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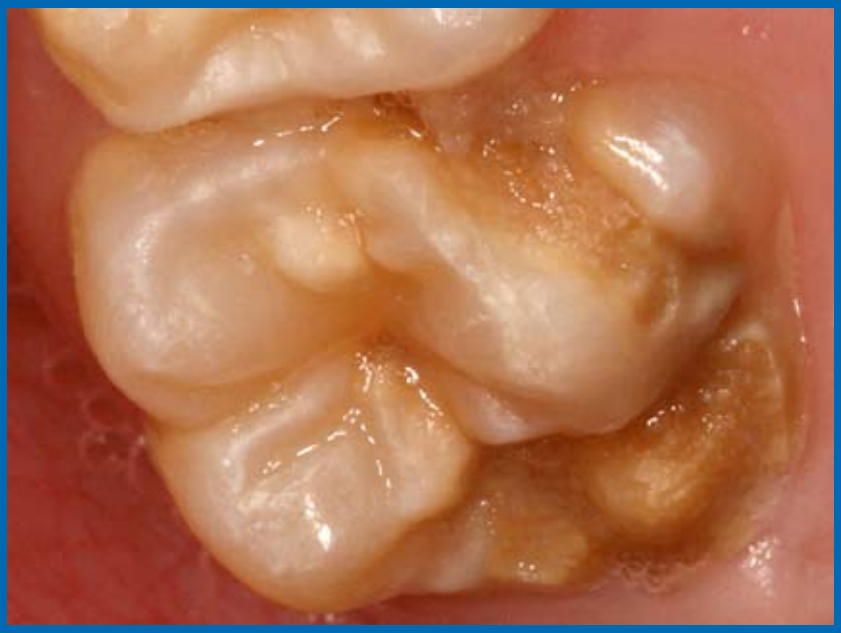

Aetiology of severe demarcated enamel opacities – an evaluation based on prospective medical and social data from 17,000 children

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Production
Carina Frohm, Tfn +46 (0)8 666 15 16
carina.frohm@tandlakarforbundet.se

Editorial address
Swedish Dental Journal
Odontologiska Institutionen
Box 1030, SE-551 11 Jönköping, Sweden
Tfn: +46 (0)36 32 46 04
Fax: +46 (0)36 71 22 35

Subscription/business address
Swedish Dental Journal
Box 1217, SE-111 82 Stockholm, Sweden
Tfn: +46 (0)8 666 15 00
Fax: +46 (0)8 662 58 42
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Treatment of oral infections prior to heart valve surgery does not improve long-term survival

JOHN BRATEL[1], CHARLES KENNERGREN[2], LEIF DERNEVIK[2], MAGNUS HAKEBERG[3]

Abstract

◎ The objective was to evaluate the importance of preoperative elimination of oral infections and oral health for survival after heart valve surgery.

In a group of patients (n=149; treatment group, GP group), oral health was examined and dental treatment was performed 3-6 months prior to heart valve surgery. In a second group (n=103; control group, SP group), oral health was examined postoperatively, but patients did not receive dental treatment prior to surgery. Sixteen years after heart valve surgery was performed, morbidity endpoint data were obtained. Differences in survival between the two groups and the influence of differences in oral health were analyzed.

Fewer patients survived in the study group (37%) compared with the control group (45%). Mean survival was 122.9 months in the GP group compared with 143.3 months in the SP group, including time to death and those alive at the endpoint (p=0.018). A positive relationship was found between the number of teeth and survival, with RR = 0.98 (95% CI 0962-0.996 (p=0.016)). The deaths from heart valve disease were 18% in the GP group and 7% in the SP group (x^2=3.65, df=1, p=0.56).

At the long-term follow-up, the results of the present study show, that it was not possible to demonstrate that dental treatment before heart valve surgery improved survival. Therefore, the need for extensive dental treatment prior to heart valve surgery may be reconsidered.

Key words

Bacteremia, dental treatment, endocarditis, oral infection, survival

[1]Mun-H-Center, Odontologen, National Orofacial Resource Center for Rare Disorders, Gothenburg, Sweden,
[2]Department of Thoracic and Cardiovascular Surgery, Sahlgrenska University Hospital, Gothenburg, Sweden,
[3]Dental public health, Institution of Odontology at the Sahlgrenska Academy, University of Gothenburg, Sweden.

Behandling av orala infektioner före hjärtklaffskirurgi förbättrar inte långtidsöverlevnaden

JOHN BRATEL, CHARLES KENNERGREN, LEIF DERNEVIK, MAGNUS HAKEBERG

Sammanfattning

◎ Syftet med denna prospektiva studie var att utvärdera betydelsen av oral hälsa och elimineringen av orala infektioner för överlevnaden efter hjärtklaffskirurgi.

I en behandlingsgrupp av patienter (n=149; GP grupp), undersöktes den orala hälsan, och orala infektioner behandlades 3-6 månader innan hjärtklaffskirurgi gjordes. I en kontrollgrupp (n=103, SP grupp), undersöktes den orala hälsan postoperativt, och patienterna fick ingen tandbehandling före utförd hjärtklaffskirurgi. Sexton år efter det att hjärtklaffskirurgin utfördes inhämtades tidpunkt för död och dödsorsak från Socialstyrelsens dödsorsaksregister. Skillnader i överlevnad mellan de två grupperna och betydelsen av skillnad i oral hälsa analyserades.

Färre patienter i behandlingsgruppen överlevde (37%) jämfört med kontrollgruppen (45%). Medelöverlevnaden var 122.9 månader i GP gruppen jämfört med 143.3 månader i SP gruppen, inklusive tid till död och de som levde då studien avslutades (p=0.018). Ett positivt samband hittades mellan antalet tänder och överlevnad, med RR = 0.98 (95% CI 0962-0.996 (p=0.016)). I GP gruppen dog 18 % i hjärtklaffssjukdom medan motsvarande siffra i SP gruppen var 7% (x^2=3.65, df=1, p=0.56).

Vid en långtidsuppföljning visar resultaten i denna studie att en elimination av dentala infektionsfoci innan hjärtklaffskirurgi inte ger längre överlevnad. Därför borde man kanske omvärdera behovet av omfattande tandbehandling inför hjärtklaffskirurgi.

Introduction

Infectious endocarditis (IE) is a major reason for heart valve surgery (3). The role of oral bacteria and oral infections in the development of IE has been continuously discussed. However, it is evident that the oral microbial flora plays an important role in developing IE (3,21,22). Predisposing cardiac lesions and immunological responses might be other factors of importance in causing IE (30). The use of antibiotic prophylaxis (AP) for patients with heart valve disease or heart valve prostheses, undergoing dental surgery, has become common practice, even though the scientific proof in favor of this strategy is not entirely convincing. (4,6,9,11,30). However, there are several case reports showing that heart valve diseases and IE may be correlated to dental treatment and the lack of antibiotic prophylaxis (10,13,21). The use of AP is not without its problems, due to the risk of allergic reactions (7) and bacterial resistance (35). Because of the low IE incidence, it is difficult to estimate the role of AP in patients about to undergo dental treatment (24).

The role of dental status has also been discussed in connection with bacteremia or in connection with postoperative complications in patients that have undergone heart valve surgery (27,33). Some studies state that there is a proportional connection between oral infection and the degree of bacteremia (1,25). The morbidity and mortality associated with prosthetic valve surgery have also been related to the oral disease burden (32). Others claim that everyday activities like eating, chewing and tooth brushing cause bacteremia which might be even more harmful than standard dental procedures (28).

In a one-year follow-up study, no positive correlation was found between sepsis and endocarditis in relation to preoperative dental treatment (16). Long-term studies addressing survival after heart valve surgery in general and in connection with oral health in particular are lacking. The aim of this study was to evaluate patient's long-term survival after heart valve surgery specifically in relation to preoperative oral and dental disease.

Material and methods

Patients

All the patients (n=252) in this study, who were referred to the Department of Thoracic and Cardiovascular Surgery, Sahlgrenska University Hospital, Gothenburg, Sweden, for heart valve surgery between 1987-1991, were consecutively included in a prospective study and a one-year follow-up study has already been presented (16). The patients were divided into two groups. In the GP group (n=149), patients from Gothenburg were included, oral health was examined and dental treatment performed 3-6 months prior to heart valve surgery in order to eliminate oral infections. In the SP group (n=103), patients from the suburbs and the counties surrounding Gothenburg were included, and oral health was examined within 3 weeks postoperatively; these patients did not receive any dental treatment prior to surgery. The GP group comprised 63 women and 86 men, with a mean age of 65.3 years (SD=9.8) at the beginning of the study. The corresponding data for the SP group were 44 women and 60 men with a mean age of 60.8 (SD=13.1). Sixteen years after heart surgery, data regarding the date of death and cause of death were obtained from the Center of Epidemiology at the National Board of Health and Welfare. Differences in survival time between the two groups and the influence of differences in oral health at the time of surgery were analyzed.

Table 1. Descriptive data for the GP and SP groups

	GP	SP
Number of patients at inclusion	149	103
Mean age at time of surgery (1987-1991)	65.3	60.8
Months of survival (mean) at endpoint	122.9±67,5	143.3±65.9
No of living patients after 10 years	85(59%)*	73(71%)
Living patients (endpoint)	53(37%)*	46(45%)

* 4 missing patients

Clinical procedures

The oral examination consisted of a clinical and a radiological examination. The clinical assessment included measurements of plaque, gingivitis, periodontitis, caries, mucosal lesions, number of teeth and presence of dentures (16). Plaque was recorded if removable debris was found on any proximal surface. Gingivitis was recorded by probing on bleeding, appearing when gentle probing was performed (19). The periodontal pocket depth was measured by probing and was categorized into 4-5, 6-7 and ≥ 8 mm deep periodontal pockets.

The radiographic examination consisted of 20 intraoral radiographs and a panoramic radiograph. The variables registered that were periradicular bone lesions, as well as other pathological bone lesions.

The study was approved by the regional Human Ethics Committee, at the Sahlgrenska Academy, University of Gothenburg.

Statistical analysis

Simple descriptive statistics with means, standard deviations and 95% confidence intervals were calculated. Statistical analyses were performed using the t-test, logistic regression and survival analysis with Cox regression. SPSS version 14.0 was used.

Results

Only minor statistically significant differences between the two groups regarding patients´ oral health at the primary examination were revealed. The oral status of the two groups is presented before the dental treatment in the GP group and after heart valve surgery in the SP group (16) (Table 2). There were

Table 2. Oral status of GP preoperatively before dental treatment and in SP patients postoperatively Mean values (x) and standard deviation (SD) (Hakeberg et al. 1999)

	GP		SP	
	x	SD	x	SD
Number of teeth	14.5	10.5	14.3	11.0
Number of decayed teeth	1.7	2.6	1.6	2.2
Periradicular lesions				
≤2 mm	0.6	0.9	0.5	0.9
>2 mm	0.7	1.1	0.6	1.0
Plaque				
(Proximal surfaces)	8.4	11.2	6.6	8.7
Gingivitis				
(Proximal surfaces)	10.0	12.0***	5.0	7.0
Periodontal pocket depth				
4-5 mm	7.9	9.1	8.3	11.8
6-7 mm	1.6	2.7*	0.9	1.9
>8 mm	0.3	0.9	0.2	0.6

*p>0.05
***p<0.001

no differences in the distribution of heart valve diagnoses between the groups. Sixty-nine percent of the performed valve replacements were aortic in the GP group compared with 66% in the SP group (Table 3). When the 10-year follow-up date was reached, 59% of the patients in the GP group were still alive, compared with 71% in the SP group. At the endpoint date, 37% and 45% respectively of the patients in the GP and SP groups were still alive. The patients were significantly older in the GP group (p<0.001). The mean survival time was 122.9 months in the GP group compared with 143.3 months in the SP group, including time to death and those alive at the endpoint

Table 3. Distribution of heart valve diagnoses (etiology) [a] and operated heart valves [b]

	GP		SP	
	%	n	%	n
a)				
Degenerative	63	94	58	60
Rheumatic	17	25	17	17
Endocarditis	2	3	9	9
Congenital, other	7	11	17	18
Missing	11	16	0	0
b)				
Aorta		108		75
Mitral		40		32
Tricuspid		8		7

(Figure 1). The difference was statistically significant (p=0.018). The number of deaths from heart valve disease was 18% in the GP group and 7% in the SP group, a non-significant difference (x^2=3.65, df=1, p=0.56). Heart disease (heart valve disease excluded) was the major cause of death in both groups, 29% (GP group) and 35% (SP group) respectively (Table 4).

Survival analysis with Cox regression was applied using time to death and surviving individuals as censored with months as the time unit. Table 5 shows the final model with age, group, gender and number of remaining teeth as covariates. Age was a significant predictor of death, with a relative risk (RR) of 1.053 and 95% CI 1.031-1.076, p<0.001 indicating a higher risk per year of aging. Furthermore, the number of remaining teeth was significant (RR=0.98 and 95% CI 0.962-0.996, (p=0.016), a finding showing that this variable was protective as was the fact that the more remaining teeth the patient had the lower the risk of early death.

Figure 1. Survival time in months for both the GP and SP groups using Cox survival analysis.

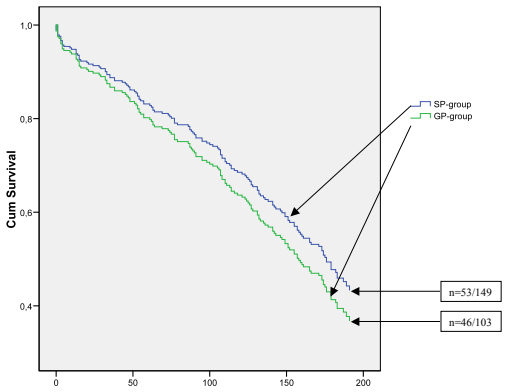

Table 4. Distribution of causes of death

	GP (n=92)		SP (n=57)	
	%	n%	%	n%
Heart valve disease	18	17	7	4
Heart, other	29	26	35	20
Atherosclerosis, circulation	16	15	12	7
Infections	5	5	4	2
Malignancy	10	9	12	7
Others	9	8	14	8
Missing diagnosis	13	12	16	9

Table 5. The final model of the Cox regression analysis with time measured in months

Covariables	B	SE	p-value	RR	95% CI
Group	0.209	0.170	0.220	1.233	(0.883 – 1.721)
Gender	0.303	0.169	0.073	1.354	(0.972 – 1.885)
Age (per year)	0.052	0.011	0.000	1.053	(1.031 - 1.076)
Teeth	s-0.021	0.009	0.016	0.979	(0.962 – 0.996)

Discussion

The present data show that preoperative dental treatment does not improve survival for patients who undergo heart valve surgery. The survival rate was actually higher in the group that did not receive preoperative dental treatment. This difference was, however, not statistically significant and consideration should be given to the fact that the mean age of patients in the SP group was 5 years lower than that of patients in the GP group. The survival rate was approximately 40% in this study, which was well in accordance with earlier published findings (18).

Only a few studies have analyzed the significance of dental health for the occurrence of IE (31). We found no study addressing long-term survival in this context. In addition, there is also a methodological problem in when it comes to linking dental treatment to IE, due to the low incidence of IE in the general population. The incidence of IE associated with dental treatment varies and it may be as low as 4% (14,15), rising to 64% (2).

The study patients, received AP while undergoing dental treatment, according to the recommendation at that time. Similar recommendations was also issued by, the American Heart Association (9). The consequences of not using AP have not been investigated, however, several investigators suggest that AP is not needed (28,30). Uncertainty about the efficacy of AP also exists (25). These facts must also be taken into consideration when the risk, of side-effects such as anaphylaxis (7) and antimicrobial resistance are calculated (29).

Several studies assume that the "oral infectious burden" is associated with an increased risk of bacteremia or IE (12,23,32,34). To our knowledge, this is the first study to analyze the survival of heart valve surgery patients in relation to dental care. In general, there are few, if any studies analyzing survival after heart valve surgery, while taking dental status into consideration (3). Endocarditis/sepsis was found to occur within 14 days postoperatively in 5.4% (GP) and 1.9%(SP) patients respectively in the one-year follow-up (16). Comparable numbers were found in an American study (8), with a variation between 5.1% and 2.4%, when a white population was compared with an Afro-American group, undergoing aortic valve replacement.

At many dental hospital centers, the present standard procedure for patients undergoing heart valve surgery is to eliminate all infectious oral foci. The rationale is that chronic oral infection may cause acute infection including inflammation and sometime endocarditis (32). Some reports state that dental treatments like scaling, tooth extraction, rubber dam and matrix band application can cause bacteremia (26). This fact should be compared with the information that normal daily activities like chewing and tooth brushing may also cause bacteremia that is considered to be even more significant than that following dental surgical procedures (26). Subsequently, IE prophylaxis should primarily be directed at good oral hygiene and at the prevention of oral disease, in order to reduce the magnitude and frequency of spontaneous bacteremia (20). However, in a study by *Tomas et al.* in 2007 (33), odontogenic abscesses or periapical lesions were not found to increase the risk of bacteremia.

In our initial paper studying the same population one year postoperatively (16), no support was found for a better postoperative result, from a one-year perspective, if dental treatment was performed prior to heart valve surgery. The results of the present study are in accordance with our earlier findings (16). The results should be interpreted, as meaning that remaining chronic infectious dental conditions do not influence survival. Evaluating death in heart valve disease alone, we found a difference albeit not statistically significant; 18% in the GP group compared with 7% in the SP group. In addition, there was no statistically significant difference with regard to age between the groups in terms of death from heart

valve disease. This finding strengthens the opinion that improved dental heath prior to valve surgery does not increase survival. Instead, factors like the functional status of the patients are probably of greater importance (18). This opinion is contradicted by *Terzhalmy et al.* (1997) (32), who state that there is a cumulative risk with acute or chronic odontogenic infections.

When we investigated survival, a general analysis was made and the result is therefore not limited to death from heart valve disease alone. As expected, age was an important predictor of death, indicating a higher risk per year of aging, and, as a result, the GP group had a shorter mean survival of 4.5 years ($p<0.001$). It would have been preferable to have a more similar mean age in the two groups, but we regard this difference as hazardous due to the design of the study. In the conclusions drawn in the Cox regression analysis, this fact was taken into consideration. We also found that dental health, measured by the number of remaining teeth, was of significant importance for survival ($p=0.016$) (5,17). This indicates that dental health in general is of greater importance than the number of infectious foci or group affiliation (GP/SP).

Study limitations: Even if this is a prospective study, all the confounding factors were not controlled. The baseline data were not collected at the same time in the two groups, which would have been desirable. However, as the oral health status were reasonably similar in both groups, it is not likely it would affect the outcome of the study. Further, oral health as measured in this study have more of a chronic course indicating that the development of respective disease may not have changed considerable over a period of up to 6 months. Dental treatment in the GP group prior to heart valve surgery was performed by the patient's regular dentist. Treatment protocols from the patient's dentists were collected and checked. The patient's dental care during the time from surgery to the respective endpoint has not been recorded, and for this reason, the result should be interpreted with some caution. Furthermore, other background data relating to morbidity from serious illnesses other than cardiovascular disease have not been not analyzed in this study. The dental health status of the Swedish population is fairly good. The question of whether these results are valid for a population with a poorer dental status needs to be further investigated. A loss to follow-up analysis of the four missing patients in the GP group did not reveal any differences in the initial parameters affecting our result.

In conclusion, no significant difference in survival time between the groups, independent of the age difference between the groups, was found. In addition, at the long-term follow-up, it was not possible to show that dental treatment before heart valve surgery improved survival.

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Corresponding author:
Dr John Bratel
Mun-H-Center, Odontologen
National Orofacial Resource Center for Rare Disorders
PO Box 71 63
SE 402 33 Gothenburg, Sweden
E-mail: john.bratel@vgregion.se

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Aetiology of severe demarcated enamel opacities – an evaluation based on prospective medical and social data from 17,000 children

Tobias G. Fagrell[1,2], Johnny Ludvigsson[3], Christer Ullbro[4], Sven-Åke Lundin[5], Göran Koch[4]

Abstract

◉ During the 1970s dentists reported an increasing prevalence of a "new" type of enamel disturbance. The disturbance was very specific, with areas of demarcated hypomineralised enamel, and was mostly found in permanent first molars and incisors. Several studies have tried to reveal the aetiology behind the enamel disturbance but so far no clear factors correlated have been found.

The aim of the present study was to evaluate aetiological factors to severe demarcated opacities (SDO) in first permanent molars in a large cohort of children enrolled in the "All Babies in Southeast Sweden" (ABIS) project. ABIS is a prospective study of all children in five Swedish counties born between Oct 1, 1997 and Oct 1, 1999, in all about 17,000 children. They have been followed from birth with recording of a large number of factors on nutrition, diseases, medication, infections, social situation etc.

With help from 89 Public Dental Service clinics in the same area preliminary examinations of the children, born between Oct 1, 1997 and Oct 1, 1999, reported 595 children with severe demarcated opacities (SDO) in first molars. These children and a randomly selected age matched group of 1,200 children were further invited to be examined by specialists in paediatric dentistry. At these examinations 224 severe cases were identified as well as 253 children completely without enamel disturbances among children registered in ABIS. These two groups were analysed according to any correlation between SDO and variables in the ABIS databank.

The analyses showed no association between SDO and pre-, peri-, and neonatal data. However, we found a positive association between SDO and breastfeeding for more than 6 months (OR 1.9; 95% CI 1.1–3.2), late introduction of gruel (OR 1.9; 95% CI 1.1–2.9), and late introduction of infant formula (OR 1.8; 95% CI 1.2–2.9). A combination of these three variables increased the risk to develop SDO by more than five times (OR 5.1; 95% CI 1.6–15.7). No significant associations were found to other environmental, developmental, or medical factors. We conclude that nutritional conditions during first 6 months of life may influence the risk to develop severe demarcated opacities in first permanent molars.

Key words

Demarcated opacities, enamel, hypomineralisation, MIH, aetiology, permanent teeth, children

[1] Paediatric Dentistry, Special Dental Services, Sahlgrenska University Hospital Mölndal, Sweden
[2] Department of Pedodontics, Institute of Odontology at the Sahlgrenska Academy at Göteborg University, Göteborg
[3] Division of Pediatrics, Department of Clinical and Experimental Medicine, Faculty of Health Sciences, Linköping University, Linköping, Sweden
[4] Department of Paediatric Dentistry, The Institute for Postgraduate Dental Education, Jönköping, Sweden
[5] Department of Pediatric Dentistry, The Postgraduate Dental Education Center, Örebro, Sweden

Etiologiska faktorer till grava, avgränsade emaljhypomineraliseringar – analys baserad på prospektiva medicinska och sociala data från 17 000 barn

Tobias G. Fagrell, Johnny Ludvigsson, Christer Ullbro, Sven-Åke Lundin, Göran Koch

Sammanfattning

◎ Under 1970-talet rapporterade barntandläkare en ökad förekomst av en ”ny” typ av mineraliseringsstörning i tandemalj. Störningen var mycket karakteristisk med väl avgränsad hypomineralisering, främst i permanenta molarer och incisiver (MIH). Den kunde variera i svårighetsgrad från missfärgade områden till sönderfall av emaljen. Prevalensstudier visade att störningarna fanns hos 10–20 %. Trots ett stort antal studier har etiologin till dessa specifika emaljförändringar ej kunnat fastställas. Orsaker till detta torde främst vara svårigheten att få säkra uppgifter kring barnets första levnadsår genom att de flesta studier är retrospektiva.

Syftet med föreliggande studie var att utvärdera etiologiska faktorer till grav hypomineraliseringsstörning i första permanenta molarer i ett stort barnmaterial som ingår i den s.k. ABIS-studien (Alla Barn i Sydöstra Sverige). Denna prospektiva studie omfattar fem län och startade åren 1997–1999 med ca 17 000 barn som följdes från födelsen och upp till för närvarande 12 års ålder. Medicinska och sociala data (ca 4 000 variabler) finns inmatade i en databank vid Linköpings universitet.

Tandvårdsteam vid 89 folktandvårdskliniker inom ”ABIS-området” utförde en första undersökning av samtliga barn inom den aktuella åldersgruppen och fann då 595 barn med gravt mineraliseringsstörda första molarer. Dessa barn samt en slumpmässigt utvald grupp inom samma geografiska område och åldersgrupper inbjöds att deltaga i en klinisk undersökning utförd av författarna. Det slutgiltiga materialet utgjordes av 224 barn med gravt hypomineraliseringsstörda molarer (SDO) och 253 barn utan kliniska tecken på mineraliseringsstörda molarer. Samtliga barn var registrerade i ABIS. Dessa två grupper analyserades sedan statistiskt avseende korrelation mellan grav mineraliseringsstörning (SDO) och ett urval av de 4 000 insamlade variablerna.

Analysen gav inga statistiskt säkra samband mellan pre-, peri- och neonatala avvikelser eller sjukdomar, medicineringar samt vaccinationer under barnets första 3 levnadsår och förekomst av grav hypomineralisering av emalj. Statistiskt säkerställt samband mellan förekomst av grav hypomineralisering av första molarer förelåg för amning längre än 6 månader, sen introduktion av välling (efter 6 månader) och sen introduktion av bröstmjölksersättning (efter 6 månader). Kombinationen av dessa tre variabler ökade risken att utveckla SDO med 5,1 gånger (OR 5,1; 95% CI 1,6–15,7). Studien indikerar att nutritionella förhållanden under de första 6 levnadsmånaderna kan medföra ökad risk för grav hypomineralisering av permanenta första molarer.

Introduction

During the 1970s dentists increasingly reported a "new" type of mineralisation disturbance of the enamel. It was very typical with areas of demarcated hypomineralised enamel varying from opacities to enamel surface breakdown. This enamel disturbance was found predominately in first permanent molars and incisors. One of the first more extensive studies on the prevalence of demarcated opacities in first permanent molars and incisors was reported by *Koch et al.* in 1987 (13). The condition was later denominated Molar Incisor Hypomineralisation (MIH) (22). Over the following decades, after 1980, a large number of prevalence studies have been published. In a systematic review of previous studies in 2010 by *Jälevik* (12) only 24 of 414 papers met the inclusion criteria when examination criteria, selection of study groups, presentation of results etc. were assessed. The review found that the prevalence was rather stable throughout the years, affecting about 10–20% of the children. However, the review also concluded that it was urgent to standardise the diagnostic criteria and study design and also that the participants should consist of whole age cohorts or randomly selected children in a target population.

At the same time as the prevalence studies were being conducted there was intensive research, on the aetiology of these specific demarcated opacities. Most of the studies concentrated on the period when tooth enamel development can be affected by internal and environmental disturbances, namely during the secretory, transition and maturation phases of the enamel (20). Since the enamel matrix of the crown of first permanent molar is completed by the age of 1 year (18) it is generally agreed that the first year is the critical period for the development of enamel hypomineralisation in first permanent molars and incisors. Two extensive systematic reviews have recently been published on the aetiology of demarcated opacities in permanent first molars and incisors (5, 8). The review by *Crombie et al.* (8) started off with a total of 1,123 papers of which 53 were selected for review. The corresponding figures for the review by *Alaluusa* (5) were 1,142 and 28 respectively. Practically all studies reviewed were retrospective. Most focused on medical/health problems, medication, feeding/nutrition, and exposure to environmental toxicants, during pre-, peri-, and postnatal periods and in the first years of life.

During the prenatal period no aetiological factors responsible for MIH could be identified. Factors during the perinatal period that have been suggested to influence the prevalence of MIH are hypoxia (17), hypocalcemia (2, 10), and preterm birth (7, 9). However, no clear single causative factor responsible for MIH has been identified during the perinatal period.

Other analyses looked at feeding pattern and environmental toxicants during the postnatal period. In a Finnish study (3) it was found that long breastfeeding was associated with MIH. However, other studies have not been able to confirm this (11, 14). In another Finnish study (4) it was found that exposure to dioxin via mothers' milk was associated with MIH. However, recent research could neither confirm this (14, 15).

In the literature also different diseases in childhood, fever, and medication (e.g. antibiotics) have been suggested to cause MIH (6, 10, 24). To conclude the findings emerging from these two extensive systematic reviews (5, 8) there is still insufficient evidence to verify the aetiology of demarcated opacities in the enamel.

Among reasons why the aetiological factors to MIH have not been possible to identify, the following have been suggested (5, 8):

- Unclear/inexact diagnostic criteria had been used for classifying demarcated opacities
- Most parents were unable to remember details with sufficient accuracy from 8–10 years before (unreliable information)
- There were variations in the quality and completeness of observations noted in children's medical records
- The study populations were small and con sisted of atypical individuals.

Hence to further research on aetiological factors this should preferably be based on established diagnostic criteria for the enamel disturbance and a prospective detailed, medical, study following a large child cohort during their first years of life.

Diagnostic criteria

Although many papers have been published on the subject of hypomineralised molars and incisors over the last 30 years, the terminology used to describe the condition has been inconsistent, including terms such as defective enamel and "cheese" molars. Among others *Weerheijm et al.* (21) and *Jälevik* (12) stressed the importance of using accepted, established criteria for diagnosing the enamel mineralisation disturbance Molar Incisor Hypomineralisation (MIH). To clarify this issue the European Academy

of Paediatric Dentistry in 2003 invited researchers and experts within the field to analyse existing diagnostic systems and propose a generally accepted, reproducible scoring index of the condition MIH to be used in prevalence studies. The outcome of this workshop has been published by *Weerheijm et al.*, 2003 (23). The most severe clinical forms of enamel hypomineralisation in permanent first molars are demarcated opacities with post-eruptive breakdown and/or atypical restorations surrounded by severely hypomineralised enamel (Figure 1). The authors suggest that this stage of severe hypomineralisation should be denominated severe demarcated opacities (SDO).

Figure 1. Maxillary first molar with severe demarcated opacities and posteruptive enamel breakdown (SDO).

ABIS – a prospective medical social population study from birth of 17,000 children in southeast of Sweden

ABIS (All Babies in Southeast Sweden) was initiated in the late 1990s with the purpose to prospectively investigate risk factors for immune mediated diseases, especially Type 1 diabetes, in children (16). All children in five Swedish counties born October 1, 1997–October 1, 1999, in all 21,700 individuals, were invited to take part in the study. The parents of 17,055 children (78.6%) of these gave their informed consent for enrolment of their children in the ABIS-study. Medical data and information from interviews and questionnaires were collected at delivery (blood from the umbilical cord, breast milk, hair sample etc.). A detailed diary was kept during first year of life documenting diseases, medication, feeding, exposure to environmental toxicants etc. There were examinations and interviews/ questionnaires at 1 and 2.5 years of age with follow-up at 5 and 8–9 years of age (blood, faeces, urine, hair etc.) and now follow-up at 12 years of age is ongoing. All the information collected, about 4,000 variables for each child covering somatic growth; pre-, peri-, and neonatal status; childhood diseases; medications; vaccinations; socioeconomic factors; and nutrition etc., was entered into this ABIS databank, at the Department of Paediatrics, Linköping University, Sweden.

Aim

The aim of the present study was to evaluate possible aetiological factors to severe demarcated opacities (SDO) in first permanent molars in a large cohort of children by using social and medical data collected prospectively during their first years of life by the ABIS study.

Materials and Methods

Study design

The investigation was planned as a case-control study involving all available children in the ABIS material with a clear diagnosis of severe demarcated opacities in the enamel (SDO) of their first molars and an age- and gender-matched control group without enamel disturbances in their first permanent molars from the same database.

Selection of participants to the study

This part of the study was divided into three phases:

Phase I – strategy and information

In Sweden 95% of children are regularly treated in the Public Dental Service (PDS), organised within each county. The children involved in the ABIS study lived in the following five counties: Blekinge, Jönköping, Kalmar, Kronoberg, and Östergötland. The process to inform all dental personnel in the PDS within these areas about the aim and design of the study started with visits to the five chief dental officers. Next the heads of all the PDS clinics in the five counties (89 clinics) got detailed information on diagnosis of MIH and the research plan in connection with a series of lectures given by the authors (TGF, S-ÅL, GK). The heads of the clinics were asked, in their turn, to present the lecture content to all dental staff at their clinics. It was also decided to appoint one contact person at each PDS clinic, who was responsible for distributing material from and report to the authors.

Phase II – examination by the PDS dentists

Over a 2-year period all children living in the five counties in Southeast Sweden and born between

Figure 2. The examination form used by the Public Dental Service dentists when reporting children with severe hypomineralised molars to the authors.

Examination form *20051014*

The form should be used to report the occurrence of severe MIH (Molar Incisor Hypomineralisation) in permanent molars in all children born from 1 October 1997 – 1 October 1999 (the ABIS-material).

The pictures below are examples of permanent first molars with severe MIH.

Diagnose children with severe MIH similar to the pictures below and fill in one form per patient. All forms with entries should be sent to the principal investigator. Reported children will be asked to take part in a secondary screening performed by the principal investigators.

Example of teeth diagnosed with severe MIH, which should be reported.
Teeth may have light- to dark-brown opacities, post eruptive breakdown and/or atypical restorations and/or atypical dental caries.

Name _____
ID _____
Public dental office _____
Date _____

Please indicate below if the tooth have severe MIH or any other discrepancy which have a possible origin from a severe enamel developmental defect.

16	26	36	46

X- *Severe MIH*
K- *Atypical dental caries*
F- *Atypical restorations*
S- *Post eruptive breakdown*

October 1, 1997 and October 1, 1999 in all about 22, 000 children and attending the PDS were checked for severe MIH. As it would have been impossible for one small research group to clinically examine all these children the PDS dentists were used to make this initial screening.. The PDS dentists were not aware if the child was participating in the ABIS study or not. Each child with severe MIH in one or more of his/her first permanent molars and identified by his/her PDS dentist was registered on a specially designed form (Figure 2). Five hundred and ninety-five forms were completed and sent to the research team.

Phase III – examination by the research teams (the authors)

The basic aim of the examinations by the authors was, by using very strict criteria for the occurrence of enamel hypomineralisation, to secure one group of children with SDO and one group without any clinical enamel disturbances in their first molars. These groups should then be checked for complete ABIS data and used in the statistical evaluation.

Every child with MIH, identified by the PDS (n=595), was invited by letter from his/her PDS clinic to be examined by the authors. In addition, two age- and sex-matched children to each reported MIH child (n=1,180) were also invited. These children were next before and next after the MIH child in the class list and with the same sex. The examinations took place at the children's regular dental clinic and were performed by two research teams, each consisting of two experienced specialists in paediatric dentistry (the authors). Every child was examined for the evidence of SDO by both examiners in the respective team. During 1.5 years the examination teams visited 89 dental clinics. The mean age of the children at examination was 10 years 2 months (9 years 3 months–11 years 2 months).

Before start of the examinations the authors were calibrated concerning diagnosing enamel disturbances. The calibration, which took place in a clinical setting, on 96 molars in children in the study, resulted in a kappa of 0.85. The following diagnostic criteria were used for the classification:

A. Demarcated opacities with posteruptive enamel surface breakdown (SDO)
B. Demarcated opacities without posteruptive breakdown.
C. Other enamel disturbances e.g. amelogenesis imperfecta, dentinogenesis imperfecta, enamel hypoplasia, dental fluorosis.
D. No clinical enamel disturbances.

The children were then subdivided into Groups A, B, and C if one or more first permanent molars were diagnosed according to criteria A, B, or C respectively. Children who were diagnosed according to criteria D formed subgroup D and had no clinically detectable mineralisation disturbances in their first permanent molars. The permanent incisors and second deciduous molars were also examined for evidence of hypomineralisation but these results will be reported in another study.

Out of the 1,775 children invited 1,076 accepted to be examined by the research teams . The examinations classified the children as follows: Group A 398, Group B 177, Group C 51, and Group D 450. When group A and D were checked for complete ABIS data the final outcome of this selection procedure was 224 ABIS participants with severe demarcated opacities and 253 ABIS participants with no clinically detectable enamel disturbances in their first permanent molars. These final Groups A and D were used for statistical analyses.

Selection of ABIS data used in the analysis

The following information was extracted from the ABIS databank to compare the children in Groups A and D (see Tables 1–3):

- Pre-, peri-, and neonatal data from the child and its mother
- Diseases during first 3 years of life
- Medication and vaccinations during first 3 years of life
- Socioeconomic factors
- Nutrition during first 3 years of life.

Statistical analysis

The data analysis was generated using SAS/Stat software (version 9.2 of the SAS System for Windows, Copyright © 2002–2008/ SAS Institute Inc. Cary, NC, USA). Fischer's exact test was used to analyse this differences in distribution on categorical variables between the SDO group and the controls, a p-values below 0.05 were considered statistically significant.

Ethical considerations

The children's parents received a letter with information about the study. The study was approved by the Ethics Committee of Linköping University, Linköping, Sweden (ref. no.: 96287) in accordance with the guidelines of the Declaration of Helsinki.

Results

The results are shown in Tables 1–3. In Table 1 all variables without statistical association to SDO are presented. Table 2 shows the results of the univariable analysis and in Table 3 the result of the multivariable logistic regression. In Table 3 also the result from the grouping of three of the explanatory variables, breastfeeding more than 6 months, late introduction of gruel (after 6 months), and late introduction of infant formula (after 6 months) is presented.

Pre-, peri-, and neonatal problems in the child and/or mother

There was no difference between the mothers of the children in Groups A and D with respect to infection, diseases or medication during pregnancy. Similarly, no difference was found in the frequency of preterm birth, birth weight or delivery complications. Nor could any other factor during the neonatal period be connected to the development of SDO (Table 1).

Diseases during first 3 years of life

It appears that diseases during the first 3 years of life, such as respiratory problems, otitis media, asthma, allergies, chicken pox, fever etc. had no influence on the prevalence of severe demarcated opacities (Table 1).

Medication and vaccination during first 3 years of life

There were no statistically significant differences in occurrence of SDO between Groups A and D as a result of medications, such as antibiotics; painkillers; cortisone; vitamins; or mineral intake. Vaccination could not be verified as an aetiological factor to SDO (Table 1).

Socioeconomic factors

A number of socioeconomic factors were analysed (Table 1). The two variables that showed statistically significant differences in the univariable model were mother's education level and domestic moisture and mould (Table 2). However, in the multilogistic regression model these significances disappeared.

Nutrition during first 3 years of life

The following variables showed significant increased odds for developing SDO between Groups A and D in the univariable model: breastfeeding more than 6 months, late introduction of gruel (after 6 months), and late introduction of infant formula (after 6 months) (Table 2). To investigate if a combination of long breastfeeding, late introduction of gruel, and late introduction of infant formula had any impact on the odds ratio of developing SDO a combined group was created and this increased the risk of developing SDO by over five times (OR 5.1, Table 3).

Discussion

As far as we know, there have been, on a population level, no studies investigating possible aetiological factors for demarcated opacities (5, 8). To date most shortcomings might be that the majority of the studies have been retrospective and based on a small number of participants

In the present study statistically significant positive association was found between breast feeding more than 6 months, late introduction to gruel, and late introduction to infant formula. These findings have been possible to document by use of the unique ABIS databank, where prospective data from a large child population are accumulated. In addition, the permission to use the 89 Public Dental Health clinics in the five counties, responsible for the dental treatment of the approximately 17,000 children enrolled in the ABIS study at start, was invaluable as was the assistance and support of all dental teams involved.

The sampling procedure used to select the study participants could be questioned, in particular, with regard to inclusion criteria. There have been different opinions on how to diagnose MIH. In our study, with over 250 examining dentists (Phase II), who screened the participants to be re-examined by the authors, it was important to use as simple methods and criteria as possible. Therefore, this screening was restricted to the first permanent molars and to record severe demarcated opacities, atypical restorations, atypical dental caries, and posteruptive enamel breakdown (Figure 2).

In an attempt to further increase the examiners' reliability the authors (Phase III) further narrowed the inclusion criteria to include only severe demarcated opacities with surface breakdown (Figure 1) and/or atypical restorations (SDO). This meant that children with less severe to mild/moderate MIH were excluded. They will, however, be included in a future study.

It might also be argued that it was unethical to clinically examine children in Phase III before they had been checked for complete ABIS data. The reason was that all the invitations to the Phase III examinations were organised by the administration at each of the 89 dental clinics and that such a selection would have placed too much workload on the clinic. It might seem curious that only 56% of the children

Table 1. Possible explanatory variables for SDO that were excluded from the univariable analysis since they did not meet the inclusion criterion for the multivariable model, p<0,2

Pre-, peri- and neonatal problems in the child and/or the mother
Family diseases i.e. thyroid disorders, B12 deficiency, adrenal deficiency, celiac disease, rheumatoid arthritis; family allergies i.e. cow's milk-, lactose-, food allergy or asthma; family situation; birth country mother, father
Medication during pregnancy
Antibiotics, cortisone, blood pressure medication, psychopharmacology medication, painkillers, hormone therapy, chemotherapy, other medication, smoking during pregnancy, pregnancy diabetes/gestational diabetes
Delivery
Delivery week, birth weight, type of delivery
Infectious diseases of mother during pregnancy
Neonatal complication of the child (birth-1 month)
Infections, respiratory problems, jaundice, phototherapy, blood transfusion, Rh immunization, other blood group immunisation
Common childhood illnesses during birth–3 years
Illnesses 1–12 months
Upper respiratory infections, otitis media, lower respiratory infections, stomach flu, other infection, other disease
Infectious diseases 1–12 months
Measles, rubella, mumps, chickenpox, pertussis, other infectional diseases, illnesses, cold, stomach flu, infection which need antibiotics treatment, flu, cow's milk allergy, eczema, asthma/bronchitis
Illnesses 1–3 years
Cold, tonsillitis, otitis media, pneumonia, meningitis, infection which need antibiotics treatment, stomach flu, flu, three-day fever, poor weight gain, psychiatric problems, other illnesses, asthma, poor appetite, diabetes, gluten intolerance, other allergy
Infectious diseases 1–3 years
Measles, rubella, mumps, chickenpox, pertussis, other infectional diseases
Medication and vaccination during birth–3 years
Medication, 1–12 months
Antibiotics, vitamin AD drops, other vitamin and/or mineral supply, iron tablets
Medication 1–3 years
Vitamin AD drops 1–2,5 y, other vitamin and/or mineral supply, iron tablets, nose drops, painkillers–paracetamol, painkillers–ASA, antibiotics–PcV, antibiotics–others, bronchitis medication, cortisone, cough drops, other medication
Vaccinations
BCG/Calmette, polio, tetanus, diphtheria, measles, mumps, rubella, hepatitis B, pertussis, hemophilus, other vaccination, followed the Swedish vaccination programme the first 3y
Nutrition during birth–3 years
Consumption water (private well /municipal water supply), cow's milk introduction, gluten intolerance, weekly intake of venison (mother birth, year 1), weekly intake of pork (mother birth, year 1), weekly intake of beef (mother birth, year 1), weekly intake of mushroom (mother birth, year 1), Baltic sea fish (mother birth, year 1), other fish (mother birth, year 1)
Socio-economic factors during birth–3 years
Gender, living area, education level (father), age (mother), age (father), siblings y/n, do mother/father work professionally, does mother consider her self healthy, domestic smoking mother/father, BMI (mother), BMI (father), born summer/winter, domestic smoking mother/father (yr 1), self estimation of health (yr 1), domestic high level of radon.

Table 2. Result from the univariable logistic regression with SDO as the outcome variable

Variables	n	OR	95% CI	P-value
Introduction of infant formula	309		1.2-2.9	0.01
1-5m	132	Reference		
≥6m	177	1.9		
Breastfeeding	373		1.1-3.2	0.03
1-5m	66	Reference		
≥6m	307	1.9		
Introduction of gruel	305		1.1-3.6	0.02
1-5m	64	Reference		
≥6m	241	2.0		
Education level (mother)	461		1.1-2.5	0.01
≤Upper secondary school	319	Reference		
≥University	142	1.6		
Domestic moisture and/or mold	303		1.1-6.0	0.02
No	276	Reference		
Yes	27	2.6		

Table 2. The final logistic regression model with the grouping of three explanatory variables that combines long breast feeding and late introduction of gruel and infant formula compared to the control group and SDO as outcome

Variables	n	OR	95% CI	P-value
Introduction of gruel >6m Breastfeeding >6m Introduction of infant formula >6m	173	5.1	1.6-15.7	0.02

examined in Phase III could be found in the ABIS databank. However, the children treated in the PDS constitute about 95% of the total child population and the participation in ABIS at start was about 75%. In addition, there has also been a migration during the 10 years. Thus, today a participation in ABIS of 50–60% of the actual child population is to be expected.

Uni- and multivariable logistic regression were used to estimate the odds ratio (OR). In a case-control study the OR is an estimate of the relative risk. If the for an explanatory variable (i.e. breast feeding longer than 6 months) OR is 1.9 this means that the odds of having SDO is 1.9 times the odds of having SDO when breastfed shorter time than 6 months. The odds ratio OR and 95% Confidence Interval (CI) was calculated for possible explanatory variables for the emergence of SDO using logistic regression. From the results of the univariable logistic regression and a judgment by the authors of the probability of any possible impact (Table 2), variables that should be analysed in a multivariate model were selected. Multivariable logistic regression was used to estimate the odds ratios (OR), with a 95% confidence intervals (CI), for the significance of the explanatory variable in a final model.

No variables covering pre-, peri-, and neonatal periods, diseases, medication, and vaccination showed any correlation to SDO in the present study although several other researchers have mentioned these variables as tentatively causative factors to MIH (6, 7, 10, 11, 21, 24). However, these results should be analysed against the background that they were retrospective and there were great differences in the populations studied. The present study's findings, using data available on a large child population clearly indicate that breastfeeding more than 6 months will result in an increased risk for SDO. The result are partly in accordance with result presented by *Alaluusa et al.*(3, 4.) They speculated that it was environmental toxicants in the human milk that caused the enamel disturbances and not the long breastfeeding as such. However, other studies have not been able to confirm any detrimental effect of toxicants (14, 15). The tentative role of toxicants, such as dioxin, in the present cohort will later be analysed in hair samples from children at 1 year of age.

Most studies on the prevalence of MIH report similar and rather stable figures, around 10–20% (12). However, in an earlier study *Koch et al.* (13) found that the prevalence of MIH varied considerably between different years of birth in the same population with a particularly high peak in children born 1970. To look for an explanation to these annual variations in context of the present study it would be necessary to look for any changes in breastfeeding recommendations or any deficiencies in gruel or infant formula used during the actual period.

In the univariable statistical analysis there was correlation between SDO and education level of the mother and domestic moisture and mould. However, these variables lost their significance in the multivariable logistic regression model.

It is clear from the present study that the combination of breastfeeding more than 6 months, late introduction of gruel and/or infant formula (after 6 months) caused a five fold higher risk for SDO compared with a control group. The present study, therefore indicates that minor differences in nutrition during the first months of life might be responsible for hypomineralisation of enamel. There are several possible reasons why earlier studies were not able to

discover this: poor study design, small study populations, and unreliable retrospective data on childrearing practices during the early years

A recent study (7) on 82 preterm birth children (between 23 and 32 weeks of gestation) found that these children had statistically significant higher prevalence of MIH compared to a control group born at least after 37 weeks of gestation (38% and 16% respectively). This could not be explored in the present study when the pre-, peri-, and neonatal data were analysed as children with severe neonatal problems less often participated in the ABIS study. Nevertheless, both the study on the preterm birth children and the present study suggest, that disturbances in nutrition during the first 6 months of life might have an effect on the development of demarcated opacities.

In addition, there is limited evidence that introduction of gruel or infant formula between 4–6 months of age is harmful or unfavourable compared to introduction after 6 months (1, 9). Thus, introduction of gruel or infant formula at 4 months of age might decrease the risk of developing SDO as found in this study.

It seems urgent and important that further research is undertaken on nutrition and how it affects formation and mineralisation of enamel, especially during the first months of life.

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Corresponding author:
Dr Göran Koch
The Institute for Postgraduate Dental Education
P.O. Box 1030
SE-551 11 Jönköping, Sweden
E-mail: goran.koch@lj.se

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A history of frequent dental care reduces the risk of tooth loss but not periodontitis in older subjects

STEFAN RENVERT[1,2,3], RIGMOR E PERSSON[4,5,6], G RUTGER PERSSON [4,5,6]

Abstract

◎ Objectives: Information on the significance of dental care in older adults is limited. We hypothesized that regular dental visits has an effect on the number of remaining teeth and periodontal conditions in older subjects. Materials and Methods: 1020 randomly selected individuals age 60 - 96 from the Swedish National Study on Aging and Care Blekinge received a comprehensive oral health examination. Results: Dentate women and men had, on average 18.4 teeth (SD +7.6,) and 18.9 teeth (SD + 7.5) respectively (NS). In the youngest group (60 and 66 years old) with less than one dental visit per year, 37 % had >20 teeth, compared with 73 % among those with at least annual visits. Among the old-old, comparable figures were 1.8 % and 37 % respectively. Across age groups, bleeding on probing was 23 %. When adjusting for age, and number of teeth GLM univariate analysis failed to demonstrate an effect of dental visit frequency on alveolar bone loss ($p = 0.18$), the number of periapical lesions ($p = 0.65$), or the number of endodontically treated teeth ($p = 0.41$). Frequent dental visitors had more teeth than infrequent visitors ($p = 0.001$).

Conclusions: Tooth loss and alveolar bone loss severity increase with age. Individuals with regular dental visits retained more teeth but the frequency of dental visits had no impact on plaque deposits, gingival inflammation, or alveolar bone levels.

Key words

Dental care, older, periodontitis, tooth loss, oral health

[1] Department of Health Sciences, Kristianstad University, Kristianstad, Sweden
[2] School of Dental Sciences, Trinity College, Dublin, Ireland
[3] Blekinge Institute of Technology, Karlskrona, Sweden
[4] Department of Periodontology, University of Bern, Bern, Switzerland
[5] Department of Oral Medicine, University of Washington, Seattle WA, USA
[6] Department of Periodontics, University of Washington, Seattle WA, USA

Frekventa tandvårdsbesök reducerar risken för tandförluster men påverkar inte förekomsten av parodontit hos äldre individer

STEFAN RENVERT, RIGMOR E PERSSON, G RUTGER PERSSON

Sammanfattning

◎ Tillgänglig information om tandhälsa hos äldre är begränsad. Avsikten med denna studie var att undersöka om regelbunden tandvård påverkade tandstatus hos 1020 slumpmässigt utvalda individer mellan 60-96 år. Kvinnor med kvarvarande tänder hade i genomsnitt 18.4 tänder (SD +7.6) medan män hade 18.9 tänder (SD ± 7.5) (NS). I den yngre åldersgrupperna (60 och 66 år) med oregelbunden tandvård (< 1 gång per år) hade 37 % > mer än 20 tänder. Hos dem som fått regelbunden tandvård, minst en gång per år, hade 73 % mer än 20 kvarvarande tänder. I den äldsta gruppen (> 81 år) var andelen med > 20 tänder 1.8 % bland de som erhållit oregelbunden tandvård och 37 % om man fått regelbunden vård. De som regelbundet sökt tandvård hade signifikant fler tänder ($p = 0.001$). I genomsnitt hade hela gruppen äldre ett blödningsindex efter sondering på 23%. Efter justering för ålder, och antal kvarvarande tänder visade GLM univariate analys att frekvensen av tandvård inte hade någon effekt på omfattningen av alveolär benförlust ($p = 0.18$), förekomsten av periapikala destruktioner ($p = 0.65$) eller antalet rotbehandlade tänder ($p = 0.41$). Sammanfattning: Tandförlust och alveolar benförlust tilltar med ålder. Individer som fått regelbunden tandvård har fler kvarvarande tänder men inte mindre gingival inflammation, alveolär benförlust eller färre tänder med periapikala destruktioner.

Introduction

Information on the consequences and significance of dental care visits among older people is limited (13). Tooth loss is associated with poor status across a wide range of health measures (34). Chewing ability as a consequence of tooth loss has been linked to lower oral-health-related quality of life, and to have an impact on general health status (4). Periodontal health is an important component of older persons´ self-perception of quality of life (53). It appears that older people are unaware of their potential risk for periodontitis (25) and therefore may not understand the benefits of regular periodontal supportive care.

Since the early 1990s, data from the US suggest that the severity and prevalence of periodontitis has decreased, specifically among older people (9). Limited access to dental care as a result of socio-economic factors results in high prevalence of periodontitis in older individuals (2, 19, 15). A robust association between severe periodontitis and socio-economic factors has been documented in the National Health and Nutrition Examination Survey (NHANES III) (3). Longitudinal studies on the progression of periodontitis suggest that the rate of periodontal breakdown in most individuals is low (16, 21, 23). Data from a longitudinal study over five years have also suggested that baseline clinical periodontal parameters correlate strongly with future periodontal breakdown and tooth morbidity (22).

Studies of nursing home residents have shown that good oral hygiene may only be found in 12% of dentate persons (37). In older people, having probing pocket depth ≥ 5 mm at several sites, a diagnosis of osteoporosis, and being of Caucasian or African descent is predictive of periodontal decline (36). Many older people remain healthy up to very old age. Changes in, lifestyle, health habits, physical and physiologic insults may quickly make them frail, and cause significant oral health problems (28).

Longitudinal studies of individuals with a diagnosis of periodontitis, and well maintained in a periodontal practice, have shown that older age is an explanatory factor to tooth loss (5). Significant progression of periodontitis has been found in approximately 20% of older people receiving regular dental care (38). Data from NHANES III have suggested that having dental insurance is associated with better clinical oral health status (33).

In 1973, a national dental insurance system for all inhabitants was introduced in Sweden. One of the aims of the insurance system was to make dental care available and affordable to all individuals. From 1973 the preventive efforts in dental care in Sweden has improved and a considerable number of dental hygienists have been educated and participate in dental health care delivery.

The objectives of the present study were to assess the effects of dental visits and age on tooth loss and periodontal conditions in older subjects participating in a regional comprehensive medical and dental survey, the Swedish National Study on Aging and Care Blekinge (SNAC-B). We hypothesized that regular dental care visits has an effect on the number of remaining teeth and periodontal conditions in older subjects.

Materials and Methods

The study subjects were participants of the Swedish National Study on Aging and Care (SNAC), which is a population based and multicenter, cohort study. The study has four participating centers in Sweden. One of the centers is Blekinge (SNAC-Blekinge), which encompasses the Karlskrona community with 60600 inhabitants.

Briefly, the study sample was selected randomly in age cohorts of 60, 66, 72 and 78 year old. In the age cohorts of 81, 84, 87, 90, 93, and 96 year old all inhabitants were included. The participants were invited by mail to take part in medical, psychological, and dental examinations by research staff in two sessions of four hours. If the subjects accepted to participate, but were not able to come to the medical research centre, the examinations were performed in their homes. The Research Ethics Committee at Lund University, Sweden approved the study. Informed consent was obtained from all participants, and they were asked to sign a release form for their medical records. The participants of the present study were consecutively enrolled between September 2001 and April 2004.

Clinical dental examinations

Two trained and experienced dental hygienists performed routine clinical dental examinations. They accounted for the number of remaining teeth, intact teeth, evidence of tooth decay, overall dental plaque assessment (ODPA) (0 = no deposits, 1= limited soft deposits at the gingival marginal, 2= clearly visible soft deposits, and 3= extensive soft and hard deposits), dry mouth assessment using the mirror test (14), and the presence of partial and full dentures. Soft tissue lesions were identified. Probing pocket depth (PPD) measurements were performed at four surfaces per tooth (mesio-buccal, mid-buccal, disto-

Table 2. Selection of questions asked to all subjects in order to assess their perceptions on oral health and whether they were seeking regular dental care or not.

Questionnaire
Do you smoke? (Never, some times, quit smoking (year), current smoker
Are you pleased with your oral conditions?
Do you find it difficult to chew food items? Specified as eating apples, breakfast buns, meat
Do you avoid talking to people due to your tooth conditions?
When did you last time have tooth ache (never, or year)?
Do you feel that you have a dry mouth and little saliva during daytime? (often, sometimes, never)
Do you feel that you have a dry mouth and little saliva during nighttime? (often, sometimes, never)
Is it important for you to have a healthy dentition? (Scale 1-5)
How important is it to be able to chew any type of food? (Scale 1-5)
How important is it for you to have regular dental care (scale 1-5)
How important is it for you not to have missing teeth in the front tooth region to have regular dental care (scale 1-5)
How important is it for you to have regular dental care (scale 1-5)
Does it matter to you if your teeth are discolored? (Scale 1-4)
Does it matter if your gums bleed? (Scale 1-4)
Does it matter if you have bad breath? (Scale 1-4)
Does it matter if you have deposits on your teeth (scale 1-4)
Does it matter if you have deposits or stain on the back of your tongue (scale 1-4)
Why have you lost teeth?
At your last dental visits did the dentist/hygienist informed you about oral hygiene methods
By whom did you receive treatment last time (dentist, hygienist)
Do you use any of the following when you are cleaning your teeth (toothbrush, inter-proximal brushes, toothpaste, dental floss, tooth picks
Do you rinse with a fluoride solution?
How often do you seek dental care? (Twice a year or more, once a year, every second year, rarely, never, do not remember)

buccal, mid-lingual/palatal). The deepest PPD, and the presence or absence of bleeding on probing was recorded for the tooth. The percentage of sites with bleeding on probing (assessed from the same four sites that had been exposed to PPD measurement) was computed. An extensive questionnaire was used to identify subject self-perception of oral health, chewing capacity, frequencies of dental visits, the use of oral hygiene aids, smoking habits, halitosis, pain, and dry mouth. A summary of the questionnaire is provided (Table 1).

Panoramic radiographs were taken in those subjects who were included. These panoramic radiographs were coded, and analyzed by one of the authors (REP). The extent of alveolar bone loss was measured at the mesial and distal aspects of all teeth, and expressed as the numbers and proportions of sites expressing a distance between bone level and the cement-enamel junction on teeth ≤ 4.0 mm (ABL) (24, 26, 27). Thus periodontitis was defined as having radiographic evidence of ABL ≤ 4 mm at 30 % of inter-proximal sites that could be assessed. The presence of endodontically treated teeth and the presence of peri-apical lesions, root remnants, implants, and peri-implantitis was recorded. The Klemetti index (18) was used to assess the mandibular cortex area as an indication of osteoporosis. All subjects underwent bone density assessment of both heels using a Lunar PIXI densitometer (Lunar, Madison, WI). Subjects were classified as having osteoporosis if they had a T-value > - 1.6. (adjusted WHO standard for calcaneous assessments).

Statistical methods

Independent T tests, oneway ANOVA, Kruskal Wallis ANOVA, general linear model univariate, and stepwise regression analytical methods were performed. The SPSS 17.0 statistical software program for MAC was used (SPSS Inc, Chicago IL).

Results

The mean age of the 554 women was 74.5 years (S.D. ± 9.5), and 74.0 (S.D. ± 9.5) for the 466 men (p = 0.39). Among these subjects, 149 (14.6 %) were edentulous (88 women and 61 men), whereas 74 subjects (8.5 %) had ≥ 28 teeth. Dentate women and men had, on average, 18.4 teeth (S.D. ± 7.6), and 18.9 teeth (S.D. ± 7.5) (p = 0.37) respectively. In the youngest age group (60 and 66 years), 50.5 % had ≥ 20 teeth, in the old age group (72 and 78) 58.1 % had ≥ 20 teeth, and 9.2 % of the old-old subjects (> 81 years) had > 20 teeth. Overall, 32 % of the subjects reported that they went to the dentist ≥ twice yearly, 48 % once a year, and 20 % less frequently. In the youngest age group with

infrequent dental visits (less than once yearly) 37% had > 20 teeth, and 73% of this group had > 20 teeth if they attended a dental clinic at an annual rate. In the old-old age group, with infrequent dental visits only 1.8% had > 20 teeth, whereas 37% of those who received frequent dental services at a level greater than once yearly had > 20 teeth.

The distribution of dental conditions by age categories is presented (Table 2). The number of remaining teeth, intact teeth, decreased significantly by increasing age ($p < 0.001$) and the proportion of teeth with evidence of ABL ≥ 4.0 mm increased ($p < 0.001$). The distribution of ABL scores is presented in a boxplot diagram (Figure 1). When including dentate subjects and adjusting for age, as well as for missing teeth, GLM univariate analysis failed to demonstrate an effect of frequency of dental visits, ABL scores ($p = 0.18$), number of peri-apical lesions visible on radiographs adjusted for the number of remaining teeth ($p = 0.65$) and the number of endodontically treated teeth adjusted for the number of remaining teeth ($p = 0.41$).

The relation between ODPA scores and age is presented in a boxplot diagram demonstrating more severe extent of deposits with increasing age (Figure 2). The prevalence data suggested that oral hygiene as assessed by the ODPA was poor in all groups but similar and very high in the two older groups. One-way ANOVA demonstrated no difference in ODPA between those attending dentistry frequently or annually. Data analysis demonstrated that the old-old subjects had worse oral hygiene than the younger-old subjects ($p < 0.001$). A current regular smoking habit was reported by 8.2 %, occasional smoking habits by 2.8 %, quit smoking 35.8% whereas 50.2 % of the subjects had never smoked (no answer from 2.6 %). Oneway ANOVA failed to demonstrate that smoking had an impact on the number of remaining teeth. The proportion of interproximal sites with ABL at > 30% of interproximal tooth surfaces was significantly higher among current smokers in comparison with never smokers ($p<0.001$).

Calcaneus PIXI T-values <-1.6 identified osteoporosis in 28.2% of the older persons. Evidence of osteoporosis was assessed by the Klemetti index (1994) and was found in 18.5 % of the subjects (5.7 % of the men and 29.9 % of the women) and with increasing severity and prevalence by age. Stepwise linear regression analysis demonstrated that increasing age, the severity of osteoporosis, higher ABL, higher BOP %, higher ODPA scores, and frequency of dental visits were explanatory to reduced number of remaining teeth ($p < 0.001$). In this assessment gender, tooth-brushing and smoking habits were excluded as non-explanatory factors to the number of remaining teeth by the statistical analysis.

Discussion

The questionnaire was constructed such that several questions should provide reliable information on the subjects´ perception of dental care needs, and frequency of dental visits over time. It may be difficult to remember how often a person has utilized dental care. The panoramic radiographs from the

Figure 1. Boxplot diagram illustrating the distribution of alveolar bone loss defined as the % sites with a distance CEJ to bone level ≥ 4 mm (ABL) for all subjects separated in three age cohorts.
(o = outlier values).

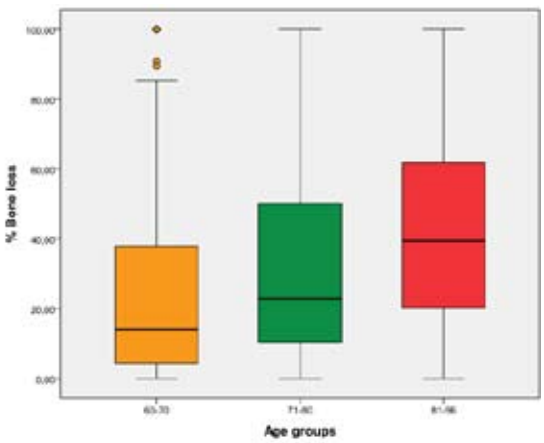
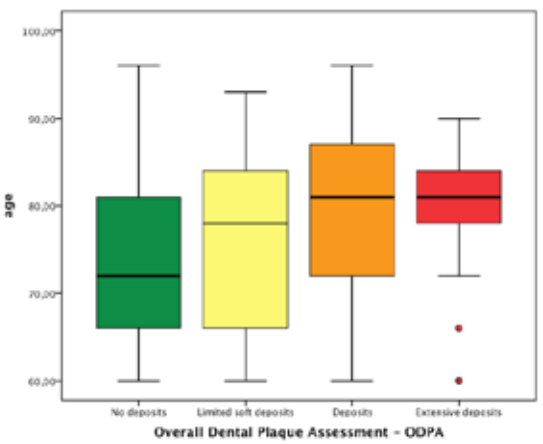


Figure 2. Boxplot diagram illustrating the distribution of deposits as defined by the overall dental plaque assessment (ODPA) scores arranged in four categories and in relation to age.



dentate subjects confirmed, however, that a majority of the study subjects had utilized dental care to a great extent with evidence of comprehensive dental care. Radiographic evidence of large caries lesions was uncommon whereas endodontic treatments were frequently found. Regular dental visits with focus on prevention can limit oral disease progression but also that root fractures commonly cause tooth loss (1).

Ageing had an important impact on the number of remaining teeth, and the extent of alveolar bone loss (ABL). The extent of ABL did, however, not differ by the frequency of professional dental care and consistent with other studies (17, 38). Studies have shown that persistent bleeding on probing and poor oral hygiene has been associated with an increased risk for tooth loss (29, 31). The present study failed to show that the frequency of dental visits among the older people reduced the extent of gingival bleeding. Our findings of poor oral hygiene among older individuals are consistent with others (15). The extent of BOP remained rather similar across ages. The lack of correlation between plaque, BOP and ABL scores may be explained by changes in immunity as an effect of ageing (6, 12). Thus, the extent of BOP may not be a reliable tool to assess gingival inflammation in old-old subjects. Failure to observe periodontitis in older subjects may explain why periodontal status in the present study was poor.

The WHO goal is that throughout life, people should retain at least 20 functional teeth. When the dental insurance system was introduced in Sweden, the individuals in the younger old group (60 and 66 years old) were 30 or 36 years old. In spite of a comprehensive dental insurance plan, and good to excellent availability of dental care at least 30% in the younger age groups, (60 and 66 years old) and 63% in the older age group (>81 years old) did not meet the WHO goals of tooth preservation throughout life. In spite of a dental insurance system and good availability of dental care in Sweden periodontal health do not seem to have improved. This in contrast to the report of oral health in the US(9). The prevalence of periodontitis in the US older population is lower than reported for older Swedes in the present study. This is especially remarkable as the criteria for periodontitis in the present study was defined such that periodontitis must be of extensive and advanced in nature to classify a diagnosis periodontitis (evidence of bone loss at > 30 % of sites), whereas the NHANES III would define periodontitis based on at least one periodontal site with 3 millimeters or more of attachment loss and 4 millimeters or more of pocket depth.

It is generally perceived that smoking has a negative impact on periodontal conditions. Data suggest that smoking among older men predict tooth loss. However, smoking cessation advice may not prevent the progression of periodontitis in susceptible individuals (10). The low prevalence of smoking reported in the present study may explain why smoking was not identified as a contributory factor to tooth loss, or to other oral conditions.

Osteoporosis is a disease prevalent in older people, and more prevalent among older individuals in Scandinavia and in the United States than elsewhere (11, 20, 32). Several factors have been associated with osteoporosis, including female gender, age, ethnicity, diet, and lifestyle (7). Our data suggested that osteoporosis was associated with the severity of ABL. Several studies usually including people younger than 75 years of age have assessed the relationship between osteoporosis and periodontal conditions (8,30). Further studies are needed to assess the relationship between osteoporosis and periodontitis in subjects older than 75 years.

In conclusion, the number of remaining teeth decreased, and the extent of alveolar bone loss at existing teeth increased with age. Frequent dental visitors presented with more teeth while frequency of dental visits did not have an impact on alveolar bone levels, amounts of deposits gingival inflammation or periapical lesions.

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Corresponding author:
Dr Stefan Renvert
Department of Health Sciences,
Kristianstad University
SE- 291 88 Kristianstad, Sweden
E-mail: stefan.renvert@hkr.se

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Changes in tooth mortality between 1990 and 2002 among adults in Västerbotten County, Sweden: Influence of socioeconomic factors, general health, smoking, and dental care habits on tooth mortality

KARIN PIHLGREN[1], HANS FORSBERG[2], LARS SJÖDIN[3], PER LUNDGREN[2], ANDERS WÄNMAN[4]

Abstract

◉ The objectives of the study were to analyse changes in tooth mortality among adults in Västerbotten County, Sweden, between 1990 and 2002 and determine whether socioeconomic factors, general health, smoking, and dental care habits influenced tooth mortality. The study was based on samples drawn from the adult population in Västerbotten County in 1990 and 2002. The studied age groups were 35-, 50-, and 65-year-olds. In 2002 75-year-olds were included. The surveys comprised a clinical examination and a questionnaire. The latter focused on oro-facial symptoms, socioeconomic factors, general health, smoking, and dental care habits. Complete data were obtained from 715 individuals in 1990 and from 768 individuals in 2002. Variables used to depict tooth mortality were edentulousness, occlusal supporting zones (Eichner index), and number of teeth. The prevalence of edentulousness in Västerbotten County decreased from 12.7% in 1990 to 3.7% in 2002 ($P < 0.001$). The mean number of teeth increased in all age groups between 1990 and 2002, and so did the number of individuals with tooth contact in all occlusal supporting zones and no gaps between teeth. Low educational level, weak economic status, smoking, and irregular visits to the dental clinic were all significantly related to increased tooth mortality. Between 1990 and 2002 tooth mortality decreased significantly in the adult population of Västerbotten County, Sweden. Cross-sectional analysis identified socioeconomic factors, smoking, and irregular use of dental care services as being related to tooth mortality in both 1990 and 2002.

Key words

Epidemiology, general health, oral health, tooth mortality, socioeconomic

[1]Public Dental Health Care, Dalarna County Council, Sweden
[2]Public Dental Health Care, Västerbotten County Council, Sweden
[3]Dental and Pharmaceutical Benefits Agency, Stockholm, Sweden
[4]Department of Odontology, Faculty of Medicine, Umeå University, Sweden

Förändringar i tandmortalitet mellan 1990 och 2002 bland vuxna i Västerbotten, Sverige. Påverkan av socioekonomiska faktorer, allmänhälsa, rökning och tandvårdsvanor på tandmortaliteten

KARIN PIHLGREN, HANS FORSBERG, LARS SJÖDIN, PER LUNDGREN, ANDERS WÄNMAN

Sammanfattning

◉ Syftet med denna studie var att analysera förändringar avseende tandmortalitet hos Västerbottens läns vuxna befolkning mellan åren 1990 och 2002 samt att fastställa om socioekonomiska faktorer, allmänhälsa, rökning och tandvårdsvanor påverkade tandmortaliteten. Studien baseras på två epidemiologiska undersökningar som utfördes i Västerbottens län år 1990 och år 2002. Individer i åldersgrupperna 35, 50 och 65 år valdes slumpmässigt ut 1990 och 2002. År 2002 inkluderades även individer som var 75 år. Studierna bestod av en klinisk undersökning och ett frågeformulär. Frågeformuläret omfattade frågor avseende symtom från tänder och käkar, socioekonomiska faktorer, allmän hälsa, rökning och tandvårdsvanor. Fullständiga data erhölls från 715 individer år 1990 och från 768 individer år 2002. Variablerna som användes för att beskriva tandmortalitet var tandlöshet, ocklusala stödzoner (Eichner index) och antal tänder. Tandlösheten i Västerbottens län minskade från 12.7% år 1990 till 3.7% år 2002 ($P < 0.001$). Antalet individer med tandkontakt i samtliga ocklusala stödzoner och utan tandluckor ökade signifikant i alla åldersgrupper mellan 1990 och 2002. Medeltalet för tänder ökade i samtliga åldersgrupper mellan 1990 och 2002. Låg utbildningsnivå, svag ekonomisk situation, rökning och oregelbundna besök hos tandvården ökade tandmortaliteten i de studerade åldersgrupperna. Mellan 1990 och 2002 minskade tandmortaliteten signifikant hos den vuxna befolkningen i Västerbottens län i Sverige. Genom tvärsnittsanalys av data från 1990 samt 2002 påvisades ett samband mellan tandmortalitet och socioekonomiska faktorer, rökning samt oregelbundna besök i tandvården.

Introduction

Västerbotten County, in the northern part of Sweden, consists principally of a more sparsely populated inland and a more densely populated coast. Dental clinics, and consequently access to dental care, are concentrated in the urban part of the county. Dental care was for a long time neglected in Sweden, especially in the north, where the lack of dentists was evident. In 1923 only 7 out of a total of 750 dentists in Sweden worked in Västerbotten County. The recruitment of dentists was especially difficult in the rural parts of the north of Sweden during the Second World War (3). Due to lack of dental care resources, in the inland region of Västerbotten, dental treatments have focused on extractions and removable dentures (3, 35).

Politically important questions have thus been: Have inhabitants in these regions received dental care on equal terms to other residents of Sweden? Do oral status and related treatment needs of northerners differ from those of residents in other parts of Sweden? Planning and allocation of resources require monitoring of changes in dental status over time. Knowledge of possible determinants of the oral health status is also important to meet national health goals.

There has been a clear trend in industrialised countries, since the Second World War, of improved oral health (13, 22, 23, 29, 31, 37). Several studies have analysed oral health in a number of regions in Sweden (1, 5, 8, 9, 13, 21, 33). National patterns may or may not be relevant to specific regions. Consequently, patterns in the northern part of Sweden may differ from patterns in the southern part, and variations may exist between rural and urban regions.

One national health goal in Sweden is to provide dental care on equal terms and to obtain good oral health for the entire population (26). Nevertheless, studies demonstrate that socioeconomic factors affect oral health in Sweden (10, 18, 20, 21, 27), as well as in other countries (11, 14, 20, 23, 29, 30, 31).

A primary aim of this study was to analyse changes in tooth mortality between 1990 and 2002 among adults in Västerbotten County, Sweden. A secondary aim was to analyse whether socioeconomic factors, general health, smoking, and dental care habits had influenced tooth mortality.

Hypotheses

- Tooth mortality had decreased in all age groups between 1990 and 2002.
- Regional differences in tooth mortality existed between the inland and the coast regions in Väs terbotten County, Sweden, in both 1990 and 2002.
- Socioeconomic factors, general health, smoking, and dental care habits influenced tooth mortality.

Materials and methods

Study population

In 1990 a sample was drawn from the adult population in Västerbotten County (35). The study population included those aged 35, 50, and 65 years, a total of 9 051 individuals. These were stratified according to place of residence, that is, resident at the coast or in the inland region. In each regional stratum 450 participants were randomly drawn, proportional to the demography of the selected ages, for a total of 900 participants. In 2002 another sample was drawn from the same population, together with an additional age group of 75-year-olds (36). Hence, in 2002 the study population comprised all individuals aged 35, 50, 65, and 75 years old living in Västerbotten in September 2002, totalling 11 324 individuals. For each stratum, coast and inland, 600 participants were included, 150 in each age group; consequently, the sample comprised 1200 individuals. Since the selection procedure was different in 1990 and in 2002, individual weights have been used to correct for the stratification when presenting figures for the total county. The surveys included a clinical examination, free of charge, and a questionnaire to capture case history. All participants gave informed consent to participate in the oral health survey. The studies were approved by the Ethics Committee at Umeå University, Sweden.

Participation rate

In 1990 complete datasets were obtained from 715 individuals (79.4%). Ninety-eight individuals (10.9%) only answered the questionnaire. Twenty-eight individuals (3.1%) answered via telephone. Altogether, 93.4% took part in the survey. In 2002 complete datasets were obtained from 768 individuals (64%). Two hundred nineteen individuals (18%) only answered the questionnaire. Eleven individuals (1%) only took part in the clinical examinations. Altogether, 998 individuals (83%) took part in the survey. Only participants with complete datasets, that is, those who completed both the clinical examination and questionnaire, were included in the present study.

Clinical examinations

The clinical examinations were performed from September to December in 1990 by six examination teams. In 2002 the examinations were done from October 2002 to February 2003 by four examination teams. The latter examination will be referred to as 2002. Each team consisted of a dental nurse and a dentist. The dental teams were calibrated in the examination procedures and diagnostic criteria. Reliability tests were carried out for a range of variables before the studies started (35). The clinical variables were the same in the two examinations. The 1990 and 2002 examinations included registration of number of teeth, previous dental treatment, periodontal status, decayed teeth/surfaces, temporomandibular joint status, signs of muscle pain, maximal jaw opening capacity, and mucous membrane status. Clinical data were registered in laptops with customised software. Radiographic pictures (bite-wings) were taken on dentate individuals.

Questionnaires

The participants filled out questionnaires with 45 (1990) or 65 (2002) questions, respectively. The questions were mainly to be answered with a yes or no and targeted information about general health status, self-perceived oral health status, symptoms from teeth and jaws, medication, smoking, and dental care, and socioeconomic variables such as age, gender, marital status, level of income, and level of education. In 1990, the individuals who did not participate in the examinations received the questionnaire by mail with a postage-paid return envelope. Those individuals who did not answer by mail were contacted via telephone. Questions asked over the telephone involved information about number of teeth, dentures, dental care, and reason for not participating in the examination. In the 2002 survey individuals who did not answer the questionnaire within the time limits received two reminders. A subsample was contacted by telephone and asked questions concerning dentures, dental care, chewing capacity, self-perceived health, and living conditions.

Variables

Tooth mortality was analysed based on three variables used as dependent variables:

1. Edentulousness
2. Occlusal supporting zones, i.e., Eichner index (4)
3. Number of teeth

The following were used as independent variables in the analyses:

(a) Socioeconomic factors
- Age group
- Gender
- Place of residence
- Living conditions: living alone/other. Other included a) married or cohabiting (1990), b) married/cohabiting with children living at home (2002), and c) married/cohabiting without children living at home (2002).
- Level of education: a) comprehensive school only/additional schooling b) university level: no/yes
- Employment: working/not working
- Level of income: <15 000 SEK/month/ ≥15 000 SEK/month (2002).
- Financial resources: can obtain 14 000 SEK within a week: a) from own savings: yes/no and b) from own savings or by borrowing: yes/no (2002).

(b) General health
- Regular use of prescribed medicine: yes/no
- Self-perceived health 1990: very good or fairly good/other; 2002: a) very good to neither good nor bad/other

(c) Smoking
- Smoking: current smoker/non-smoker

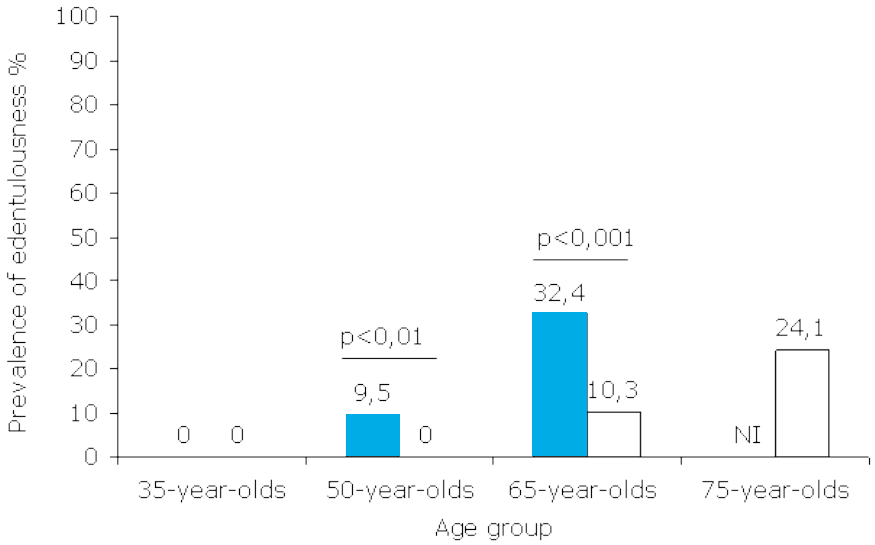
(e) Dental care habits
- Visiting dental health care: >2 years apart/ ≤2 years apart
- Tooth brushing: less than once per day/once per day or more often
- Chewing capacity 1990: avoid certain foods/do not avoid certain foods; 2002: a) can chew hard food or I am careful while chewing/cannot chew hard food
- b) can chew hard food/cannot chew hard food or I am careful while chewing

Statistical methods

The data analyses were performed using the Statistical Package for Social Science, SPSS, version 15.0 (SPSS Inc.). Analyses were performed to calculate frequencies, mean values, and standard deviations (SD). Hypothesis was tested with Student t-test, odds ratio, Chi-2 test, Fisher's exact test and logistic regression analysis. Cross-tabulation and logistic regression were used to analyse associations between the dependent and independent variables. The null hypothesis was rejected when $P < 0.05$.

The dependent variable edentulousness included individuals with no remaining teeth, with or without complete dentures. When analysing edentulousness

Figure 1. Changes in prevalence of edentulousness in 35-, 50-, 65-, and 75-year-olds between 1990 and 2002 in Västerbotten County, Sweden. In 1990 the age group 75-year-olds was not included (NI). Filled bars denote year 1990 and open bars denote year 2002.



in relation to the independent variables, the age group 65-year-olds in 1990 and the age groups 65- and 75-year-olds in 2002 were used, since the number of edentate individuals in the other age groups were few. In the data from 2002, participants aged 65 and 75 years old were combined into one age group named 65+75-year-olds. The dependent variable occlusal supporting zones were subclassified into A, B, and C when analysing changes between 1990 and 2002. When analysing occlusal supporting zones in relation to the independent variables, they were first dichotomised as follows: a) A1/other: 35-year-olds (1990), 35- and 50-year-olds (2002); and b) A1–B3/other: 50-year-olds (1990) and 65+75-year-olds (2002). The dependent variable number of teeth was dichotomised into < mean and ≥ mean. Edentate individuals were excluded when using number of teeth. All 32 existing teeth were registered. Roots having clinical usefulness were regarded as existing teeth. Partially erupted teeth were registered as existing teeth. All age groups were analysed separately.

Drop-out analysis

Drop-out analyses were performed comparing those with complete data, that is, examination and questionnaire, and those with only questionnaire, which were as follows: for 1990, 715 individuals vs. 98 individuals, and for 2002, 768 individuals vs. 219 individuals. In the 1990 sample, non-attendees to the clinical examination reported via questionnaire a higher prevalence of having dentures than the examined individuals. Nevertheless, in the 1990 sample the possible higher prevalence of edentulousness showed marginal effect on the estimated total prevalence (35). Hence, the results are considered representative for the adult population in the selected age groups in 1990. In 2002 the drop-out analysis was carried out by comparing the prevalence of edentulousness using the result from a question about dentures. There was no significant difference in prevalence of edentulousness when analysing the total sample or when analysing every age group separately.

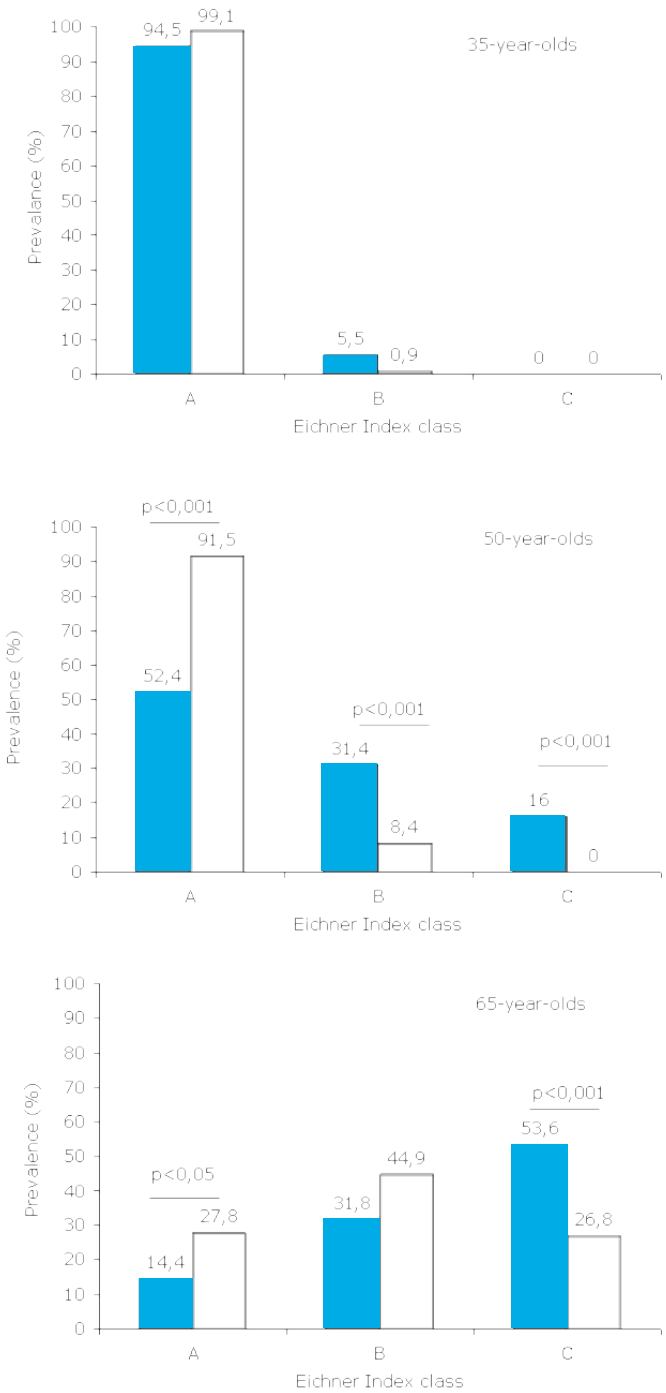
Results

Changes in tooth mortality between 1990 and 2002 in Västerbotten County, Sweden

Edentulousness

The prevalence of edentulousness in Västerbotten decreased significantly between 1990 and 2002 from 12.7% to 3.7% ($P < 0.001$). In 1990 and 2002 all participants in the age group 35-year-olds were dentate (Fig. 1). In 1990 the prevalence of edentulousness among 50-year-olds was 9.5% compared to none in 2002 ($P < 0.01$). The prevalence of edentulousness among 65-year-olds decreased from 32.4% in 1990 to 10.3% in 2002 ($P < 0.001$). When

Figure 2. Changes in prevalence of Eichner index classes A, B, and C for 35-, 50-, and 65-year-olds between 1990 and 2002 in Västerbotten County, Sweden. Filled bars denote year 1990 and open bars denote year 2002.



the total populations in the inland and coast regions were analysed separately, a significant decrease ($P < 0.001$) in prevalence of edentulousness was found in both regions from 1990 to 2002. Sixty-five-year-old men living in the inland region in 1990 had a slightly more than 4-fold risk of being edentate compared to the corresponding sample in 2002 (OR 4.2; 95% CI, 1.7–11.0). Sixty-five-year-old men living in the coast region had no higher risk of being edentate in 1990 compared to the corresponding group in 2002. Women aged 65 years living in the inland region had a 7-fold risk of being edentate in 1990 compared to the corresponding group in 2002 (OR 7.1; 95% CI, 2.7–18.8).

Occlusal supporting zones

The prevalence of persons who fulfilled the criteria of Eichner index class A1, that is, contact in all four occlusal supporting zones and no gaps between teeth in the upper and lower jaw, increased in all age groups between 1990 and 2002. Between 1990 and 2002 the proportion of 50- and 65-year-olds with no occlusal supporting zones, that is, Eichner index class C, decreased significantly between 1990 and 2002. No individuals aged 50 years in 2002 were classified as class C compared to 16% in 1990. In 1990 54% of the individuals aged 65 years were classified as Eichner index class C compared to 27% in 2002 (Fig. 2).

Number of teeth

Between 1990 and 2002 the mean number of teeth significantly increased in the age groups 35-, 50-, and 65-year-olds (Fig. 3).

Socioeconomic factors in relation to tooth mortality

Gender

In 1990 women had twice the risk compared to men of being edentulous ($P < 0.05$), but in 2002 no such significant gender difference was observed. There was no statistically significant difference in number of teeth between men and women in the examined age groups.

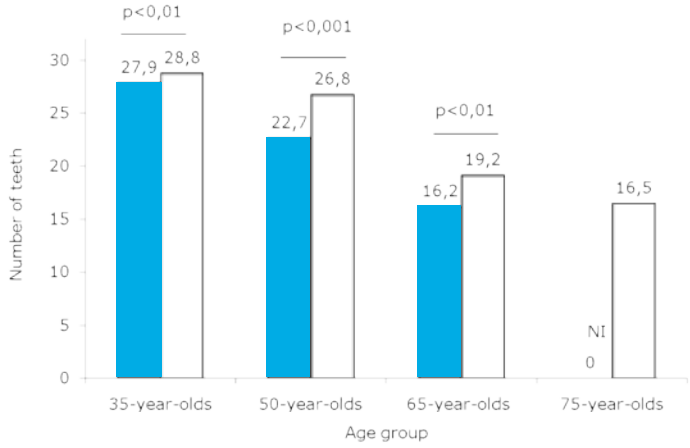
Place of residence

In 1990 inhabitants in the inland area had a slightly more than 2-fold risk of being edentate (OR 2.2; 95% CI 1.2–4.2). No such significant regional differences were observed in 2002. When analysing the included age groups and study-populations separately, 65-year-olds living in the inland region in 1990 had a 2-fold risk (OR 2.0; 95% CI 1–3.5) of being edentate, and those who were dentate had less occlusal support compared to the corresponding group living in the coast region ($P < 0.01$). Sixty-five-year-olds living in the inland region had in both 1990 (OR 2.1; 95% CI 1.1–4.1) and 2002 (OR 2.3; 95% CI 1.2–4.3) a slightly more than 2-fold risk of having fewer teeth than the mean number of teeth for their age group.

Living conditions

No significant associations between living conditions and the variables depicting tooth mortality were observed in 1990 or in 2002, except among 50-year-olds in 2002. In that sample, living alone increased the risk of having less occlusal support (OR 3.6; 95% CI 1.6–7.8).

Figure 3. Changes in the mean number of teeth in 35-, 50-, 65-, and 75-year-olds between 1990 and 2002 in Västerbotten County, Sweden. In 1990 the age group 75-year-olds was not included (NI). Filled bars denote year 1990 and open bars denote year 2002.



Level of education
A low level of education was significantly associated with a higher degree of tooth mortality in certain age groups. Edentulous 65-year-olds in 1990 were approximately 11 times (OR 10.7; 95% CI 1.4–81.8) and 65+75-year-olds in 2002 were 5 times (OR 5.3; 95% CI 2.1–13.8) more likely to have discontinued education after comprehensive school compared to dentate individuals of the same ages. Higher level of education was associated with a significantly higher degree of occlusal support among all age groups in 1990 and among 50-year-olds and 65+75-year-olds in 2002. Fifty-year-olds in 1990 with comprehensive school education as the highest educational level had a nearly 10-fold risk (OR 9.7; 95% CI 3.3–28.5), and those without university level had a 7-fold risk (OR 7.0; 95% CI 2.0 – 24.0), of having fewer teeth than the mean of their age group. Also in 2002 the level of education and number of teeth were significantly associated for the 50-, 65-, and 75-year-olds.

Working status
Working status and being edentulous did not show any significant association, except among 50-year-olds in 1990. Being edentulous in that sample was significantly associated with unemployment (OR 4.3; 95% CI 1.2–15.4). Those with a reduced number of occlusal supporting zones were, in the 1990 study population, significantly more often found among unemployed 35- (OR 4.0; 95% CI 1.4–11.5) and 50-year-olds (OR 6.8; 95% CI 2.1–21.8). In the 2002 study population, unemployed 35-year-olds in 2002 had a reduced number of occlusal supporting zones (OR 4.1; 95% CI 1.4–12.3).

Level of income
Questions about level of income were only available in 2002. A monthly income lower than 15 000 SEK was significantly ($P < 0.05$) associated with edentulousness in the age group 65+75-year-olds. Individuals aged 65 and 75 years with reduced occlusal supporting zones had a significantly lower income (OR 2.3; 95% CI 1.3–3.9). Those who were 50 years old and reported a monthly income <15 000 SEK had a significantly ($P < 0.01$) lower mean number of teeth (24.7 teeth), compared to those who reported a higher monthly income (27.1 teeth).

Financial resources
Individuals in all age groups in 2002 who reported that they could not obtain 14 000 SEK within a week, either from their own savings or through borrowing, had a significantly higher risk of presenting a reduced number of occlusal supporting zones. Among 50-year-olds who could obtain 14 000 SEK, the mean number of teeth was 26.9 compared to 24.3 among those who could not get the money ($P < 0.05$). The corresponding mean numbers of teeth among 65-year-olds were 18 teeth and 9.9 teeth, respectively ($P < 0001$).

General health in relation to tooth mortality
Regular use of prescribed medicines
Regular use of prescribed medicines among 50-year-olds in 1990 was associated with an increased risk of edentulousness (OR 2.5; 95% CI 1.1–6.1) and not having all four posterior supporting occlusal zones (OR 2.5; 95% CI 1.1–5.3). In 2002, the corresponding age group had a 2-fold risk of having a reduction in occlusal contacts compared to those who did not use prescribed medicines on a regular basis.

Self-perceived health
The individual's self-perceived health was not significantly associated with tooth mortality.

Smoking in relation to tooth mortality
Smoking
Edentate 50-year-olds in 1990 were 3 times more likely to smoke (OR 3.0; 95% CI 1.2–25.2) than dentate individuals, and were also more likely to be sorted in Eichner index class B4–C3 (OR 3.5; 95% CI 1.7–7.4). In 2002 current smokers had fewer occlusal supporting zones compared to non-smokers, among the 35- (OR 7.8; 95% CI 2.4–25.0) and 65+75-year-olds (OR 2.4; 95% CI 1.1–5.1). Current smokers aged 50 years old in 2002 had significantly fewer teeth compared to individuals of the same age who did not smoke ($P < 0.01$).

Dental care habits in relation to tooth mortality
Patterns of visiting dental clinics for regular checkups
In the study population 1990, a time elapse of more than 2 years between checkups was significantly associated with higher prevalence of being edentulous and having less occlusal support among 50- and 65-year olds. Those in the latter sample with longer time between checkups also had fewer teeth (OR 4.0; 95% CI 1.3–12.2). In the study population 2002 a similar pattern was found for edentate 65- and 75-year-olds; 50- , 65-, and 75-year-olds had less occlusal support; and 35- and 50-year-olds had a mean value of teeth that was lower than the mean value for their age groups, respectively.

Tooth brushing
There was no statistically significant association between tooth mortality and frequency of reported tooth brushing, except among 35-year-olds with irregular brushing habits in 2002, who had significantly ($P < 0.01$) fewer complete occlusal supporting zones than 35-year-olds who reported that they brushed their teeth at least once per day.

Chewing ability
Individuals with complete tooth loss, lack of occlusal support, and fewer teeth significantly more often reported difficulties in chewing.

Discussion

The main finding in the present study was a significant decrease in tooth mortality among the adult population in Västerbotten County, Sweden, between 1990 and 2002. Factors such as financial resources, smoking, and irregular use of dental care services were at cross-sectional analysis related to tooth mortality in both 1990 and 2002. Place of residence was related to tooth mortality among the 65-year-olds in 1990. However, the regional differences in tooth mortality had diminished in 2002.

The two surveys that formed the basis for the present analysis obtained information about the oral health status of the adult population in the inland and coast regions, respectively, of Västerbotten County. The use of specific age groups as indicators of the population was done in accordance with recommendations from the National Board of Health and Welfare in Sweden (28). Using only a few indicator ages gives the advantage of increasing the number of participants within the target ages, and thus increases statistical power within reasonable costs. Another advantage is the possibility to compare results between different areas and changes on a group level, prospectively. Since the population was not evenly distributed in the county, the studies were based on stratified samples. This was done to obtain an adequate number of participants living in the inland region for comparison purposes. A consequence of the sampling procedure was thus a need for individual weightings to correct for the stratification, when presenting figures for the total county. The size of the samples in 1990 and 2002 were decided after a power analysis of the possibilities to observe differences in one tooth between the specific regions and ages. When using the dependent variables edentulousness, occlusal supporting zones, and number of teeth to depict tooth mortality, different aspects of tooth loss were taken into account. Tooth loss is regarded as a reliable measure of a population's oral health status (30). Consequently, changes in tooth mortality may be regarded as changes in oral health status.

Since there was a possibility of overrepresentation of edentate individuals among the drop-outs, drop-out analyses were performed. No major systematic error due to drop-out was observed in relation to having complete dentures. The results are thus considered representative for the adult population in Västerbotten in the selected age groups.

Cross-sectional studies are not suited to observing individual changes over a period of time. In this study, however, we were more interested in observing changes of prevalence on a group basis and between "generations," as a basis to predict future changes in need and demand related to tooth mortality. For that purpose, a cross-sectional study is well suited and may also be used to investigate possible associations between risk factors and the outcome of interest.

The registered decrease in tooth mortality concurs with studies from other parts of Sweden. In Jönköping County surveys have been conducted every 10th year since 1973. These studies have also reported an increase in the number of teeth and a decrease of edentulous individuals over time (12). Edentulousness was reduced in the age groups 40–70 years from 16% in 1973 to 1% in 2003. Similar surveys have been conducted at 5-year intervals in Dalarna County since 1983 (33), and a decrease in prevalence of edentulousness from 17% to 3%, as well as an increase in number of teeth, was observed. The decrease in tooth mortality in different regions in Sweden thus corresponds to national surveys based on interviews between 1975 and 1997 by the Bureau of Statistics, Sweden (37), in which the prevalence of edentulousness in Sweden decreased from 19% to 3% in the ages from 25 to 74 years. Decreasing tooth mortality is not a Swedish phenomenon, but is also found in other industrialised countries. The prevalence of edentulousness among adults in Finland decreased from 14% to 6% between 1978 and 1997 (29), and a similar tendency has been reported in Denmark (23) and in Norway (11). The reduced tooth mortality, hence an improved oral health status in Sweden, is probably a result of several factors, for instance, the introduction in the 1950s of regular dental checkups and free dental care for children and adolescents, the implementation of prevention-oriented dental care in the

1960s, and the introduction of the national dental insurance system in 1974, which aimed to make dentistry available to the whole population. These factors may also have contributed to the diminished regional differences in 2002.

Regional differences in edentulousness were apparent in Västerbotten County in 1982 (1), where edentulousness was more common in the mountain districts than in the town of Umeå. The present study shows that regional differences of edentulousness, for the total population, were present also in 1990, but had disappeared in 2002. But, 65-year-olds living inland had fewer teeth compared to the corresponding age group living in the coast regions in 2002. Regional differences have also been observed in other Swedish surveys, where individuals in rural areas had a higher degree of tooth mortality (5, 9, 37). In contrast, 17% of 60- and 70-year-olds living in the city were edentulous compared to 13% in the rest of Jönköping County in 1993 (18). According to a nationwide survey performed in 1996–1997 by the Bureau of Statistics in Sweden (27), the northern rural area had the highest proportion of edentulous individuals in Sweden, followed by the northern urban area.

In Finland regional differences in edentulousness increased from 1978 to 1997 (29). Three to four times as many edentulous individuals were observed in the northern parts of Finland compared to the capital area. In Canada, no association between incidence of tooth loss and community of residence, metropolitan vs. non-metropolitan, was observed between 1989 and 1992 (14). Differences in social class structure could potentially account for persisting regional differences in tooth loss in the United Kingdom (31). The regional differences in tooth mortality in Västerbotten County, especially among elderly inhabitants, are most likely remnants of lack of dental health care resources in the past. The levelling out of regional differences among edentate elderly people may also be a consequence of migration.

The educational level was associated with tooth mortality in both 1990 and 2002. A low education level has in several similar surveys of adult populations shown a correlation to increased tooth mortality (7, 21, 23, 32, 34). Education is one commonly used socioeconomic indicator to reflect human capital (19). Although not completely conclusive, the level of education may mirror social class and financial resources. In line with level of education, low incomes among the elderly and limited financial resources were associated with increased tooth mortality. In an American prospective study (7), the authors reported that people with lower socioeconomic status were more likely to receive an extraction when they attended for dental care. They were also less likely to report that the dentist had discussed alternative treatments with them. The outcome of reduced number of teeth may thus also be a part of a dentist's decision process and not solely a demand from the patient, based on his/her financial status.

Lack of regular professional dental health care was also associated with tooth mortality. This association may be due to two different factors. First, edentulous individuals do not perceive the same demand for regular dental checkups as dentulous individuals (15). Second, more irregular use of dental health care may consist of dental visits mainly for acute treatment needs. Under such circumstances, extraction may be a treatment of choice, especially if dental resources and continuity are lacking (5). In a Swedish survey, low education level, no cash margin, and being born outside Sweden were related to not having been treated by a dentist in the previous 24 months (10). Thus, tooth mortality seems to be related to several socioeconomic factors, most likely interdependent.

In general, there were few significant associations between indicators of general health (regular use of medicine and self-perceived health) and tooth mortality in the present study. This was somewhat surprising, since chronic diseases and many oral diseases share common risk factors (24). One such common factor is smoking (25), which in these study populations, as in others (2, 29, 30, 34), showed a fairly consistent pattern of being associated with tooth mortality. Knowing this, it seems reasonable that resources aiming to reduce smoking be allocated within dentistry. In a recent prospective study based on 70-year-olds (38), edentulousness predicted an almost three times greater risk of mortality compared with having ≥20 teeth. Remaining number of teeth was a predictor of mortality independent of health factors, socioeconomic status, and lifestyle.

The significant decrease in tooth mortality among adults will imply a reduced demand for complete dentures (16). Consequently, a reduction of the general dentist's skills to perform such treatments will follow (16, 31). In the United Kingdom, many dental schools have already found it difficult to supply undergraduate teaching with such patients (31). This may also occur in Sweden, if it is not already a reality. An increase in number of teeth among elderly people also implies an increase of sites exposed to

caries and periodontitis. Previous predominately low dental treatment demands among the elderly population have thus shifted to preventive and restorative needs. Demand of major fixed dentures may increase in the short period, but will most likely turn into a rare intervention procedure in the near future. Strategies that suit the elderly and institutionalised, especially with preventive focus, need to be developed and implemented. It may be necessary to involve non-dental health professionals and caregivers to meet the needs and demands of elderly dental patients (17, 24).

Health planners require reliable data that mirror the population's dental needs, to allocate resources where they are needed the most. Soon electronic dental patient records may be used to determine a population's oral health. The obvious advantages would be the ease of obtaining large samples at a lower cost. However, a recent study in Västerbotten County, Sweden, shows that clinical registrations based on electronic dental patient records are at present not accurate enough to be used as indicators of oral health status among adults in a community (6).

In conclusion, the present study shows that tooth mortality has decreased significantly between 1990 and 2002 in the adult population of Västerbotten County, Sweden. The regional differences in tooth mortality between the inland area and the coast that existed only among the 65-year-olds in 1990 had diminished in 2002. Despite economical subventions from the Swedish government aiming to provide dental care on equal terms, socioeconomic factors still influence oral health status when measured in terms of tooth mortality.

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Corresponding author:
Dr Anders Wänman
Department of Odontology/Clinical Oral Physiology
Faculty of Medicine
Umeå University
SE-901 87 Umeå, Sweden
E-mail: anders.wanman@odont.umu.se

Self perceived oral health, oral treatment need and the use of oral health care of the adult population in Skåne, Sweden

NINA LUNDEGREN[1], BJÖRN AXTELIUS[2], SIGVARD ÅKERMAN[1]

Abstract

◎ The aim was to describe how the adult population in Skåne, Sweden, perceived their oral health, dental status, oral treatment need and use of oral health care. A questionnaire was sent to a randomly selected sample of 10 000 persons in Skåne, Sweden. The individuals were between 20 and 89 years old and registered as residents of the region during 2006. After excluding those no longer living in the region, 9 690 individuals remained. The response rate to the questionnaire was 63%, of which 57% were women and 43% men. A majority was satisfied with their teeth and with their teeth's appearance, 65% and 62% respectively. Of the respondents, 35% considered their dental health to be better than others in their age group. Symptoms associated with periodontitis were experienced by 40%. 7% were missing more than ten teeth while 7% had no dental fillings. 30% rated their need of dental treatment as high and most expected their treatment need to increase in the future. Most of the respondents, 60%, received their oral care at a private practice, whereas 13% did not see a dentist regularly for check-ups. More women than men perceived a high dental treatment need, 32% compared to 28%.

Conclusions: A majority of the adult population in Skåne have a positive attitude towards their oral health. Most individuals had lost few teeth and removable dentures were uncommon. A third rated their dental treatment need as high and most expected their treatment need to increase in the future..

Key words

Oral health, questionnaire, dentistry, epidemiology.

[1]Department of Oral Diagnostics, Faculty of Odontology, Malmö University, Sweden
[2]Department of Oral Public Health, Faculty of Odontology, Malmö University, Sweden

Självupplevd oral hälsa, tandvårdsbehov och tandvårdsutnyttjande hos den vuxna befolkningen i Skåne, Sverige

NINA LUNDEGREN, BJÖRN AXTELIUS, SIGVARD ÅKERMAN

Sammanfattning

◉ Målet med denna studie var att beskriva hur den vuxna befolkningen i Skåne, Sverige, upplevde sin orala hälsa, sitt tandstatus, sitt tandvårdsbehov och sitt tandvårdsutnyttjande. En enkät med 58 frågor skickades till ett slumpmässigt urval på 10 000 individer boende i Skåne. Dessa individer var 20 till 89 år gamla och registrerade som boende i regionen under 2006. Efter att ha uteslutit individer som inte längre bodde i regionen, utgjorde 9 690 individer det slutliga urvalet. Enkäten besvarades av 6 123 individer (63%). Av respondenterna var 57% kvinnor och 43% män. En majoritet var nöjd med sina tänder och med sina tänders utseende, 65% respektive 62%. Bland respondenterna ansåg 35% att deras tandhälsa var bättre än andra i deras åldersgrupp. Förändringar i munhålan som associeras med parodontit hade noterats av 40%. Bland respondenterna angav 7% att de saknade fler än 10 tänder och 7% hade inte några fyllningar. Nästan en tredjedel, 30%, av respondenterna upplevde ett stort tandvårdsbehov idag och de flesta bedömde att deras tandvårdsbehov skulle öka i framtiden. De flesta erhöll sin tandvård hos en privatpraktiserande tandläkare, 60% och 13% gick inte regelbundet till tandläkare för undersökningar. Kvinnorna upplevde i större utsträckning ett stort tandvårdsbehov, 32%, jämfört med 28% av männen.

Slutsatser: Den självupplevda orala hälsan är överlag god. En majoritet av den vuxna befolkningen i Skåne har en positiv attityd till sin orala hälsa, speciellt de i den yngsta åldersgruppen. De flesta hade endast förlorat ett fåtal tänder och avtagbar protetik var inte vanligt förekommande. En tredjedel bedömde sitt tandvårdsbehov som stort och de flesta väntade sig att deras tandvårdsbehov skulle öka i framtiden.

Introduction

Oral health has improved in the Swedish population and diseases such as dental caries have decreased in the population as a whole. Studies of oral health, oral treatment need and use of oral health care are of importance for the evaluation of prevalence and incidence of oral diseases in a population, effects of treatment and prophylaxis strategies, effects of financial systems in oral health care and for the planning of oral health care. During the last decades, a number of epidemiological clinical and questionnaire studies of the Swedish adult population have been performed. Whilst some of these studies have looked at the Swedish adult population as a whole (12,13), most studies have been aimed at a particular age group or geographical area (2,8,10,11,19,29). Furthermore, authors have tended to focus on either the clinical findings or the results from questionnaires.

The tendency to focus on specific findings or groups can also be seen in many international epidemiological studies. For example, *Hermann et al* specifically studied the periodontal status of the Hungarian adult population (9), *Schiffner et al* described the oral health in certain age groups in Germany (22), *Zitzmann et al* reported on the oral health in the adult population of Switzerland, studied only by a questionnaire and interviews (33). Studies on children's and older adults' oral health are numerous, for example *Östberg & Yazdani* looked at adolescents (32,34) whilst *Österberg, Berg, Samson* (4,21,35) studied older adults. However, studies that include all adult ages are lacking.

The patient's perception of his/her oral health is a factor that influences the oral treatment need (18) and the use of oral health care. Therefore, a study should also examine both the patient's and the dentist's perception of the patient's oral health and treatment need and then compare these. In all likelihood oral health and oral treatment need is a combination of the two perspectives. Thus, there is a need for studies that examines the population from both the view of the dental profession, i.e. clinically, and from the view of the patient, i.e. through a patient questionnaire and an in-depth-interview.

This study collected data for epidemiological description of the patients' perception of their oral health, oral treatment need, use of oral health care, and factors of importance for oral health in the adult population in Skåne. The study population had to be large enough in order for the results to be representative of the whole population of Skåne, and they should encompass a large variety of variables of interest. The total study (Skåne Oral Health Survey, SkanOHS) consisted of three parts: a questionnaire aimed at 10 000 individuals, a clinical part (which included the same questionnaire) aimed at 1 000 other individuals and in-depth-interviews of 30 of the individuals that participated in the clinical part. The study was designed in such a way that the contents of the different parts could be validated against each other (i.e. questionnaire versus clinical part).

Skåne is a county situated in the southern part of Sweden with a population of 1 184 500 individuals (in 2006) of which 895 745 were in the age group 20-89 years old (25) (Table 1). The average age of the population in the county was 49. Of the adult population i.e. >15 years of age, 16% were born in a country other than Sweden, compared to 15% in Sweden as a whole. Skåne has had a migration surplus of approximately 4 000 individuals annually during the years prior to 2006 and this surplus was expected to increase (5). Of these 4 000 individuals, about 1 000 (25%) were born abroad (25). Skåne consists of 33 municipalities which in 2006 varied in size from 6 898 to 276 244 inhabitants. Skåne is divided into four districts: South West (SW), North West (NW), North East (NE) and South East (SE). The larger cities of Skåne are situated in the SW and NW. In these districts the population is growing, whilst it is decreasing in the NE and SE. Skåne has agricultural districts, especially in the SE.

The aim of this study was to investigate, through a questionnaire, how the adult population in Skåne, Sweden, perceived their oral health, oral treatment need and use of oral health care. Another aim was to study if there were any differences in the perceptions due to age and gender.

Table 1. Percentages of the individuals (n) in the different age groups of the population in Skåne, the final sample and the study sample.

Age group	Population in Skåne (%) n = 895 745	Final sample (%) n = 9 690	Study sample (%) n = 6 123
20-29	17	17	14
30-39	18	18	16
40-49	18	18	17
50-59	17	17	19
60-69	15	15	18
70-79	10	10	11
80-89	6	6	6
Total	100	100	100

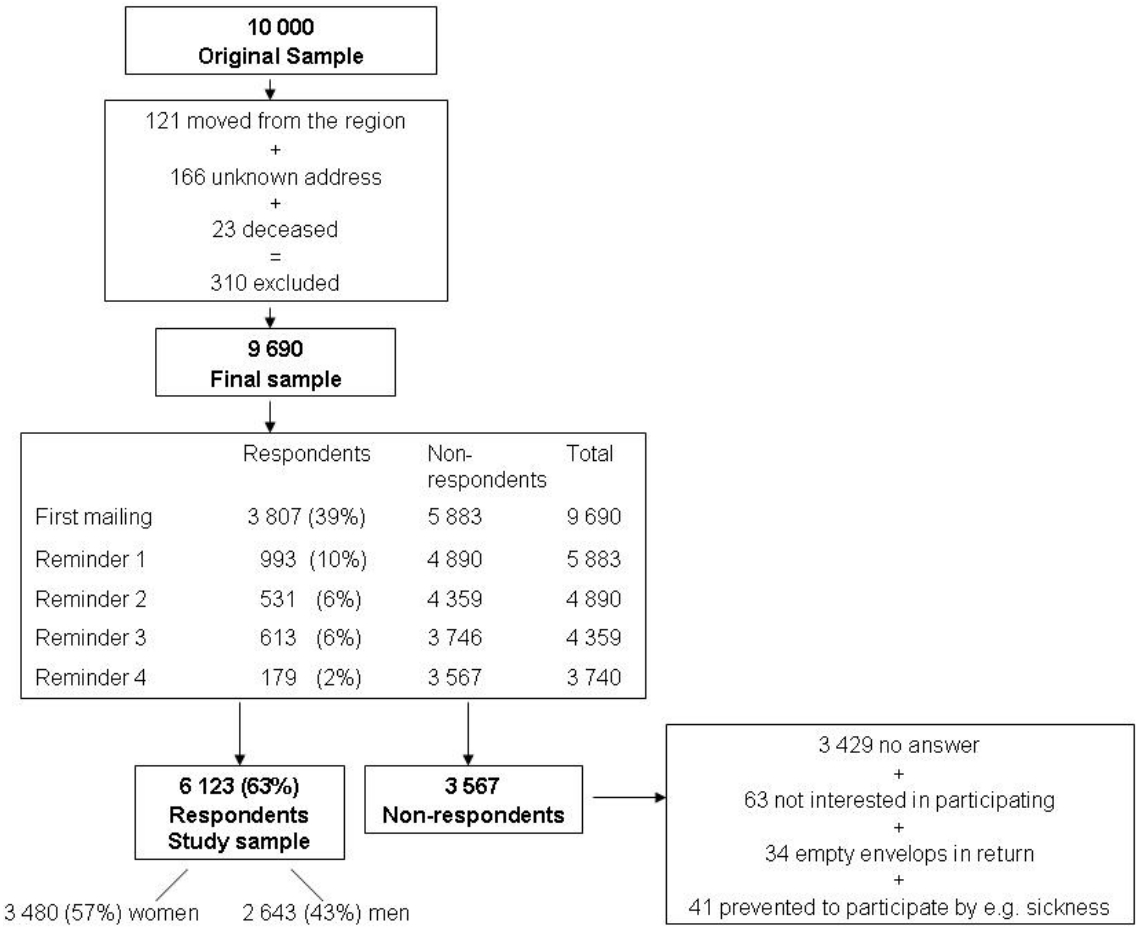
Material and methods

A questionnaire was sent to a randomly selected sample of 10 000 individuals living in Skåne, Sweden. The individuals were between 20 to 89 years old and registered as residents of the region during 2006. The sample was obtained from SPAR (The Governments Person Address Register in Sweden) together with background variables such as gender, domicile, address and age in five-year intervals. Of this original sample, 121 persons had moved from the region, 166 had unknown addresses and 23 were deceased, thus leaving 9 690 individuals as the final sample. The questionnaire was delivered by mail in May 2006 and reminders were sent in June, August, and October 2006 and in May 2007. The questionnaire was answered by 6 123 individuals, i.e. a response rate of 63% comprising a study sample of 3 480 women (57%) and 2 643 men (43%) (Figure 1). The distribution of the population in Skåne, final sample and study sample is presented in Table 1.

Non-respondents comprised 3 567 individuals, i.e. 37% of the final sample. Non-respondents were individuals that did not answer the questionnaire, e.g. did not reply (97%). The other 3% were individuals who were not interested in participating in the study, too ill to fill in the questionnaire, temporarily lived abroad or returned an empty envelope.

The questionnaire consisted of 58 questions. The questions concerned patient perception of oral health including perception of oral health care need, perception of pain, use of oral health care, dental materials and background factors. In this study we report the results regarding three different parts; perception of oral health, oral treatment need and use of oral health care. Concerning the respondents' perception of their teeth's status, questions were asked about existing teeth, number of fillings or if they had received some kind of prosthetic treatment. The questionnaire also included OHIP-14

Figure 1. Flow-chart describing selection of final study sample



(Oral Health Impact Profile) (23). All questions had multiple-choice answers. Several of the questions used in the questionnaire, e.g. questions concerning general satisfaction with teeth, satisfaction with teeth's appearance, perception of oral health, ability to chew hard food, perception of dental treatment need and perception of general health, had been validated and previously used in other questionnaires (3,8,27,28,30). Other questions were constructed for this particular questionnaire.

The questions about experience of tender and bleeding gums, longer teeth, increased space between the teeth, a loose tooth, bad taste in the mouth or bad breath were grouped in such a way that a positive answer to one of these questions gave a positive value on the variable "Changes in the mouth associated with periodontitis". The patients' answers to the questions concerning perception of oral health, perceptions of their teeth's status, use of dental care and dental treatment need were dichotomised or combined to binomial variables. Thus, the question "Are you in general satisfied with your teeth?" were dichotomised into "satisfied" (combining the answer alternatives "very satisfied" and "rather satisfied") and "not satisfied" (combining the answer alternatives "neither satisfied nor dissatisfied", "rather dissatisfied" and "very dissatisfied").

Statistical methods

The individuals were divided into seven groups based on age. These were in ten-year intervals, starting at 20 and ending at 89 years. For the non-response analysis, cross tabulations were made concerning response versus age and gender. A logistic regression analysis was performed with response/non-response as the dependent variable. Age and gender were used as independent variables. The chi-2 test was used to measure statistical significance. A p-value ≤ 0.05 was considered as significant. Statistical calculations were performed in the Statistical Package for the Social Sciences (SPSS 15 for Windows).

Results

Non-respondents

For the non-response analysis, the logistic regression analysis showed that both independent variables, age and gender, were significant (p=0.000). The likelihood for non-response was higher for men (OR=1.65) and the likelihood for response increased with age (OR=1.15). Thus non-response/response was not random. Younger men were overrepresented in the non-respondent group. There were no significant differences in the non-response rates between the four different districts of Skåne, ranging from 33% to 37%.

Respondents

The response rate in the age group 20-29-years was the lowest, 51%. Individuals aged 60-69 had the highest response rate, 74% (Table 2). In the age span 20-69, a majority of the respondents were women. The largest difference between the genders was in the age group of 20-29-year-olds, where 61% of the women in the final sample responded to the questionnaire compared to 41% of the men (Table 2). The educational level in Skåne is in line with the national average of Sweden. In Sweden as a whole, 37% had finished upper secondary school and 35% had a degree beyond upper secondary school. In Skåne, the corresponding figures were 35% and 36%, and among the respondents 41% and 29%, respectively. Among the respondents, 87% were born in Sweden and 13% were born abroad.

Perception of oral health, oral health care and use of oral health care

Significant differences between the genders were found concerning most of the questions on perception of oral health, perception of oral treatment need and use of oral health care (Table 3). Age differences were all significantly associated with questions on perception of oral health, perception of oral treatment need, use of oral health care (Table 4), and various prosthetic constructions according to self reports (Table 5).

OHIP-14

Concerning OHIP-14, the mean value for the total sample was 5.6 (Table 6).

Table 2. Number of individuals in each age group in the final sample (n) and percentages of individuals in the final sample (n) and percentages of those responding to the questionnaire (%) in the final sample for both genders.

	Final sample (n = 9 690)			Respondents (n= 6 123) % of final sample		
	(n)	%	%			
Age group	Total	Women	Men	Total	Women	Men
20-29	1 626	50	50	50	61	41
30-39	1 693	50	50	57	67	47
40-49	1 685	52	48	63	70	55
50-59	1 652	50	50	69	76	63
60-69	1 470	51	50	74	77	72
70-79	954	60	40	72	71	73
80-89	610	61	39	58	55	63
Total	9 690	52	48	63	69	57

Discussion

The response rate was similar to that of other studies performed in Skåne (22) and in Sweden as a whole (7,10,14) during the last five years. Although there was a shortage of men and younger individuals among the respondents, the response rate in each age group was deemed high enough to be representative thus allowing conclusions to be drawn about these groups. The results for the entire group of respondents may however be slightly affected by the shortage of younger individuals, in particular when it comes to the description of number of teeth and restorations.

The lower educational level among the respondents compared to the population in Skåne as a whole may have some effect on the results. However, the shortage of individuals with a higher education may be explained by the shortage of younger individuals among the respondents, since it is three times more common to have a higher educational level in the younger generations than in the older (25). Therefore the results for the entire group may be affected, but not for the separate age groups. In view of the randomised selection method, the large original sample and the response rate of 63%, this study can be considered representative of the adult population aged 20-89 years in Skåne, Sweden.

A majority of the respondents had a positive attitude towards their oral health. It is worth noticing that the individuals most satisfied with their teeth were the ones in the youngest age group. Least satisfied with their teeth and their appearance were individuals between 50 and 69 years old. In the oldest age group the high satisfaction might be explained by the fact that these individuals in general have better functioning teeth as well as more remaining teeth than their parents did at the same age. Furthermore, the individuals may have developed other health problems that make oral health problems seem of less importance. Many of the individuals aged 50 to 69 have received several dental fillings and prosthetic restorations.

A surprisingly high number of individuals in the youngest age group had experienced some kind of change in the mouth associated with periodontits. However, younger individuals might be more anxious about some of these changes, i.e. bad breath and bad taste in the mouth, as these are seen as related to social interaction. For measuring periodontal disease, the validity of this variable might not be strong. Some of the questions in this variable; tender and bleeding gums, bad taste in the mouth and bad breath are also signs of gingivitis. The question that contributed the most to this variable was the question about tender and bleeding gums at tooth brushing, a typical sign of gingivitis as well as periodontitis. Thus this variable describes both periodontitis and gingivitis. Another strong contributor

Table 3. Affirmative responses to questions concerning perception of oral health, perception of oral treatment need and use of oral health care. Total percentage and percentage distributions between genders including p-values.

	Total	Women	Men	P-values
Perception of oral health				
Satisfied with teeth	65	65	64	0.355
Satisfied with teeth's appearance	62	64	59	0.000
Oral health better than those of the same age group	35	33	38	0.000
Changes in the mouth associated with periodontitis	40	39	42	0.063
The mouth feels dry when eating	15	16	13	0.001
Need to drink to facilitate swallowing of food	19	17	20	0.003
Feel pain when opening the mouth or chewing	13	14	11	0.000
Having difficulty chewing hard food	22	23	21	0.058
Missing more than 10 teeth	7	7	8	0.423
No fillings	7	7	7	0.751
Having some kind of prosthetics	49	48	49	0.638
Perceptions of oral treatment need				
A high treatment need today	30	32	28	0.000
A high treatment need in the future	41	44	36	0.000
Use of oral health care				
Do not go for regular checkups to the dentist	13	12	15	0.002
Usually gets the dental treatment at the National Dental Health Service	40	40	40	0.757
Usually gets the dental treatment at a private practice	60	59	58	0.685

to this variable was the experience that the teeth had gotten longer. Longer teeth may be a result of using the wrong tooth brushing technique as well as a symptom of periodontitis.

There were differences between the age groups concerning the experience of having a dry mouth. It was, however, more common among the oldest individuals to have a mouth that feels dry when eating or needing to drink to facilitate swallowing of food. This might, in part, be explained by the fact that it is more common with medication and diseases that causes hyposalivation in this age group. Changes in diet may also contribute to hyposalivation.

It was most common in the youngest age group to experience pain when opening the mouth or when chewing. This is a somewhat surprising finding as the younger individuals are expected to have the least problems with tender teeth as periodontitis and TMD, which can cause tender teeth, are unusual in this age group (16). However, difficulty in chewing

Table 4. Affirmative responses to questions concerning perception of oral health, perception of oral treatment need and use of oral health care. Total percentage and percentage distributions between the age groups including p-values.

	Total	20-29	30-39	40-49	50-59	60-69	70-79	80-89	p-values
Perception of oral health									
Satisfied with teeth	65	74	67	65	60	60	65	67	0.000
Satisfied with teeth's appearance	62	69	63	62	57	57	64	66	0.000
Oral health better than those of the same age group	35	41	34	33	33	36	37	38	0.004
Changes in the mouth associated with periodontitis	40	40	41	42	44	41	38	28	0.000
The mouth feels dry when eating	15	14	10	13	15	15	19	20	0.000
Need to drink to facilitate swallowing of food	19	21	14	17	18	17	23	32	0.000
Feel pain when opening the mouth or chewing	13	19	14	17	13	10	6	6	0.000
Having difficulty chewing hard food	22	8	12	18	21	28	40	51	0.000
Missing more than 10 teeth	7	0	1	3	6	12	21	25	0.000
No fillings	7	25	8	1	2	3	6	8	0.000
Having some kind of prosthetics	49	8	13	30	62	81	88	83	0.000
Perceptions of oral treatment need									
A high treatment need today	30	26	25	28	31	35	38	34	0.000
A high treatment need in the future	41	35	34	39	43	45	50	40	0.000
Use of oral health care									
Do not go for regular checkups to the dentist	13	23	18	14	11	6	9	14	0.000
Usually gets the dental treatment at the National Dental Health Service	40	67	51	46	28	27	25	31	0.000
Usually gets the dental treatment at a private practice	58	30	46	52	71	72	73	67	0.000

Table 5. Various prosthetic constructions according to self reports. Total percentage and percentage distributions between the age groups including p-values.

	Total	20-29	30-39	40-49	50-59	60-69	70-79	80-89	P-values
Crown	35	5	10	24	50	61	52	43	0.000
Fixed partial denture	15	1	2	7	16	27	35	32	0.000
Dental implants	4	2	2	2	3	5	9	9	0.000
Partial removable denture	4	0	0	1	3	6	13	14	0.000
Full removable denture	3	0	0	1	2	4	11	17	0.000

Table 6. Table showing the mean, standard deviation, median, and range of OHIP-14 in different age groups.

OHIP-14	Total	20-29	30-39	40-49	50-59	60-69	70-79	80-89
Mean	5.6	4.9	5.0	5.8	6.1	5.7	5.4	5.9
Standard deviation	7.7	6.3	7.3	8.4	8.6	7.7	7.2	7.3
Median	2.0	3.0	2.0	2.0	2.0	2.0	2.0	3.0
Range	0-56	0-38	0-56	0-56	0-56	0-49	0-50	0-39

hard food increased with age, as could be expected.

Concerning the self reported number of missing teeth, received fillings and prosthetic replacements, a longitudinal study performed 1973 to 2003 (11) showed that these numbers have decreased markedly during the last 30 years. Since self reporting of existing teeth trough questionnaires has been found to be reliable (1,20,29), the result from this study is probably representative of the population, especially when each age group is studied. The self report of the presence of removable dentures has also been found to be reliable (29) and therefore the present findings should represent the situation in the population as a whole.

Almost a third of the respondents perceived their dental treatment need to be high or very high. This finding is not in agreement with the number of patients that are considered to be risk patients and who use a lot of dental care. In Sweden, 10% of patients are considered to be risk patients for periodontal disease and caries. However, the individuals in the age group 20-29 years did not perceive as high treatment need as 20-25-year-olds did in a previous study in Sweden, where 33% perceived a high treatment need (27). The dental treatment need, as perceived by the patients, is probably influenced by other factors than the dentist's clinical findings. The patient's self-assessment and concern with dental health, in combination with the educational level of the patient, were in a previous study found to be of greater importance in predicting the self-assessed treatment need of the patient than the dentist's opinion (18).

Almost one fourth of the respondents in the age group 20-29 years did not go for regular checkups at the dentist. This can probably be explained by the fact that the youngest in this group had recently left the free dental care system (in Sweden free dental care is available until the age of 20), and to pay for dental care might not be a high priority at an age when your life and financial situation is changing, e.g. due to studies, leaving the parental home or starting work. The number of dentists in Sweden was, in 2006, about 81 dentists /100 000 inhabitants and the corresponding figure for Skåne was about 84/100 000 (24). This must be considered a high number of dentists and should therefore not be considered as an important factor in explaining why some individuals do not go for regular checkups. In other European countries, the numbers varied from 10 to 133/100 000 with an average of about 55/100 000. In large parts of the world, such as Africa, South East Asia and the Western Pacific, the numbers were below 10/100 000 (31).

It was more common among the younger individuals to get their dental care at the National Dental Health Service (NDHS) than at a private practice. This might be explained by the fact that the NDHS is the largest dental care provider in Sweden to children and therefore the younger individuals continue to get their care there. The NDHS was until 1999 the only dental organisation where all children, until the age of 20, could get their dental care for free.

There were some differences between the genders. Men were more positive towards their oral health in comparison to others in the same age group then the women where. They did not perceive their dental treatment need, today or in the future, to be as high as the women did and they did not go for regular checkups at the dentist to the same extent as the women did. However, men probably do not have a better oral health or less of a treatment need than women. For example, the questions about previous dental care, such as number of fillings and missing teeth, do not show any differences between the genders. It is likely that men are more prone to be positive about their dental health than women are. Women are more prone to seek health care than men are, which was also shown by The Statistics Sweden's ULF-studies (Surveys of Living Conditions) (26). Possible differences between the genders will be further examined in the clinical part of the SkanOHS where the dentist's opinion on the patients' health and treatment need will be studied. The ULF-studies, in agreement with this study, have reported that younger individuals and men are less likely to go for regular check-ups (26).

Lawrence et al. found that OHIP-14 scores were significantly associated with oral health status as found at a clinical examination (15), i.e. the worse oral health the higher the score on OHIP-14. The mean values for OHIP-14 in an adult population in the city of Jönköping, Sweden, were somewhat higher than for the population of Skåne, 6.4 compared to 5.6 (6). In another Swedish study on adults a mean of 4.9 and 6.9 was found, depending on patient finance systems i.e. contract care versus fee-for-service (14). When comparing the oldest age group in this study with an older population in Canada (mean age of 83 years) the results are almost identical (17).

This study describes oral health, oral treatment need and use of oral health care in Skåne. It would be of great interest to study the possible changes and developments for these individuals over time and to

see if the self ratings of oral health and oral treatment need changes as the individuals get older. Is the tendency to rate your oral health affected by age or is it based on each generation's experiences of and attitudes to oral health care? A new questionnaire is planned to follow up these questions on this population.

The self perception of the dental status was overall good but many individuals, even in the youngest age group, experienced symptoms associated with periodontal disease. A majority of the adult population in Skåne has a positive attitude towards their oral health, in particular the individuals in the youngest age group. Most individuals had lost few teeth and removable dentures were uncommon. These findings also show that the population has a good oral health. A third rated their dental treatment need as high and most expected their treatment need to increase in the future.

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Corresponding author:
Dr Nina Lundegren
Department of Oral Diagnostics
Faculty of Odontology
Malmö University
SE-205 06 Malmö, Sweden
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