds there was no statistically significant difference in absolute or in relative number of crowns (29% or 30%).

Pontics.— The absolute and relative numbers of pontics were about the same in all three studies in comparable age groups (NS) (Fig. 3).

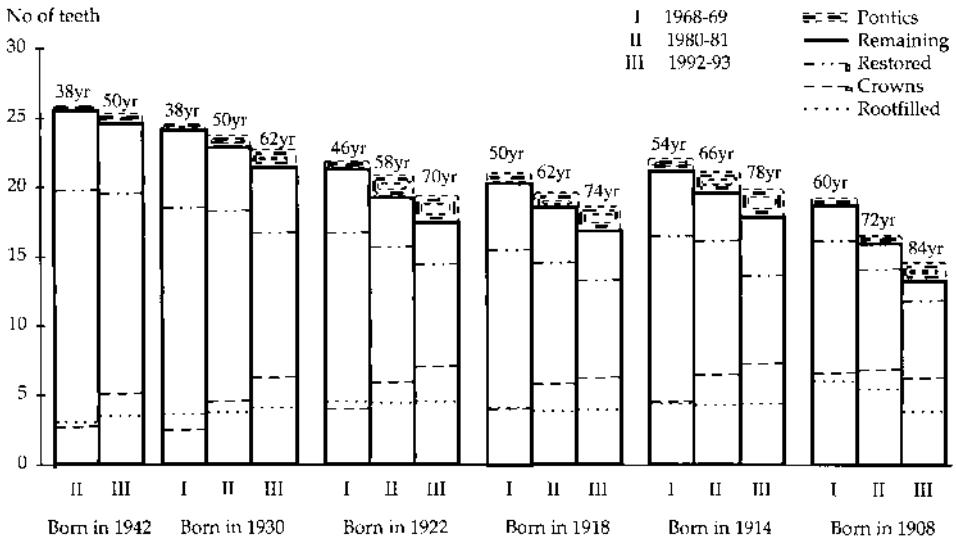

Fig. 4. No. of remaining and restored teeth, crowns, and pontics among women in the longitudinal study.

Longitudinal findings

Loss of teeth.—The mean loss of teeth in dentate women between the first and second studies was 1.7, with the lowest figure (1.4) in the youngest age group (born in 1930) and the highest (2.7) in the oldest (born in 1908). The mean loss between the second and third studies was 1.5, with the lowest figure for the youngest age group (0.8), born in 1942, and the highest for the oldest age group (2.7).

Remaining teeth.—The mean number of remaining teeth in dentate women decreased significantly within all birth cohorts by increasing age ($P < 0.001$) (Fig. 4).

Restored teeth.—The absolute number of restored teeth also decreased significantly in all age cohorts with increasing age ($P < 0.001$). The number of restored teeth related to those remaining showed no statistically significant difference in any cohort except in the case of women born in 1922, who had a statistically significant increase, from 78% in 1968–69, at age 46 years, to 81% in 1980–81, at age 58 years, to 83% in 1992–93, at age 70 years. The lowest relative number of restored teeth in the longitudinal study was 76% (50-year-olds in 1968–69) and the highest 90% (84-year-olds in 1992–93) (Fig. 4).

Root-filled teeth.—The number of root-filled teeth showed no statistically significant difference between the studies in any cohort except for women born in 1930, among whom there was an increase from 3.6 to 3.8 in the second study to 4.1 in the third study ($P < 0.05$). The relative number of root-filled teeth, compared to teeth present, was similar in the three studies in all cohorts, but the difference was statistically significant over the 24-year study period for women born in 1930, 1922, and 1918 ($P < 0.001$, $P < 0.001$, and $P < 0.01$, respectively).

Crowns.—Both the absolute and the relative number of crowns increased significantly with age ($P < 0.001$) except for the oldest women (Fig. 4). For women born in 1930 the relative number of crowns increased from 11% at 38 years of age to 23% at 50 years to 34% at 62 years in 1992–93. The corresponding figures for women born in 1922 with increasing age from 46 to 70 years were 20%, 34%, and 44%, respectively; for women born in 1918, aged from 50 to 74 years, 21%, 33%, and 41%, respectively; and, women born in 1914, from 23% at the age of 54 to 35% at age 66, to 44% at age 78 years, respectively. For women born in 1942, participating in the latter two studies only, the relative number of crowns was 12% at age 38 years and 24% at age 50 years ($P < 0.001$).

Pontics.—The absolute number of pontics also increased in all cohorts ($P < 0.001$ for women born in 1914–30, $P < 0.05$ for those born in 1942) except for the oldest cohort (born in 1908), where there was a decrease in number of pontics (NS). The relative number of pontics increased in all cohorts and the increase was statistically significant ($P < 0.001$) except for the oldest and youngest cohorts.

Discussion

This longitudinal study of women's health started in 1968–69. Dental health was examined at three time-points. The strength of the design of the study is its prospective and interdisciplinary approach, the sampling procedure, based on date of birth, and the high participation rate at the baseline study as well as in the follow-up study (9–12). Despite the long time-span and the relatively high ages, over 68% in the dental study and over 70% in the medical part of the study of those who were included in 1968–69 and still alive were examined in 1992–93.

In three cross-sectional studies in 1973, 1983, and 1993 by Hugoson et al. (2) in Jönköping, Sweden, there was, as in this study, a comparison of dental status. With few exceptions, the prevalence of edentulousness in women was shown to be approximately the same as in our study. However, the important general trend, as judged from our study as well as the studies from Jönköping, is a substantial reduction in the number of edentate individuals over time. Just three decades ago it was possible to find edentate individuals in Sweden among fairly young people. Among 50-year-olds it was a relatively common finding.

Dentate individuals in Sweden have also shown to have significantly more remaining teeth than they had earlier (2, 13) and we found that tooth loss has decreased in dentate individuals over time. Studies from other countries and cultures show the same improvement of dental status, with a lower number of edentate individuals and a decrease in tooth loss (14–19).

However, the incidence of tooth loss varies between studies (13–19). Among older women (>60 years of age), mean tooth loss over a period of 12 years varies from about 2.0 to 3.2 (13, 15–17). The corresponding figures for this study were 1.5–2.7 (women aged 62 years and older). A much higher mean tooth loss was found in a study from China by Baelum et al. (20), where men and women aged 50 and older, over a 10-year period, lost from 5.9 to 7.2 teeth. There may be several reasons for the variation in results, such as different age groups, interpretation and extra-polation of results from several studies, or sampling procedures. However, we may conclude that there are larger differences between the Western world and developing countries such as China, than between studies in the Western world. It is hoped that the high mean tooth loss shown in the study from China will decrease in the future in the same way as we have seen, for example, in this study.

However, people do still lose their teeth, so further analyses of tooth loss will be performed in this study sample, including socio-behavioural, general medical, and psychological factors, in an attempt to reveal possible risk factors and predictors of tooth loss and edentulism. In a

study by Burt (19) it was concluded that socio-behavioural factors as much as disease-related factors were associated with tooth loss.

The changes over time in keeping and treating teeth have changed. In the first study no women had titanium implants but as many as 14 had at least one edentate jaw rehabilitated with osseous-integrated implants in the 1992–93 study. Edentulousness has become 'possible to treat' during this 24-year period, and the number of individuals with teeth replaced by titanium implants, also single implants, will probably increase further in the future.

The numbers of crowns and pontics have also increased in this longitudinal study over time, which shows, among individuals with a majority of their teeth restored, a change in the pattern of treatment. It might be a result of pressure from society to have good-looking esthetical teeth, but it might also be the result of better treatment possibilities of teeth that earlier had been extracted.

In the 1992–93 study, 38-year-old women showed a lower number of restored teeth for the first time. This finding, as well as the increased number of teeth and the decreased number of edentate individuals in comparable age groups, is a good sign. However, even in this latest study there are women still losing their teeth, and new edentate individuals appearing. These facts give us the impetus to continue the work with new studies of the same women as well as new 38-year-old cohorts. The National Dental Insurance in Sweden was introduced in 1974 and with time has become impaired, with considerable lowered economic compensation for patients. This may once more change the trend in an unwanted direction, thus making it important to follow the forthcoming development.

Acknowledgements.—Swedish Medical Research Council (grant 11335 and B93-27B-09026-04). We are very grateful to Philips for lending us an Orthopantomograph during the study in 1992–93.

References

1. Burt BA. Influences for change in the dental health status of populations: a historical perspective. J Publ Health Dent 1978; 38:272–88.
2. Hugosson A, Koch G, Bergendal B, Hallonsten A-L, Slotte C, Thorstensson B, et al. Oral health of individuals aged 3–80 years in Jönköping, Sweden in 1973, 1983, and 1993. Swed Dent J 1995;19:243–60.
3. Birkeland JM, Bragelin J. Continual highly significant decrease in caries prevalence among 14-year-old Norwegians. Acta Odontol Scand 1987;45:135–40.
4. Hugoson A, Koch G, Hallonsten A-L. Caries prevalence and distribution in individuals aged 3–20 years in Jönköping, Sweden, in 1973, 1978 and 1983. Swed Dent J 1988;12:125–32.
5. Österberg T, Carlsson GE, Mellström D, Sundh W. Cohort comparisons of dental status in the adult Swedish population between 1975 and 1981. Community Dent Oral Epidemiol 1991;19:195–200.
6. Ainamo A, Österberg T. Changing demographic and oral disease patterns and treatment needs in the Scandinavian populations of old people. Int Dent J 1992;42:311–22.
7. Ahlqwist M, Bengtsson B, Gröndahl HG, Halling A. Tooth mortality in women in a 12-year follow-up of a population sample in Gothenburg, Sweden. Community Dent Oral Epidemiol 1986;14:358–61.
8. Ahlqwist M, Bengtsson B, Gröndahl HG, Lapidus L. A 12-year cross-sectional and longitudinal radiographic study of dental restorations in women in Gothenburg, Sweden. Community Dent Oral Epidemiol 1988;16:175–80.
9. Bengtsson C, Blohme G, Hallberg L, Hällström T, Isaksson B, Korsan-Bengtsen K, et al. The study of women in Gothenburg 1968–1969: a population study. General design, purpose and sampling results. Acta Med Scand 1973;193:311–8.
10. Ahlqwist M. Women's teeth. A cross-sectional and longitudinal study of women in Gothenburg, Sweden, with special reference to tooth loss and restorations. Swed Dent J 1989;Suppl 62.
11. Bengtsson C, Gredmark T, Hallberg L, Hällström T, Isaksson B, Lapidus L, et al. The population study of women in Gothenburg 1980–81: the third phase of a longitudinal study. Comparison between participants and non-participants. Scand J Soc Med 1989;17:141–5.
12. Bengtsson C, Ahlqwist M, Andersson K, Björkelund C, Lissner L, Söderström M. The prospective population study of women in Gothenburg, Sweden, 1968–69 to 1992–93. A 24-year follow-up study with special reference to participation, representativeness, and mortality. Scand J Prim Health Care 1997;15:214–9.
13. Håkansson R. Tandvårdsvanor och tandstatus bland vuxna i Sverige 1974–1985. (Dental care habits and dental status in 1974–85 among adults in Sweden) Thesis. Malmö, Sweden: Lund University; 1991.
14. Hands JS, Hunt RJ, Kohout FJ. Five-year incidence of tooth loss in Iowans aged 65 and older. Community Dent Oral Epidemiol 1991;19:48–51.
15. Eklund S, Burt B. Risk factors for total tooth loss in the United States; longitudinal analysis of national data. J Public Health Dent 1994;54:5–14.
16. Slade G, Gansky S, Spencer J. Two-year incidence of tooth loss among South Australians aged 60+ years. Community Dent Oral Epidemiol 1997;25:429–37.
17. Locker D, Ford J, Leake JL. Incidence of and risk factors for tooth loss in a population of older Canadians. J Dent Res 1996;75:783–9.
18. Hunt RJ, Hands JS, Kohout FJ, Beck JD. Incidence of tooth loss among elderly Iowans. Am J Public Health 1988;78:1330–2.
19. Burt B, Ismail AI, Morrison EC, Beltran ED. Risk factors for tooth loss over 28-year period. J Dent Res 1990;69:1126–30.
20. Baelum V, Luan W-M, Chen X, Fejerskov O. Predictors of tooth loss over 10 years in adult and elderly Chinese. Community Dent Oral Epidemiol 1996;25:204–10.

Received for publication 28 December 1998
Accepted 9 June 1999