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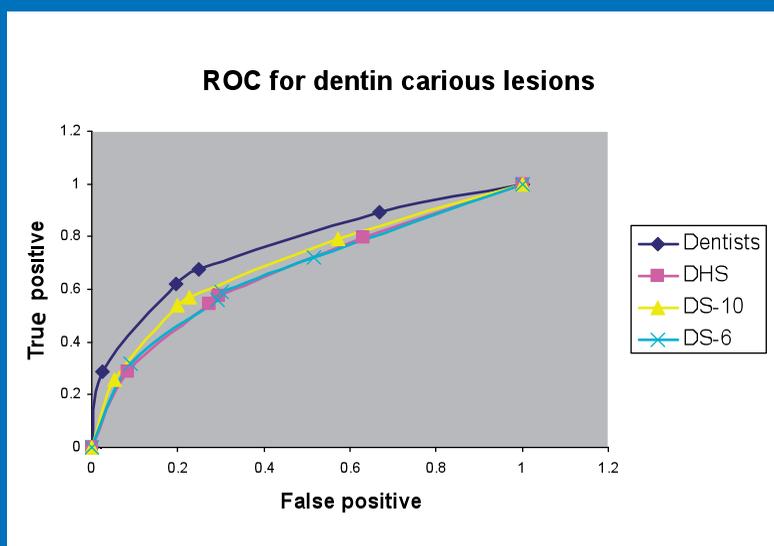
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Influence of education level and experience on detection of approximal caries in digital dental radiographs. An *in vitro* study.

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Introduction

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Peri-implantitis in a specialist clinic of periodontology

Clinical features and risk indicators

OLIVIER CARCUAC, LEIF JANSSON

Abstract

© Implant therapy has become a widely recognized treatment alternative for replacing missing teeth. Several long term follow-up studies have shown that the survival rate is high. However, complications may appear and risk indicators associated with early and late failures have been identified. The purpose of the present retrospective clinical study was to describe some clinical features of patients with clinical signs of peri-implantitis and to identify risk indicators of peri-implantitis in a population at a specialist clinic of Periodontology.

In total, the material consisted of 377 implants in 111 patients with the diagnosis peri-implantitis. The mean age at the examination was found to be 56.3 years (range 22-83) for females and 64.1 years (range 27-85) for males. The mean number of remaining teeth was found to be 10.5 (S.D. 8.89) and the mean number of implants was 5.85 (S.D. 3.42). For a majority of the subjects, more than 50% of the remaining teeth had a marginal bone loss of more than 1/3 of the root length. Forty-six percent of the patients visited regularly dental hygienists for supportive treatment. The percentage of implants with peri-implantitis was significantly increased for smokers compared to non-smokers ($p=0.04$). In the group of non-smokers, 64% of the implants had the diagnosis peri-implantitis, while the corresponding relative frequency for smokers was 78%. A majority of the individuals had a Plaque index and Bleeding on probing index $>50\%$. The median of the follow-up time after implant placement was 7.4 years and the observation period was not significantly correlated to the degree of bone loss around the implants. Among the subjects with a mean bone loss >6 mm at implants with peri-implantitis, more than 70% had a mean marginal bone loss $>1/3$ of the root length of the remaining teeth. A positive and significant correlation was found between the degree of marginal bone loss in remaining teeth and the degree of bone loss around implants with peri-implantitis.

In conclusion, the results of the present study indicate that smoking as well as previous history of periodontitis are associated with peri-implantitis and may represent risk factors for this disease.

Key words

Marginal bone loss, peri-implantitis, periodontitis, retrospective study, risk indicator

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Periimplantit vid en specialistklinik i parodontologi Förekomst och riskindikatorer

OLIVIER CARCUAC, LEIF JANSSON

Sammanfattning

⊙ Implantatbehandling har på senare tid blivit ett väl utprövat behandlingsalternativ för att ersätta förlorade tänder. Flera långtidsstudier har visat att lyckandefrekvensen är hög. Komplikationer efter implantatbehandling har dock rapporterats och riskindikatorer har identifierats som är associerade med ökad risk för tidiga och sena förluster av fixturer. Syftet med följande retrospektiva, kliniska studie var att beskriva kliniska kännetecken och att identifiera riskindikatorer hos individer med periimplantit remitterade till en specialistklinik i parodontologi.

Materialet bestod av totalt 377 implantat hos 111 patienter med diagnosen periimplantit. Kvinnornas medelålder vid det första undersökningstillfället var 56.3 år och männens medelålder 64.1 år. De hade i genomsnitt 10.5 (S.D. 8.89) kvarvarande tänder och 5.85 (S.D. 3.42) fixturer installerade. Den marginal benförlusten var större än 1/3 av rotytan på mer än 50% av de kvarvarande tänderna hos de flesta individerna. Fyrtiosex procent av patienterna besökte regelbundet tandhygienist för stödbehandling. Hos icke-rökare fastställdes diagnosen periimplantit för 64% av fixturerna medan motsvarande procentandel hos rökare var 78%. Denna skillnad var statistiskt signifikant ($p=0.04$). De flesta patienterna hade ett plackindex och blödningsindex >50%. Uppföljningstiden var i genomsnitt 7.4 år vid undersökningstillfället och den var inte signifikant korrelerat till graden av benförlust vid fixturerna. Hos mer än 70% av individerna som hade en genomsnittlig benförlust >6 mm vid fixturer med periimplantit, hade majoriteten av de kvarvarande tänderna en benförlust > 1/3 av rotlängden. Det fanns en positiv och signifikant korrelation mellan graden av marginal benförlust vid de kvarvarande tänderna och graden av benförlust vid fixturerna vid de fixturer som hade diagnosen periimplantit.

Sammanfattningsvis så indikerar resultaten i denna studie att rökning och parodontitbenägenhet ökar risken för periimplantit och kan därmed utgöra riskfaktorer för sjukdomen.

Introduction

Implant therapy has become a widely recognized treatment alternative for replacing missing teeth. Although a number of long term follow up studies have shown that the survival rate is high (7, 11, 30, 55), complications appear either early following implant installation or later following periods of implant stability. Factors such as bone quality, surgical trauma or bacterial contamination during implant surgery have been associated with early failure (13, 14). Factors associated with late failures of implants seem to be related to overload (21, 22) or peri-implantitis (56).

The term peri-implantitis was introduced in the late 1980s (39) and is defined at the 6th European Workshop on Periodontology (EWOP) as an inflammatory lesion that in addition to inflammation in the mucosa in the tissues surrounding implants is characterized by loss of supporting bone (36, 58). The bacterial colonization of dental implant is a prerequisite for the development of peri-implantitis and considered as the major aetiological factor of the disease (6, 31, 40, 42, 45).

It has been demonstrated that the peri-implant sulcus becomes rapidly colonized by indigenous bacterial flora from the oral cavity (41). The periodontal status of the remaining teeth has been found to be associated to the microbial composition of the peri-implant site (2, 46). This emphasizes the importance of an adequate infection control before placement of osseointegrated oral implants and an individual treatment plan including regular supportive periodontal maintenance care (10, 44). Consequently, the hypothesis that the presence of periodontal disease increases the risk for peri-implantitis complications in individuals receiving dental implant treatment has been supported in studies demonstrating an increased incidence of peri-implantitis and implant loss in patients with a history of periodontitis compared to patients without periodontitis. (5, 24, 50, 52).

The purpose of the present investigation was to describe some clinical features of patients with clinical signs of peri-implantitis and to identify risk indicators of peri-implantitis in patients at a specialist clinic of Periodontology.

Material and Methods

The investigation was conducted as a retrospective cross-sectional study on a consecutive referral population at the Department of Periodontology at Skanstull, Public Dental Service, Stockholm County

Council, Sweden. Subjects referred by general dentists or dental hygienists between January 2002 and December 2007 for peri-implantitis treatment were collected from a computer database. This study included 111 patients examined by eight periodontists. The following recordings were collected from the clinical and long-cone radiographic examination in the database:

- Age
- Gender
- Medical history with focus on coronary disease and diabetes was registered from the health questionnaire.
- Smoking habits (current smoker, former smoker or never smoker).
- Number of remaining teeth.
- Plaque Index (PI): The percentage of sites with presence of plaque was registered at four surfaces (mesial, distal, buccal, lingual) per tooth/implant after application of a staining solution. PI was stratified into three categories: 0-9%, 10-49%, 50-100%.
- Bleeding on Probing (BoP): The percentage of sites with presence of bleeding following probe insertion to the base of the gingival pocket measured at four sites (mesial, buccal, distal and lingual surfaces) per tooth and implant. The variable BoP was stratified into three categories: 0-9%, 10-49%, 50-100%.
- The marginal bone loss was determined by assessments on the approximal surfaces of all measurable teeth with a mouse-driven cursor on the digital radiographs and defined as the ratio between the distance cementum enamel junction - alveolar crest and the distance apex - cemento-enamel junction. The mean of the marginal bone loss of all measured approximal surfaces from the same individual was calculated.
- Number of implants.
- Frequency of supportive therapy since placement of the suprastructure (yes/no)
- Implant position (maxillary, mandibular, anterior : incisor-cuspid region, posterior : premolar-molar region.)
- Marginal bone loss of implants : The radiographic surface in millimeters of implant threads not supported by bone was measured. The reference level was the implant-abutment interface. The bone loss on the radiographs was registered on the mesial and the distal surfaces of the implants and the mean value of the two measurements were calculated.

The radiographic measurements were performed by one examiner (author O.C.). In order to assess the intra-examiner variability, 37 implants in 10 subjects (10%) were randomly selected for repeated measurements on the radiographs.

Statistical methods

The descriptive statistics and statistical analyses were performed using the statistical package SPSS (PC+ 4.0, SPSS, INC., Chicago, IL). In all analyses, the statistical computational unit was at subject level. One-way variance analyses or Student's t-tests were performed in order to study differences between groups

according to investigated variables. The Pearson's correlation coefficient was used to calculate the correlation between the degree of marginal bone loss in remaining teeth and the bone loss around implants and to estimate the intra-examiner correlation according to bone loss measurements. Results were considered statistically significant at $p < 0.05$.

Results

The intra-examiner correlation of radiographic assessments was calculated for 37 implants and the Pearson's correlation coefficient of the distance measurements was 0.96.

In total, the material consisted of 377 implants in 111 patients with the diagnosis peri-implantitis. A minority of the implants (9%) were installed at the Department of Periodontology of Skanstull. A majority of the implants (57%) were manufactured by the Nobel Biocare system, while 36% of them were Astra Tech implants. The age distribution of the subjects is presented in Table 1 and a majority of the sample were females (57%). The mean age at the examination was found to be 56.3 years (range 22-83) for females and 64.1 years (range 27-85) for males. The mean number of remaining teeth was found to be 10.5 (S.D. 8.89) and the mean number of implants was 5.85 (S.D. 3.42, Table 1). For a majority of the subjects, more than 50% of the remaining

teeth had a marginal bone loss of more than 1/3 of the root length (Table 1). A significant and positive correlation ($r=0.36$, $p < 0.001$) was found between age and number of lost teeth (Table 1), while age was not significantly associated to the degree of marginal bone loss or the percentage of implants with peri-implantitis. The age group 20-39 years had significantly more teeth and fewer implants compared to age group >40 years (Table 1).

In the health questionnaire, 38% of the subjects declared that they had a good health. Eight% of the subjects reported presence of diabetes and 36% had a cardio-vascular disease. The percentage of non-smokers was found to be 47% and 13% declared that they were former smokers (Table 2). Forty-six percent of the patients visited regularly dental hygienists for supportive treatment. Presence of diabetes, cardio-vascular disease or the frequency of supportive treatment was not significantly correlated to the degree of marginal bone loss around the implants or the percentage of implants with peri-implantitis.

The number of teeth, the degree of marginal bone loss and the number of implants did not differ significantly between different smoking groups (Table 2). However, the percentage of implants with peri-implantitis was significantly increased for smokers compared to non-smokers ($p=0.04$). In the group of non-smokers, 64% of the implants had the diag-

© **Table 1.** Number of remaining teeth, the relative frequencies of subjects with a marginal bone loss >1/3 of the root length, number of implants and number of implants with peri-implantitis according to age group.

Age	N	Number of teeth (mean (S.D.))	Marginal bone loss >1/3 of the root length (percentage (S.D.))	Number of implants (mean (S.D.))	Percentage of implants with peri- implantitis (S.D.)
20-39	13	19.0 (11.1)	40.0 (51.6)	3.31 (2.56)	80 (33)
40-59	29	11.2 (9.56)	82.6 (38.8)	6.44 (3.79)	73 (34)
60-79	60	9.21 (7.40)	71.4 (44.8)	6.03 (3.31)	70 (32)
80-	9	7.67 (9.08)	66.7 (58.2)	6.33 (2.78)	64 (29)
Total	111	10.5 (8.89)	70.3 (46.0)	5.85 (3.42)	71 (33)

© **Table 2.** The mean number of teeth, the degree of marginal bone loss, the mean number of implants and the percentage of implants with peri-implantitis according to smoking habits.

Smoking habits	%	Number of teeth (mean (S.D.))	Marginal bone loss >1/3 of root length (percentage (S.D.))	Number of implants (mean (S.D.))	Percentage of implants with peri- implantitis (S.D.)
Non smokers	47	11.3 (7.75)	75.8 (43.5)	5.44 (3.06)	64 (33)
1-10 cigarettes per day	20	11.6 (10.9)	63.6 (50.4)	5.75 (3.57)	74 (35)
>11 cigarettes per day	20	8.80 (8.67)	57.1 (51.4)	6.81 (3.89)	82 (27)
Former smoker	13	10.2 (10.9)	75.0 (46.3)	6.08 (3.73)	79 (30)

nosis peri-implantitis, while the corresponding relative frequency for smokers was 78%. Among former smokers, peri-implantitis was diagnosed for 79% of the implants.

The distributions of the subjects according to Plaque Index and Bleeding on probing index are presented in Table 3. A majority of the individuals had a Plaque index and Bleeding on probing index >50%.

The distribution of bone loss around implants with peri-implantitis is illustrated in Figure 1. For 48% of the sample, the mean bone loss was found to be <4.0 mm. The mean marginal bone loss around implants with peri-implantitis and the frequency of disintegrated implants according to position of the

implants are presented in Table 4. Most implants with peri-implantitis were found in the maxillary front region (48%). The marginal bone loss around implants with peri-implantitis did not differ significantly according to implants position or implant system. All the five disintegrated implants were found in the maxilla.

The median of follow-up time after implant placement was 7.4 years and the observation period was not significantly correlated to the degree of bone loss around the implants (Table 5). The follow-up time data for 47 implants were missing.

Among the subjects with a mean bone loss >6 mm at implants with peri-implantitis, more than 70% had a mean marginal bone loss >1/3 of the root length of the remaining teeth (Figure 2). A positive and significant correlation was found between the degree of marginal bone loss in remaining teeth and the degree of bone loss around implants with peri-implantitis (Figure 2, $p=0.04$).

© **Table 3.** The distribution (%) according to Plaque Index and Bleeding on probing index.

%	Plaque Index	Bleeding on probing index
0-9	5.3	3.1
10-49	42.6	37.1
50-	52.1	59.8

© **Table 4.** Mean marginal bone loss ((mm (S.D.)) around implants with peri-implantitis and frequency of disintegrated implants according to position of the implants.

Position	N	Marginal bone loss	Number of disintegrated implants
11-13, 21-23	169	4.38 (2.14)	2
14-15, 24-25	80	4.24 (1.84)	2
16-17, 26-27	6	3.50 (1.92)	1
31-33, 41-43	52	5.41 (2.55)	0
34-35, 44-45	48	4.60 (2.53)	0
36-37, 46-47	22	4.71 (2.30)	0

© **Table 5.** Mean marginal bone loss ((mm (S.D.)) around implants with peri-implantitis after stratification according to time (months) since the implant installation.

Number of months since implant installation	N	Marginal bone loss
1-6	2	2.61 (3.69)
7-12	12	4.89 (1.82)
13-36	59	4.30 (1.95)
37-60	31	4.08 (2.28)
61-120	135	4.93 (2.46)
121-	91	4.28 (2.17)
Total	330	4.53 (2.23)

Discussion

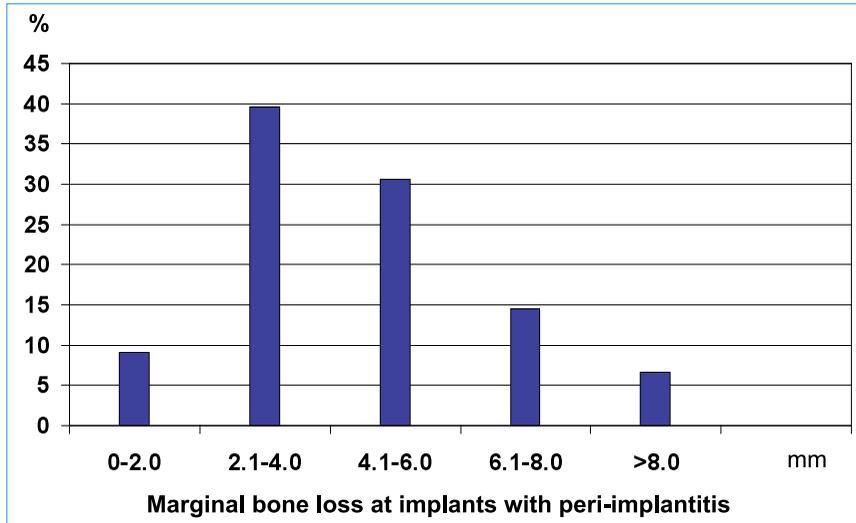
The present retrospective study has demonstrated that

- The degree of peri-implantitis was found to be more severe in individuals with advanced marginal bone loss around the remaining teeth,
- smoking was significantly associated with an increased frequency of affected implants in patients with peri-implantitis.

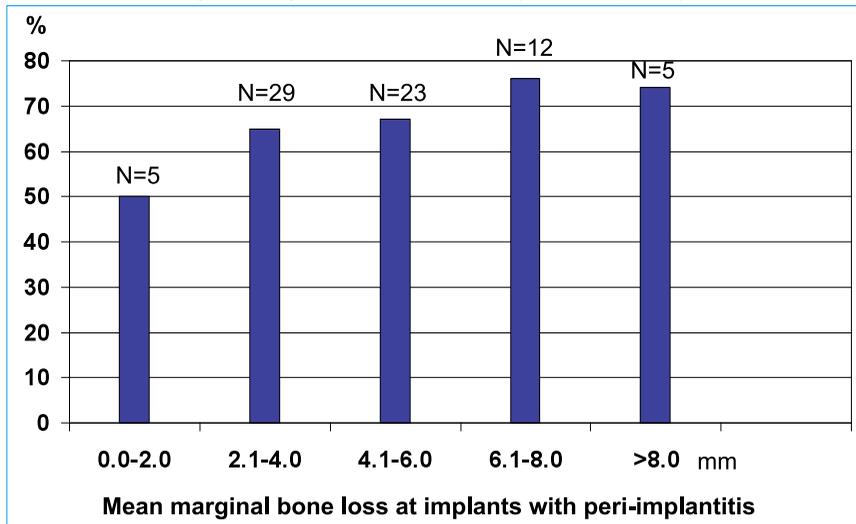
The retrospective design of the present study probably results in a lower reliability compared to prospective studies due to a higher inter-examiner variability. However, as long as there are no systematic errors, a larger size of the sample studied may compensate for a high variance between the observations.

This retrospective study is based on a referral patient population at a specialist clinic of periodontology. The mean marginal bone loss was found to be >1/3 of the root length for about 70% of the teeth. In epidemiological studies (20, 34), the mean marginal bone loss was found to be about 3.5 mm for individuals with a mean age of 50 years, which differs significantly from the mean marginal bone loss >5 mm in the present material. However, the magnitude of mean marginal bone loss in the present study is in accordance with a former study at patients referred for periodontal treatment at the same clinic (23). Thus, the individuals of the present study may be regarded as representative of a periodontitis-prone population.

© Fig 1. The distribution of bone loss ((mm (S.D.)) around implants with periimplantitis



© Fig 2. The percentages of subjects with marginal bone loss >1/3 of the root length after stratification according to the degree of bone loss around implants with peri-implantitis.



A positive and significant correlation was found in this study between the degree of marginal bone loss in the remaining teeth and the degree of bone loss around implants with peri-implantitis. These findings support early reports in the literature having demonstrated an association between peri-implantitis and periodontal variables (49, 50). A number of recent systematic reviews have addressed the question of whether patients with a history of periodontitis have an increased risk of peri-implantitis (26, 52, 54). Based on several earlier studies (19, 24,

35, 38), the authors concluded that there was a significantly increased incidence of peri-implantitis and increased peri-implant marginal bone loss in individuals with periodontitis-associated tooth loss and a previous history of periodontitis. Thus, subjects with a history of periodontitis may have a greater risk to develop peri-implant disease.

The regular implant surgery activities started at the Department of Periodontology at Skanstull about ten years ago and approximately 400-500 implants have been installed every year during the

last five years. However, the frequency of implants with peri-implantitis in the present study that have been installed at this clinic is low, probably since the time elapsed since implant installation was short at follow-up. Thus, a majority (about 90%) of the implants with peri-implantitis in the present study, have been installed at other clinics. In addition, many cases may be untreated or have been treated for peri-implantitis at other clinics.

In the present study, 8% of the subjects reported presence of diabetes and 36% declared that they had a cardio-vascular disease compared to 5% and 10%, respectively, in a sample from an earlier study at the same clinic (29). The mean age, especially for males, was higher in the present study and diabetes, as well as cardio-vascular disease, was more frequent with an increasing age (29). In an earlier follow-up study of patients with a mean age of 66 years at follow-up after implant treatment (49, 50, 51), 5% of the subjects reported presence of diabetes and 17% had coronary heart disease. *Kotsovilis et al* (28) and *Mombelli & Cionca* (43) performed systematic reviews and the results from these reviews investigating the relationship between implant loss and diabetes showed that poor metabolic control in subjects with diabetes was associated with peri-implantitis in accordance with a study on Brazilian subjects (15).

A majority of the patients did not visit dental hygienists regularly for supportive treatment and had plaque and bleeding indices >50%. For individuals with a history of periodontitis, regular supportive periodontal therapy (SPT), as defined by *Lang & Tonetti* (32), has been shown to represent the basis of long term success after periodontal treatment (33, 48). In addition, a high plaque index increases the risk of recurrence of periodontal disease (27) and may be regarded as a local risk factor of peri-implantitis (3). Consequently, the lack of maintenance therapy for many subjects in the present study has probably increased the risk of peri-implantitis and recurrence of periodontitis. These results are in accordance with *Quirynen et al* (47) who performed a systematic review investigating the relationship between susceptibility to periodontitis and implant success and the influence of an organized supportive periodontal therapy on this relationship. In a retrospective study (19), on a group of periodontitis-susceptible patients with implant-supported fixed partial dentures in the posterior maxilla and not being included in a plaque control program during maintenance, 62% of the implants exhibited a mean bone loss > 2mm after 5 years. In a sample inclu-

ding patients who had been treated for moderate-to-advanced chronic periodontitis and enrolled in an accurate maintenance program after the implant placement and prosthetic rehabilitation, the annual amount of bone level loss was 0.02 mm during the final 4 years. Consequently, these observations and two other studies (19, 57) have demonstrated that the supportive periodontal therapy is a prerequisite for the long-term success of implant therapy in periodontitis-compromised patients.

The frequency of former smokers was about 10% in conformity with *Lagervall & Jansson* (29), while about 40% declared that they were smokers in the present study compared to about 50% in the earlier study at the same clinic (29). This difference may be explained by the selection of patients having been offered implant treatment. In the follow-up study from Kristianstad county (49), 26% of the individuals reported that they were current smokers while 37% were former smokers. Smoking is regarded as an established risk factor of periodontitis (8, 9). The relative frequency of implants with peri-implantitis was significantly increased for smokers compared to non-smokers. Thus, among the patients referred to the clinic for treatment of peri-implantitis, the disease was more extensive in smokers. Consequently, the treatment need was increased in current smokers compared to non-smokers. Several studies have documented the deleterious effect of smoking on the peri-implant tissues. A recent systematic review by *Strietzel et al* (53) indicated significantly enhanced risks of biological complications among smokers compared with non-smokers and considered smoking as a significant risk factor for dental therapy. Studies included in this review reported a significant association of smoking with peri-implant mucositis, marginal bone loss and peri-implantitis (4, 17, 18, 25, 37, 49, 50, 51, 57).

In the present study, the extent of peri-implantitis-associated bone loss regarding implant positions was also examined. The finding that the destructive disease may occur in all jaw positions is in agreement with previous observations (12, 16). Five implants were disintegrated and these implants had previously been installed in the maxilla. An earlier study (1) has reported that the survival rate of implants in the maxilla was lower compared to the survival rate of mandibular implants.

In conclusion, the results of the present study indicate that smoking as well as previous history of periodontitis are associated with peri-implantitis and may represent risk factors for this disease.

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Influence of education level and experience on detection of approximal caries in digital dental radiographs. An *in vitro* study

KRISTINA HELLÉN-HALME¹, GUNNEL HÄNSEL PETERSSON²

Abstract

© This study evaluated whether variations in education level and experience among dental staff influence the diagnostic accuracy of carious lesions on digital radiographs.

Three student groups and a fourth group of general practitioners (Dentists) with more than five years of clinical experience participated in this study. The student groups were (i) dental students in their final (tenth) semester (DS-10), (ii) dental students in the sixth semester (DS-6) who just finished dental radiology training, and (iii) dental hygiene students (DHS) in their final (fourth) semester. Seven observers from each group participated.

Standard radiographs of 100 extracted teeth (premolars and molars) were taken. The 28 observers evaluated the images for approximal carious lesions on a standard monitor. All evaluations were made in ambient light below 50 lux. Receiver operating characteristic curves were plotted to assess results. The standard criterion for healthy or carious lesions was a histological examination of sliced teeth. Kappa statistics evaluated intra-observer agreement.

For carious lesions that had extended into the dentine, significant differences were found between (i) Dentists and all other groups, (ii) Dentists and DS-10 ($p < 0.01$), and (iii) Dentists and DS-6 and DHS ($p < 0.001$). Differences between DS-10 and DHS ($p \leq 0.05$) were also significant.

In this study, education level and experience clearly influenced the diagnostic accuracy of approximal carious lesions that had extended into the dentine on digital radiographs.

Key words

Caries detection, digital radiography, observer agreement

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Påverkar utbildningsnivå och erfarenhet den diagnostiska säkerheten vid bedömning av approximala karieslesioner i digitala röntgenbilder? En *in vitro*-studie

KRISTINA HELLÉN-HALME, GUNNEL HÄNSEL PETERSSON

Sammanfattning

🕒 Målsättningen med studien var att utvärdera om utbildningsnivå och erfarenhet påverkar den diagnostiska säkerheten av approximala karieslesioner i digitala röntgenbilder.

Legitimerade tandläkare med mer än 5 års erfarenhet samt tre olika studentgrupper ingick i studien. Studenterna var tandläkarstuderande på den sista, tionde terminen, samt på den sjätte terminen där de har avslutat sin huvudkurs i röntgen. Dessutom ingick tandhygieniststuderande på sin sista (fjärde) termin. Sammanlagt ingick 7 observatörer i varje grupp.

100 extraherade tänder, premolarer och molarer röntgenundersöktes standardiserat med samma exponeringstid. De digitala röntgenbilderna granskades med hjälp av en standardmonitor och med dämpad bakgrundsbelysning. ROC (Receiver operating characteristic curves) användes för att beräkna resultatet. En histologisk utvärdering gjordes av tänderna och detta användes som en standard för om kariesskador existerade på de approximala ytorna eller om ytorna var friska. Kappa värden beräknades för att utvärdera intra-observatörsvariationer.

Signifikanta skillnader fanns mellan erfarna tandläkare och de tre studentgrupperna när det gällde den diagnostiska säkerheten för approximala kariesskador där lesionerna hade nått in i dentinet. Dessutom fanns en signifikant skillnad i den diagnostiska tillförlitligheten mellan gruppen tandläkarstudenter på tionde termin och gruppen tandhygieniststudenter för approximala karieslesioner som nått dentinet.

Konklusionen från denna studie var att ökad utbildningslängd och större erfarenhet klart medverkade till att öka den diagnostiska säkerheten i digitala röntgenbilder för approximala kariesskador som nått in i dentinet.

Introduction

On its introduction, digital radiography was found to provide more freedom for influencing final radiographic image quality than analogue film. Quality assurance procedures are generally more difficult to perform for digital systems (10, 19). The *Wenzel* (20) and *Kullendorff et al.* (12) studies demonstrated that the diagnostic accuracy of carious lesions obtained with all types of digital detectors was as good as analogue film. The *Hellén-Halme et al.* (11) and *Li et al.* (14) studies showed that it is also essential for the monitor to be adjusted or calibrated specifically for monitoring digital radiographic images. Ambient light must be dimmed so that faint contrast objects, such as small carious lesions, are detectable.

One of the most common tasks in a general dental practice is to establish presence of carious lesions. In some regions in Sweden, dental hygienists are tasked with taking radiographs and evaluating them for carious lesions so that dentists have more time for other patients. Dental hygienists in Sweden undergo a two-year education. They are then licensed to work independently with patients. According to the Swedish National Board of Health and Welfare (18), dental hygienists are qualified to identify carious lesions in dental radiographs and should, when caries is diagnosed, refer the patient to a dentist for further treatment.

Several studies (6, 7, 8, 20) have assessed intra- and inter-observer agreement according to diagnostic accuracy of carious lesions. *Gröndahl* (6) and *Haugejorden* (8) found variations in inter-observer agreement for carious lesions. Most of these studies found that number and size of carious lesions are the main influences on agreement. Carious lesion detection in digital radiographs is a matter of finding an abnormality, recognising it, and establishing it as a carious lesion. Both education level and experience of the examiner may influence detection.

A literature search found no studies that evaluated whether education level and experience significantly affect diagnostic accuracy of carious lesions. Thus the aim of this study was to evaluate the influence of these factors on the diagnostic accuracy of carious lesions on digital radiographs.

The hypothesis was that variations in education level and experience of the dental staff would not significantly affect detection of approximal carious lesions on digital dental radiographs.

Materials and methods

One hundred human teeth (40 premolars and 60

molars) were selected from a large group of extracted teeth. On visual inspection, the approximal surfaces had small carious lesions or were intact. Half (50%) of the selected teeth were visually healthy, and half had carious lesions of varying extensions on the approximal surfaces. One per cent had a visible cavity. The teeth were mounted side by side, in contact, in 30 blocks made of PRESIDENT putty (Coltène Whaledent AG, Cuyahoga Falls, Ohio), three or four teeth per block. Standard radiographs were taken. A 1-cm thick Plexiglas plate was placed in front of the sensor and teeth to simulate soft tissue.

The 30 blocks were exposed using a dental digital system (Schick CDR Wireless 2, Schick Technologies Inc., Long Island City, NY) and a Prostyle Intra X-ray machine (Planmeca Oy, Helsinki, Finland). Exposure settings were 60 kVp, 8 mA, and 0.12 s. The distance from the X-ray focus to the object was 22 cm.

A standard monitor with built-in Barten curve correction (Olorin Vista Line VL191D BARTEN, Billdal, Sweden) was used to evaluate the digital radiographs (2). The monitors were cleaned with a glass cleaner (Spectra, Nordex, Nilfisk-Advance, Stockholm) before each observation session. The monitors were turned on at least 20 minutes before each session to ensure that monitor luminance had reached its maximum. All evaluations were made in ambient light below 50 lux (range 45–49 lux) (11) measured with a light meter (Light-O-Meter, P-11, Unfors, Billdal, Sweden). The only setting that observers were allowed to change was magnification. The radiographs were displayed in the same way for each observer.

Participants

Three student groups participated in this study: (i) tenth-semester dental students (DS-10) who were nearing graduation as general dental practitioners in one of Sweden's 10-semester dental training programmes, (ii) sixth-semester dental students (DS-6) who had just completed dental radiology training, and (iii) fourth-semester dental hygiene students (DHS) who were nearing graduation from a four-semester programme. Seven individuals were randomly selected in each group and asked to participate as observers in this study. Seven experienced general practitioners (Dentists) with more than five years of clinical experience were also invited as observers. All observers graded approximal carious lesions on the 30 digital radiographs. The observers also rated their level of confidence about the presence of approximal

caries lesions on a 5-point scale:

- 1 = definitely not caries
- 2 = probably not caries
- 3 = questionable caries
- 4 = probably caries
- 5 = definitely caries

Intra-observer agreement was determined by asking each observer to re-evaluate 60 randomly chosen approximal surfaces after an interval of at least 14 days. Both evaluations were made under the same conditions.

Histological evaluation

Each tooth was cut in 1-mm slices with a low-speed saw and diamond blade (9, 21) (IsoMet® II-1180 Low Speed Saw and IsoMet® Diamond Wafering Blade, 4 x 0.012 [10.2 cm x 0.3 mm]; Buehler Ltd; Greenwood, IL, USA). The sliced teeth were attached to a microscope slide with transparent glue. Two observers – one of the authors (K H-H) and an oral pathology specialist – evaluated the teeth for caries under a light microscope (magnification x40). Disagreement was resolved by discussion until consensus was extended.

These histological results became the study's criterion standard (21). Caries was defined as present when demineralisation was observed as opaque-white to dark brown colour changes. The 200 approximal tooth surfaces were graded on a scale from 0 to 3 where 0 = sound, no visible lesion; 1 = lesion confined to the enamel; 2 = lesion involving the enamel and enamel-dentine border but not the body of the dentine; and 3 = lesion involving the enamel and undisputedly the body of the dentine.

Statistical analysis

Receiver operating characteristic (ROC) curves (15) were used to analyze all radiographic evaluations. ROCFIT software (Charles Metz, Department of Radiology, University of Chicago, Chicago, IL, USA) calculated the areas under the curves (A_z). Data from the seven observers in each group were pooled before analysis. A paired t-test (1) analysed differences between observer groups. The significance level was set to $p \leq 0.05$.

Weighted kappa (κ) statistics estimated intra-observer agreement (3). Values were interpreted using Altman's adaptation (1) of the Landis & Koch (13) guidelines.

Results

The histological evaluation found 100 surfaces to

be sound and 100 surfaces to have a carious lesion. Table 1 presents differences in carious lesion depth. The two observers disagreed in 31% of the cases. Disagreement was confined only to whether the surface was healthy (grade 0) or had a carious lesion in the enamel (grade 1).

Data from the seven observers in each group were pooled for each radiograph in the ROC curve. Table 2 presents mean areas (A_z) under the ROC curves for each group of observers according to lesion grade. For grade-3 carious lesions (Figure 1), significant differences were found between Dentists and all three student groups: when Dentists were compared with DS-10 ($p < 0.01$), with DS-6 ($p < 0.001$), and with DHS ($p < 0.001$). Also, DS-10 differed significantly from DHS ($p \leq 0.05$) in detection of grade-3 carious lesions. No significant differences between observer groups were found concerning total number of observed carious lesions and carious lesions in the ena-

© **Table 1.** Histological results for 200 approximal tooth surfaces.

Lesion (grade)	No. of surfaces	Per cent
Sound (0)	100	50.0
Enamel caries (1)	75	37.5
Enamel-dentine border (2)	14	7.0
Dentine caries (3)	11	5.5

0 = sound, no visible lesion;

1 = lesion confined to the enamel;

2 = lesion involving the enamel and enamel-dentine border but not the body of the dentine;

3 = lesion involving the enamel and undisputedly the body of the dentine.

© **Table 2.** Mean areas under the receiving operator characteristic curves for each group of observers.

Observers	Cariou lesions		
	All	Enamel (grades 1, 2)	Dentine (grade 3)
Dentists	0.598	0.576	0.758
DS-10	0.539	0.548	0.699
DS-6	0.577	0.523	0.664
DHS	0.576	0.525	0.664

DHS – dental hygiene students (in their final semester of training)

DS-6 – sixth-semester dental students

DS-10 – tenth-semester dental students (in their final semester of training)

Dentists – dentists who have worked as general practitioners for over 5 years

mel (grade 1, 2). Table 3 shows the A_z for all observers for dentine lesions.

Mean weighted values for intra-observer agreement were 0.63 for Dentists, 0.58 for DS-10, 0.24 for DS-6, and 0.21 for DHS.

© **Table 3.** Areas under the receiver operating characteristic curves for dentinal lesions (grade 3) for each observer in the four.

Observer (n)	DHS	DS-6	DS-10	Dentists
1	0.613	0.650	0.641	0.769
2	0.673	0.597	0.698	0.791
3	0.665	0.693	0.686	0.737
4	0.701	0.645	0.700	0.732
5	0.632	0.726	0.717	0.763
6	0.692	0.655	0.732	0.767
7	0.674	0.683	0.722	0.747
Mean	0.664	0.664	0.699	0.758
Standard deviation	0.032	0.041	0.030	0.021

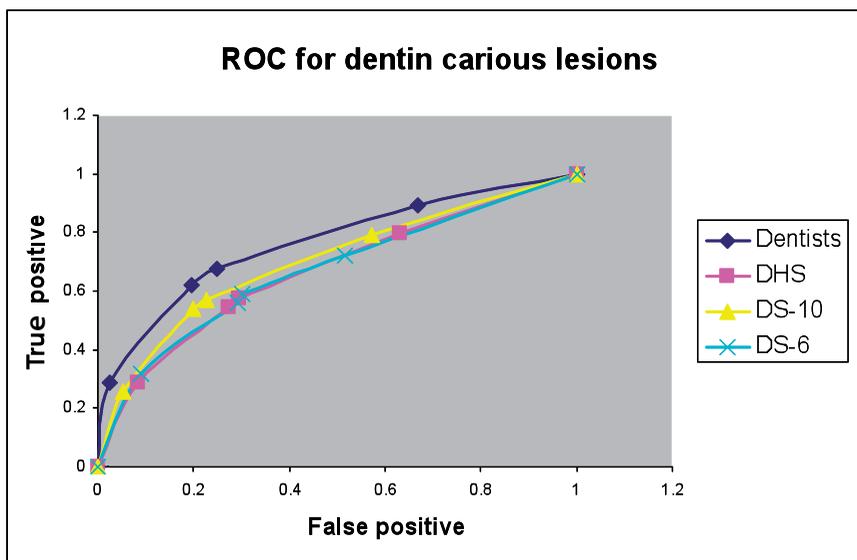
DHS – dental hygiene students (in their final semester of training)

DS-6 – sixth-semester dental students

DS-10 – tenth-semester dental students (in their final semester of training)

Dentists – dentists who have worked as general practitioners for over 5 years

© **Fig 1.** Receiver operation curve (ROC) for each observer group for carious dentine lesions. Dentists, DHS = fourth-semester dental hygiene students, DS-10 = tenth-semester dental students, DS-6 = sixth-semester dental students.



Discussion

This study found a significant difference in diagnostic accuracy between experienced dentists and dental and dental hygiene students for approximal carious lesions that extended into the dentine. The study also found that final-semester dental students diagnosed these grade-3 lesions more accurately than final-semester dental hygiene students.

The results indicate that knowledge of a phenomenon such as carious lesions is not in itself enough. Practice and experience are essential for detecting the presence of a carious lesion.

In their daily work, dentists have the advantage of feedback on their decisions. Each time they excavate a carious tooth, they can visually estimate the amount of caries in the cavity and relate it to the radiographic image, thus improving the accuracy of their diagnosis over time. However, a treatment decision has many aspects and is unique to the patient. In diagnoses of carious lesions on radiographs, the final decision is whether prevention or surgical treatment should be undertaken.

A patient's caries risk profile takes into account various caries promoting and caries inhibiting factors as well as socioeconomic, behavioural, and demographic factors. Clinical factors such as lesion severity, lesion activity, and expected lesion progression rate are contributing factors. A patient's risk status should be used to establish the patient's recall interval, which includes deciding intervals for moni-

toring caries progression radiographically. Ekstrand et al. (5) state that detection of carious lesions is only part of the caries diagnostic process. Optimally, the goal is to (i) decide accurately and reliably whether the observed condition is a carious lesion, (ii) assess its severity, and (iii) assess the lesion's activity status (5). In their education, dental students are trained and gain experience in this sequence during patient treatment when they visually inspect the carious lesion during excavation. This type of experience will accumulate during their work as a dentist. Dental hygienists do not have this kind of feedback. Intra-observer agreement for the two students groups that had less training and education also indicate this.

Due to the complexity of individual caries risk assessment, how well information is processed will be substantially influenced by the observers (16) – whether they are a dentist or a dental hygienist – and their training and experience. There seems to be some truth in the saying “practice makes perfect”.

The criterion standard in this study was established by a histological evaluation of serial tooth sections. This method has been evaluated (17,21) and found to be reliable for establishing dental caries diagnoses. Observer disagreement concerned whether a surface was healthy or had a small enamel lesion. This indicates that any diagnostic method for determining very small carious lesions in the enamel has a high degree of uncertainty. The overall results in this study concerning range of true-positive and false-positive diagnoses of carious lesions, especially for enamel caries, agreed with those of other studies (6, 20). Diagnostic accuracy of radiographically detectable carious lesions is related to lesion grade. For instance, larger carious lesions are easier to evaluate than enamel caries. The teeth in this study had no carious lesions or only carious lesions with a very small extension; no tooth was severely damaged by a carious lesion. Six per cent of the teeth had carious lesions that extended into the dentine. This figure corresponds to Swedish national findings for the frequency of carious dentine lesions in young people up to age 20 (22).

Many factors contribute to image quality. In this study we tried to optimise the conditions for evaluation, not as in a laboratory setting but as would occur in a general dental practice. In an attempt to mimic the clinical situation as much as possible, we did not calibrate the observers before the evaluation sessions. The monitor in this study had a built-in Barten curve (2, 4). Previous studies (10, 11) demonstrated that a well-adjusted, pre-calibrated monitor

is essential for evaluating radiographic images. Ambient light has also been studied, and it was concluded that it must be dimmed, preferably under 50 lux (11).

In conclusion, significant differences in diagnostic accuracy were found between experienced dentists and students at different educational levels concerning diagnosis of approximal carious lesions into the dentine. There was also a significant difference between final-semester dental students and the other two student groups. This showed that variations in the examiner's education level and experience influenced the diagnostic accuracy of dentine lesions (grade 3) on digital radiographs.

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Awareness of toothbrushing and dentifrice habits in regularly dental care receiving adults

KATARINA WIKÉN ALBERTSSON, JAN W V VAN DIJKEN

Abstract

© The aim of this study was to investigate toothbrushing and dentifrice habits in a Swedish adult population with relatively high caries frequency, which received regularly dental care and to evaluate the awareness of their toothbrush technique.

Sixty adult participants with high caries frequency, 29 woman and 31 men, answered a self-reporting questionnaire with 42 questions concerning their oral care, brushing technique and -habits. The responses were related to their clinical behaviour observed during a customary toothbrushing session.

Fifty-three participants fulfilled both the questionnaire and the clinical observation. Half of these used toothpaste containing 1450-1500 ppm fluoride but only one of all participants was aware of the fluoride concentration used. The majority used a manual toothbrush and 95% brushed their teeth twice a day using 0.9g toothpaste. A wide range of brushing methods and habits was observed. Sixty percent did not brush systematically. Spitting of toothpaste-saliva during brushing was performed by 60% and after brushing by 15%. The observed brushing times were significantly higher than the self reported. The observed brushing times were < 1min: 3.4%, 1-2 min: 36.7% and >2 min: 47.0%. There was a significant correlation between observed brushing time and caries activity. Rinsing with water after brushing was performed once (32%) or twice (44%) during the observations. Only 9% rinsed with toothpaste slurry after brushing.

It can be concluded that the awareness of the individual toothbrushing, post-brushing behaviour and the use of fluoride toothpaste was non-optimal in the adult participants. Oral health promotion by optimized use of fluoride toothpaste and improved post-brushing behaviour should be recommended.

Key words

Behaviour, dental health, fluoride, oral hygiene, plaque control

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Hur medvetna är vuxna som erhållit regelbunden tandvård om sina tandborst- och tandkrämsvanor?

KATARINA WIKÉN ALBERTSSON, JAN W V VAN DIJKEN

Sammanfattning

© Målsättningen med denna studie var att undersöka tandborst- och tandkrämsvanor i en svensk vuxen population, som erhållit regelbunden tandvård och undersöka hur medvetna de är om sin tandborstteknik.

I studien ingick en enkät del och en klinisk observation. Sextio vuxna med relativt hög kariesfrekvens, 29 kvinnor och 31 män, besvarade en enkät med 42 frågor angående deras munhygien, tandborstteknik och tandborstvanor. De enkätfrågor som handlade om tandborst- och tandkrämsteknik följdes upp med en klinisk observation. Femtiotre deltagare fullföljde hela studien. Hälften använde tandkräm med 1450-1500 ppm fluor men enbart en deltagare var medveten om vilken fluorkoncentration tandkrämen innehöll. De flesta borstade med manuell tandborste och 95% borstade två gånger per dag med 0.9g tandkräm. En stor variation av tandborstmetoder och vanor observerades. Sextio procent borstade ej systematisk. Över hälften (60%) av deltagarna spottade ut tandkräm och saliv under borstningen medan 15% gjorde det efter tandborstningen. Den observerade tandborsttiden var signifikant högre än den uppskattade. De observerade tiderna var: <1min: 3,4%, 1-2 min: 36,7% och >2 min: 47,0%. En signifikant korrelation observerades mellan borsttid och karies aktivitet. 44% av deltagarna sköljde med vatten flera gånger efter avslutat tandborstning, enbart 9% sköljde med en "tandkräms slurry"

Det kan konkluderas att de vuxna deltagarna inte var medvetna hur de utförde sin tandborstning och använde inte fluortandkrämen optimalt. Tandvården bör informera hur man kan optimera sättet att använda fluortandkräm under och efter tandborstningen.

Introduction

Development of carious lesions can be arrested by professional mechanical cleaning (16). *Källestål et al* (19) showed that oral hygiene education was the most frequently provided preventive care item for children and adults in four Scandinavian countries. The effect of high quality of plaque control in 12-year-olds performed by the parents, as demonstrated in the Nexö-studies, resulted in very low caries prevalence (12). In order to implement these preventive methods in adult patients a high level of compliance is needed, which should be kept on that high level.

Fluoride toothpastes are considered to be one of the most important and effective routes to reduce caries (5). The ability of fluoride to prevent and arrest caries by inhibiting demineralization and enhancing remineralisation is well known. However, the ubiquitous use of fluoride toothpaste makes it difficult to distinguish whether the effect of caries is due to fluoride application or to mechanical removal of the plaque. A recent Cochrane review (type I) concluded that the usage of fluoride toothpaste is associated with a 24% reduction of dental caries in the permanent dentition of children and adolescents (23). *Clarkson et al* (8) indicated in a review of clinical trials that fluoride concentration is one of the most important determinants of anticaries efficacy. Higher levels were more effective (34). *Mathiesen et al* (24) reported that amongst children who claimed to use fluoride toothpaste regularly, the amount of fluoride that each child obtained every day varied according to how often teeth were brushed in a day. Systematic reviews conclude that despite associations with confounding factors, evidence supports the recommendation that tooth brushing with fluoridated toothpaste should be performed twice a day (9, 34). However, the literature focuses almost exclusively on school children and adolescents with permanent teeth (2, 34) and few studies report the brushing duration, technique and behaviour of adults (26-28). Recently the Swedish Council on Technology Assessment in Health Care (SBU) anticipated that brushing with fluoride toothpaste was under-utilized (34). Most adults in Sweden have received professional motivation and instruction in proper oral hygiene. Compliance and awareness will probably decline by time. The hypothesis tested was that adults' regularly receiving dental care showed self reported similar tooth brushing habits and -time compared to observed ones. The aim of this study was to investigate toothbrushing, post-brushing and fluoride dentifri-

ce habits and awareness in adults with relative high caries frequency which regularly attended dentistry.

Material and methods

This study was designed as a self reported survey (questionnaire) followed by a clinical observation of the participants tooth brushing, comparing estimated and actual brushing technique. During a period of six months all adult recall patients, with relative high DMFS frequencies in their respective age group, 30-45 yrs - DMFS >30 and > 45 yrs - DMFS >45, were asked to participate in the study. The participants attended the dental clinic at the Dental Hygienist Education, Umeå, Sweden and the Public Dental Health clinic at the Dental School. Sixty of 70 asked subjects accepted to participate, 29 women and 31 men, mean age 51 years. Mean DMFS was 61.5 (SD 20.3). Informed consent was obtained from all subjects at the start of the study.

The investigation was conducted in a way that the adult subjects could answer the questionnaire directly after a dental examination under minimal stress. To ensure confidentiality and minimize response bias, the respondents used a separate room. One of the authors was available to facilitate clarification. The self-reported questionnaire contained 42 mostly closed questions; there the participants could indicate one or several alternative answers. The first part contained questions concerning their oral care and choice of dentifrice and the second part concerning their customary toothbrushing habits, including technique, brushing time, and post-brushing habits. The amount of toothpaste used by the subjects could be selected from drawings with toothpaste masses with accumulating length and thickness placed on toothbrushes. The weight of respective toothpaste volumes was measured on a micro-balance (Sartorius 2001 MP2, Kebo-Grave Stockholm, Sweden). Before the clinical observation all subjects were instructed several times how to behave during the clinical observation visit: to perform their customary tooth brushing as they were used to do at home using their own toothpaste and toothbrush. They used their own dentifrice and toothbrush. The room they brushed their teeth contained wash basin, mirror and possibilities to walk around if preferred. The observer was situated in a corner of the room in order not to interfere. A selection of the questions on knowledge and behaviour was compared to the clinical observations performed within 1-2 months. For all participants regular attending the dental clinics,

caries activity, clinically recorded as the number of manifest caries lesions observed during the last 7 years, was evaluated in their individuals dental records and bite wings.

Statistical methods

The data were analysed using SPSS (Statistical Package for the Social Science), version 12.0 and SAS^R program (version 9, SAS institute, Cary, NC, USA). Frequency distribution analysis were used for all variables. Responses to questions concerning clinical behaviour were related to the registrations during the clinical observation and analysed with Fishers exact test. Spearmans rank correlation, r_s , was computed between caries activity, brushing time estimated, brushing time observed, DMFS, fluoride concentration in participants toothpaste and brushing frequency. The significance of r_s was tested. Statistical significance was assumed when $p < 0.05$.

Results

Questionnaire

Sixty participants responded the questionnaire and 53 fulfilled the whole study. Six were not able to come to the clinic, and one did not want to continue because of dental fear. Earlier oral hygiene instructions were obtained from the regular dentist (30%), dental hygienists (23.3%) or both. Seventy percent used a manuell toothbrush, 13% an electric and the others both. All participants used fluoride toothpaste, 50% with 1450 -1500ppm fluoride. Only one participant looked after fluoride concentrations, 62% did not study the contents declaration on the toothpaste tubes, while the others were only interested in single ingredients like anti-sensitive, anti-calculus or gingival health stimulating agents. The most common self reported amount applied toothpaste was 3 cm ($\approx 0.9g$). Nighty-five percent brushed twice a day or more, the others once a day or less. The majority (78.3%) brushed after breakfast. Fifty-five percent brushed always before going to bed, while the others reported that they were sometimes too tired to brush.

Clinical observation

A low congruence was observed between the self-reported jaw the participants started their brushing and the observed one ($p < 0.01$). Most participants (62.0%) started brushing on buccal surfaces, 22.0% on occlusal and 16.0% on lingual surfaces. No difference was seen between the self-reported start surface (occlusal, buccal or lingual) and the observed

($p=0.23$). There was no difference between the self-reported answer that they finished brushing in the same jaw before continuing in the opposite one and their behaviour during observation ($p=0.54$). Sixty percent of the participants did not brush systematically in the different parts of the mouth during observation and switched brushing localisation several times during the brushing period. Forty percent used a combination of modified Bass, vertical and horizontal brushing, 25% a modified Bass, 25% a vertical brushing only and 9% a horizontal brushing only. Self-reported and observed brushing times are shown in Table 1. Sixty-five percent reported that they brushed for similar time periods each time they brushed. There were no differences in self-reported brushing times between men and women. During the clinical observation, 47.0% brushed more than 2 min. The observed brushing times were significantly higher ($p= 0.02$). Women showed a tendency, but not significant, to brush longer time periods.

A weak but significant correlation was observed between observed brushing times and the participants caries activity (Spearmans rho 0.0348, $p=0.024$). Correlation between caries activity, DMFS, fluoride concentration in participants toothpaste and self-reported brushing times were not significant. None of the participants reapplied new toothpaste during brushing compared to 98% self reported.

No difference was seen for the observed spitting of toothpaste-saliva during brushing and the self-reported habits ($p=0.16$) (Fig 1). Significant differences were observed for post-brushing habits as observed in the clinical evaluation and self-reported ($p=0.0001$).

Self-reported other behavioural components, which are related to habits that promote dental

© TABLE 1. Absolute frequencies of the by the participants self-reported and the observed toothbrushing times

Estimated time	N	Observed time				
		45 SEC	1 MIN	1½ MIN	2 MIN	>2MIN
15 SEC	2			1		1
30 SEC	3	1		1	1	
45 SEC	5		2	1	2	
1 MIN	7		1	2	2	2
1½ MIN	17		2	6	3	6
2 MIN	11			1	1	9
> 2 MIN	8				1	7

health, showed that 100% used fluoridated toothpaste, fluoride lozenges were used sometimes by 5.0%. Dental floss was used every day by 13.3% and sometimes by 53%. Tooth picks were used every day by 13.3% and sometimes by 48.3%.

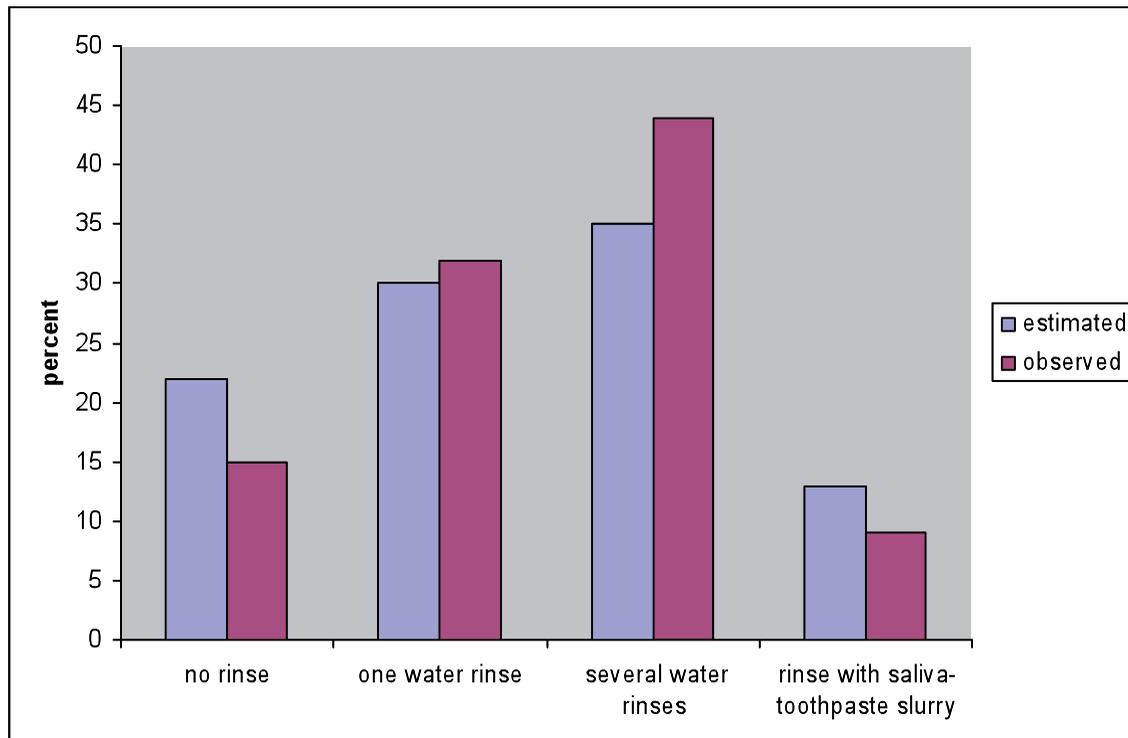
Discussion

In self reports the answers might give a too positive picture of toothbrushing, because they can be biased towards the expected behaviour. However, a good congruence between subjective reports and clinical observations primarily for conditions that are easy for the patient to observe has been reported (17, 35). The main findings in the present study were the low brushing awareness of the adults and non-optimal use of fluoride toothpaste despite that the majority of the individuals visited the dentist and/or the dental hygienist regularly at least once every second year.

It is well known that tooth-brushing habits are initiated at early ages in the family (1, 3, 22) and adolescence is an important period for learning and maintaining health-related behaviours. No studies report, however, about the long term compliance

and awareness of the adult patients of their self-prevention performance. Tooth brushing behaviour among adolescents has been measured by the daily frequency of brushing (7, 22). In the present study 95% brushed twice or more daily confirming improved brushing frequency behaviour in Sweden (17, 33). However, many of the participants indicated that they sometimes were too tired to brush in the evenings. Few individuals use aids for proximal cleaning as also found in the present study (17). However, increasing the brushing frequency per day does not necessarily imply effective plaque removal and/or decreased caries activity (4, 18). No higher tooth brushing prevalence was found for the female gender as shown in earlier studies (22). Brushing time has been indicated as a more important factor concerning plaque removal (28). It is therefore surprising that despite that it may be one of the key variables in caries prevention, almost no research has been performed on brushing time during recent years. In a recent review of the rationale use of fluoride toothpaste and the available evidence to support the appropriate use of fluoride toothpaste to maximize the benefit, brushing time was neither

© Fig 1. Relative frequencies (%) of the by participants self-reported and the observed post-brushing behaviour.



a variable (10). Earlier reviews showed that professional advice on appropriate brushing time ranged from 3-7 min, but actual brushing times were only 1 min (13, 21, 26). *Hansen & Gjermo* (14) reported that time necessary for different toothbrushing methods to remove plaque varied significantly between 2.8-4.3 min. In the present study a significant correlation was observed between the adult caries frequency during the last seven years and their observed brushing time. However, the correlation with the self-reported brushing time was not significant. In one of the few recent studies on tooth brushing time, *Saxer et al* (27) observed subjects participating in a toothpaste "taste" study and reported mean actual brushing times between 68-83 s. The subjects estimated the time they had brushed between 134-148 s. *Emling et al* (13) reported that 89% of their subjects brushed about the same time during the observation as they usually did at home. In contrast to the present study both *Emling et al* (13) and *Saxer et al* (27) obscured the time evaluation nature of the study, which may have influenced the brushing time. The subjects who rated the taste of the toothpaste as high spent more time brushing, while the group which rated the paste as poor brushed significantly less. Half of the group brushed longer than 2 min, but estimated their brushing time significantly shorter. The hypothesis was therefore not accepted. These increased brushing times in the clinical observation can partly be due to the so-called Hawthorne effect, i.e. the positive change in behaviour of a subject as a result of the special attention and status received from participation in an investigation (25).

The ubiquitous use of fluoride tooth pastes makes it difficult to distinguish whether the effect of tooth brushing on caries is the result of the mechanical removal of plaque, application of fluoride or both. *Chestnutt et al* (7) stated that fluoride tooth paste may be effective as a caries preventing effect even when an unsatisfactory brushing technique is employed (7). The efficacy of fluoride toothpastes is multifactorial, influenced by factors like: fluoride concentration, frequency of use, amount used, rinsing behaviour and brushing time (10). The clinical benefit of increased fluoride concentration is accompanied by increased plaque fluoride levels (11). In the present study, 57% of the participants used 1450-1500 ppm toothpastes. The frequent use of fluoride-containing toothpaste by Swedish adults was confirmed but it was surprising that only one of the participants was aware of the toothpaste's fluoride concentration (17, 33).

The amount of toothpaste used will also influence the intra-oral retention of fluoride. *Saxer et al* (27) weighed the dentifrice tubes before and after brushing and reported that the amount of toothpaste used per cleaning was approximately 1g, which was in accordance with the self-reported mean weight of 0.9g toothpaste applied by the adults in the present study. After-brushing rinsing has been routinely advised by the dental profession to remove debris and to avoid swallowing excess fluoride toothpaste, especially for younger children (20). However, rinsing with water significantly reduced plaque fluid fluoride concentrations (36) and may have an adverse effect on the caries preventive effect of the fluoride toothpaste (7, 36, 29-31). Spitting during brushing will also affect the intra-oral fluoride concentration and the plaque removing efficiency (7, 11, 29, 32). In the present study, 60% spat toothpaste already during brushing, while 76% rinsed with water once or twice after brushing. Only 9% used the modified toothpaste technique suggested by *Sjögren* (32). The present study showed that too many participants were not aware of their post-brushing habits as shown by the low congruency found between the self reported and the observed habits.

During the last decades, large resources have been allocated through the organized dental care system for improvement of dental health in Sweden. Clinical dental examinations also include information about dental health and training in preventive methods thus influencing attitudes and behaviour of the patients (33). The use of fluoride has caused a substantial decrease in caries prevalence, but still many patients suffer from dental caries. The present study with participants with relatively high caries frequency showed clearly that further improvements may be reached in different ways for this group. There is a need to increase compliance of the use of prevention methods and products (6). Increasing the effectiveness of fluoride toothpastes in different ways may result in individual benefits. Longer brushing times, use of sufficient toothpaste with high fluoride concentrations, and improved post brushing behaviour will increase the intra-oral fluoride retention and the caries preventive effect. Compliance is varying between individuals and behavioural changes costs energy and time. Therefore, patients do not often receive advice on proper self-care when they visit their dental clinic (15). Especially to increase the effectiveness of fluoride toothpastes has been poorly recommended in adults. More studies are necessary to explore the effectiveness of brushing technique

and brushing time as well as amount and concentration of fluoride toothpaste used by the individual patient.

It can be concluded that the awareness of the individual toothbrushing, post-brushing behaviour and the use of fluoride toothpaste was non-optimal in the adult participants. Oral health promotion by optimized use of fluoride toothpaste and improved post-brushing behaviour should be recommended.

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A randomized prospective clinical evaluation of two desensitizing agents on cervical dentine sensitivity. A pilot study

YONES JALALI¹, LISELOTT LINDH²

Abstract

© The aim of this prospective clinical pilot study was to evaluate the pain alleviation effectiveness of two desensitizing agents (VivaSens® and Seal&Protect®) on 30 patients suffering from cervical dentine sensitivity (CDS) over a six month period. Analysis of possible differences in pain alleviation effect between the agents and over time was performed. Further, the experienced pain was registered in a questionnaire regarding to what extent the treatment improved oral health/life quality among the patients. The patients (23 female, 7 male) were randomly divided into two groups. Each group was treated with one of the two desensitizing agents. Sensitivity measurements were recorded before treatment (baseline) and after treatment at time points of one week and six months. The patients were asked to rate the sensitivity experienced in the area during air stimulation by marking on a Visual Analogue Scale (VAS). At six months, 27 patients (90%) had completed the clinical trial. The results showed that a significant reduction of CDS was achieved by using VivaSens® or Seal&Protect® after both one week and six months. However, there were no differences found on treatment effects between the two desensitizing agents. The results from the questionnaire showed that the patients experienced improved oral health/life quality when comparing the status before and after treatment ($0.000 \leq p \leq 0.021$) and there were no statistically significant difference in treatment effects between the products. In conclusion, both desensitizing agents were effective in relieving cervical dentin hypersensitivity during the time course of the study as evaluated both by air stimulation and a questionnaire related to oral health/quality of life status.

Key words

Dentine sensitivity, pain measurement, quality of life, treatment, Visual Analogue Scale

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En prospektiv randomiserad klinisk utvärdering av två dentala produkter som är avsedda för behandling mot känsliga tandhalsar – en pilotstudie

YONES JALALI, LISELOTT LINDH

Sammanfattning

☉ Syftet med denna prospektiva kliniska pilot studie var att utvärdera den upplevda smärtlindrande effekten av behandling mot känsliga tandhalsar med två desensibiliseringsprodukter (VivaSens® och Seal&Protect®) samt att utreda eventuella skillnader i den smärtlindrande effekten mellan materialen. Dessutom undersöktes försökspersonernas smärtupplevelse med hjälp av en enkät för att få indikation på i hur stor grad behandlingen gav förbättrad oral hälsa/livskvalité för respektive person. Totalt 30 patienter (23 kvinnor, 7 män) delades slumpmässigt in i två grupper i denna studie med sex månaders uppföljning. Varje grupp behandlades med en av de två produkterna. Känslighetsmätning genomfördes innan behandling (baseline) och vid vardera 1 vecka och 6 månader efter behandling. Patienterna fick ange den upplevda känsligheten i området vid luftblästring genom att markera på en Visuell Analog Skala (VAS). Efter 6 månader hade 27 patienter (90%) fullföljt studien. Resultaten visade en signifikant minskning av känsliga tandhalsar efter en vecka respektive sex månader efter behandling med VivaSens® eller Seal&Protect®. Det fanns inga skillnader på behandlings effekten mellan de två produkterna. Resultaten från enkäten visade att patienterna upplevde en förbättrad oral hälsa/livskvalité efter behandling ($0,000 \leq p \leq 0,021$) och det fanns inga statistiska signifikanta skillnader mellan grupperna. Slutsatsen är att båda produkterna som användes i studien var effektiva i reducering av känsliga tandhalsar under en 6 månaders period både enligt resultat från luftblästring som utifrån frågeformulär om försökspersonernas upplevelse av sin orala hälsa/livskvalité..

Introduction

Cervical dentine sensitivity (CDS) is a commonly occurring condition, particularly when gingival recession appears and when root-cement is exposed and removed for different reasons. CDS can be defined as a painful response to an external stimulus applied to exposed dentine in the cervical region of the tooth (6). It has been reported that the occurrence of CDS is between 8-35%, depending on which patient group that has been studied, and which evaluation method that has been used (6). Different stimuli, for instance temperature- and/or osmotic changes can, according to the Brännström hydrodynamic theory, cause pain when dentinal tubules are not closed (5). Patients suffering from CDS have daily problems related to eating, drinking and also tooth brushing. These are handicapping and thereby are those patients in immense need for treatments that will last over a reasonable time period.

An important part for the treatment outcome is a correct diagnosis and to find and eliminate predisposing factors to dentin hypersensitivity. An understanding of the mechanisms that open dentinal tubules would seem important if attempts to prevent or treat dentine hypersensitivity are to be successful (1). A number of desensitizing agents (chemical and physical) have been used to block dentinal tubules with different methods to reduce or eliminate pain / discomfort from the cervical teeth area (15).

VivaSens® is a relatively new product, and has not been examined to the same extent as Seal&Protect®. Support is found in previous studies that treatment with Seal&Protect® has a significant reduction in CDS during 19 month (4), whereas VivaSens® showed significantly more effectivity in decreasing the thermal sensitivity of teeth during a six month period compared to placebo (7). In a double-blind randomised clinical trial based on a four week follow-up time it was shown that both VivaSens® and Seal&Protect® were effective in alleviating dentin hypersensitivity (17). However, a period of four week of follow-up time is a short time period for evaluation of the treatment effects and furthermore, no investigation on the eventual improvement of oral health/quality of life has been performed. Therefore the aim in this pilot study was to evaluate the pain alleviation effects of the two agents VivaSens® and Seal&Protect® over a six month long period among patients with CDS problems, and to analyse possible differences in pain alleviation effect between the agents over time. Furthermore, another aim was to

investigate if the patients experienced improved oral health/life quality due to the treatments by a questionnaire.

Material & Method

Study population

Advertising for test persons above 18 years of age were done at a Public Dental Clinic in Malmö city. In total, 30 persons volunteered, seven male and twenty-three female, between 21 and 60 years old. The mean age was 38 (sd 10) years. Medical and dental history was taken from each patient. A total of 310 teeth were found to be sensitive among the test persons.

The inclusion criteria were that the test person should be in good general health and have teeth with CDS symptoms. The teeth should be sensitive to temperature (hot and/or cold) and/or to evaporated dental air produced by the dental air syringe pointed at the cervical surface area.

Exclusion criteria were root-filled teeth, teeth with caries and marginal restorations, as well as teeth with registered sensitivity 1-2 weeks after filling treatment or after periodontal treatment, respectively. Furthermore, sensitive teeth with a record of VAS values below 10 were also excluded.

The study was approved by the ethics committee of the University of Lund (159/2007). Patients who complied with all inclusion criteria and none of the exclusion criteria was informed verbally and written of the nature, extend and purpose of the study. A written Patient Information was handed out to the patient by the investigator. Written informed consent was obtained from each patient before enrolment into the study. It was made clear that the patient was free to withdraw from the study at any time without giving reasons.

Materials

Two liquid desensitizing agents VivaSens® and Seal&Protect®, were studied.

VivaSens® (Ivoclar Vivadent AG, FL-9494 Schaan/Liechtenstein) is a film like varnish containing potassium fluoride, polyethylenglycol and methacrylates. This agent blocks dentinal tubules due to the precipitation of calcium ions and proteins in the dentinal fluid (19).

Seal&Protect® (De Trey GmbH, De-trey-str.1, D-78467 Konstanz, Germany) on the other hand is a self-adhesive, translucent, light curing, resin-based sealing material. It contains triclosan, fluoride and nanofillers. Seal&Protect® reduces wear of the cer-

vical dentine by both infiltrating and coating the dentine and thus showing an increased mechanical strength (18).

A prophylactic paste (Prophylactic CCS RDA 40, Svenska Dental Instrument AB, Upplands Väsby, Sweden) was used to clean the teeth prior treatment with the desensitizers.

Study design

The study design of this pilot investigation was performed as a prospective, randomised clinical trial including both treatment and questionnaire. All patients were seen during the whole study by the same examiner (YJ). The study was implemented randomly, meaning that each patient was treated with a randomly selected product that was coded. The key to the codes was broken first when all analysis were completed. The randomisation list was generated by assisting staff.

Visual Analogue Scale

A Visual Analogue Scale (VAS) is a line of 100 mm length where one end defined as “no pain/discomfort” (0 mm) and the other as “severe pain/discomfort” (100 mm). The patient was asked to mark on the VAS with a line at the point corresponding to the severity of his/her pain/discomfort (11). This method was used in all tests.

Treatment and measurement

To produce evaporative stimuli an operative controlled dental air blast (45-60 PSI, 19-24°C) was applied using an air syringe 2 mm away from and perpendicular to the cervical surface for approximately 1 second. Baseline-analyses were recorded. Before treatment the cervical surfaces were cleaned, using a slow speed handpiece with a rubber cup and prophylactic paste, rinsed with water and dried with air blast. The test products were applied by one operator and according to the manufacturer’s instructions. Additional analyses were repeated one week and six months after the treatment. The patients were asked to rate by marking on VAS the sensitivity they experienced in the treated area directly after air blast was applied as stimulation. Subjects were not permitted to see previous VAS records at the next occasion of measurement.

Questionnaire

All patients completed a questionnaire with the aim to evaluate the patients’ experience of possible improved oral health/life quality. The questions were:

“how intense is the pain?” and “how much discomfort do you feel?”. The questionnaire was fulfilled before the treatment and adjacent to the examination/analysis occasions i.e. after one week and six months, respectively. Subjects were permitted to see previous VAS scores in the questionnaire.

Statistical analyses

In this pilot study we report on four analysed variables regarding the treatment: by air blast to treated teeth; quadrants 1, 2, 3 and 4, and two analysed variables regarding the questionnaire (see Questionnaire above)

Among the teeth, which had a VAS score higher than or equal with 10, one tooth was chosen randomly in every quadrant of each patient by the statistical programme used (SPSS). The data were summarized as mean VAS value \pm standard deviation for each quadrant and also for the questions.

Since the data were not normally distributed we chose Wilcoxon and Mann-Whitney U-test for our statistical analysis. The Wilcoxon signed rank test was used to evaluate the treatment effect of each desensitizing agent over time. The Mann-Whitney U-test was used to analyse differences in treatment effects between the two products at 1) baseline, 2) baseline-1 week and 3) baseline- 6 months. These test methods were also used with statistical analyses of the questionnaire. The level of statistical significance was set at $p < 0.05$ in all analyses.

Results

Thirty test persons with 310 sensitive teeth volunteered to join this study. 44 teeth were excluded from analysis because of the exclusion criteria. There were three persons (52 teeth), who dropped out: 1) one person due to change in working situation and family reason after 1 week, 2) one subject did not complete the six months follow-up and finally, 3) one subject needed periodontal treatment before the study was completed. In the remaining 27 persons a total of 214 teeth were included in the study and treated with either VivaSens® (111 teeth) or Seal&Protect® (103 teeth). One tooth / quadrant (89 teeth) were chosen randomly from both the VivaSens group (44 teeth) and the Seal&Protect group (45 teeth) for statistical analysis. From the VivaSens group 13 persons and from the Seal&Protect group 14 persons answered to the questionnaire in total 27 persons.

The results of the data analysis of the dentine hypersensitivity tests are presented in Table 1. These results show that both desensitizing agents used were

© **Table 1.** Mean (standard deviation) of VAS values (on scale from zero to 100) regarding dentine hypersensitivity tests at baseline and one week and six months after treatment.

Statistical analyses of the treatment effects and differences between the VivaSens- and Seal&Protect group regarding dentine hypersensitivity at different time points after treatment compared with baseline using Exact Sig. (2-tailed).

	Mean (SD)			P-value		
	Baseline	After 1 week	After 6 months	Baseline	1 week/baseline	6 months/baseline
Quadrant 1						
VivaSens	29 (29)	14 (24)	13 (15)		0.023	0.007
Seal&Protect	30 (20)	6 (8)	13 (21)		0.000	0.020
Diff. between groups				0.332	0.144	0.308
Quadrant 2						
VivaSens	29 (20)	6 (8)	9 (10)		0.001	0.004
Seal&Protect	34 (19)	11 (15)	11 (14)		0.008	0.014
Diff. between groups				0.486	0.931	0.380
Quadrant 3						
VivaSens	35 (18)	11 (18)	7 (9)		0.020	0.001
Seal&Protect	20 (15)	3 (5)	8 (12)		0.002	0.070*
Diff. between groups				0.028**	0.159	0.011**
Quadrant 4						
VivaSens	44 (25)	7 (12)	21 (25)		0.004	0.008
Seal&Protect	31 (23)	7 (8)	12 (17)		0.001	0.000
Diff. between groups				0.134	0.149	0.891

10 < n < 13 (n = Total number of teeth in every quadrant for the respective products).

* =P> 0.05, regarding differences between products used ** =P<0.05

© **Table 2.** Mean (standard deviation) of VAS values (on scale from zero to 100) regarding questionnaire data at baseline and one week and six months after treatment.

Statistical analyses of the treatment effects and differences between the VivaSens- and Seal&Protect group regarding questionnaire data at different time points after treatment compared with baseline using Exact Sig. (2-tailed).

	Mean (SD)			P-value		
	Baseline	After 1 week	After 6 months	Baseline	1 week/baseline	6 months/baseline
How intense is the pain?						
VivaSens	69 (27)	22 (29)	33 (32)		0.001	0.000
Seal&Protect	65 (27)	35 (33)	33 (36)		0.000	0.003
Diff. between groups				0.694	0.082	0.526
How much discomfort do you feel?						
VivaSens	50 (31)	24 (28)	24 (23)		0.021	0.017
Seal&Protect	57 (23)	28 (24)	30 (27)		0.001	0.008
Diff. between groups				0.659	0.909	0.952

VivaSens: n = 13, Seal&Protect: n = 14. P < 0.05 was considered statistical significant

effective in alleviating dentin hypersensitivity and pain / discomfort checked one week and six months after treatment, respectively. According to the Wilcoxon signed rank test results, there were statistically significant difference on treatment effects, when comparing baseline data with data after one week and six months, respectively, for both agents except for the third quadrant treated with Seal&Protect at the 6 month visit. There was no statistically significant difference in treatment effects between the products at baseline, baseline-1 week and baseline- 6 month except for the third quadrant at baseline and baseline - 6 month.

The results from the questionnaire are summarized in Table 2. These results show that the patients experienced improved oral health/life quality over a six month period after the treatment for both desensitizing agents. According to the Wilcoxon signed rank test results, there was a statistically significant difference on treatment effects, when comparing baseline data with data after one week and six months, respectively, for both agents. Interestingly, there was no statistically significant difference in patients experienced effect between the products at the baseline, baseline-1 week and baseline- 6 month.

Discussion

Cervical dentine sensitivity (CDS) is the condition where a short-lived stabbing pain is felt when eating or drinking cold, hot or sweet foods and often also with dry air and touch (e.g. brushing teeth). It occurs when gingival recession exposes dentin at the cervical margins of teeth. Several factors can play a role in the aetiology of dentine hypersensitivity for instance dietary factors (2) and the dentinal tubule morphology (16). These factors might explain why there is variability in sensitivity levels from person to person that was found in the present investigation.

We have reported that reduction of the CDS after application of the desensitizing agents, VivaSens® and Seal&Protect®, were dramatic after 1 week compared to baseline and were still maintained after six months (Table 1). Both desensitizing agents block open dentin tubules however in different ways (see Materials). Still, their effectiveness was not different from each other. The results in the present investigation are supported in an earlier study based on a four weeks follow-up time (17). Analyses of our results showed that there were a statistically significant difference on treatment effects regarding dentine hypersensitivity for both agents at different time points

after treatment compared with baseline except for the third quadrant of Seal&Protect group at 6 months ($P = 0.070$). There were no statistically significant difference between the groups at different time points with exception for the third quadrant at baseline ($P = 0.028$) and 6 months ($P = 0.011$). Here it should be kept in mind that the patients in the Seal&Protect group already had low VAS values at baseline in the third quadrant (Table 1). Thus the treatment with a desensitizing agent might reduce an already low VAS value at the significance level ($P = 0.05$) during one week after treatment but not at the 6 months check-up, even though the patients experienced less pain and discomfort due to the questionnaire (Table 2). Outcome evaluation of dentine sensitivity treatment could include both a stimulus-based and a response-based assessment. The subject's overall assessment of the treatment is usually done with a questionnaire at each time period in a longitudinal study (10). In our study we used a questionnaire with the aim to evaluate the patients' experience of possible improved oral health/life quality after treatment (12, 13). The results from the questionnaire showed that the patients experienced improved oral health/life quality when comparing the status before and after treatment ($0.000 \leq p \leq 0.021$) and there were no statistically significant difference between the two products used, which indicate that these materials are equally useful in the clinic (Table 2).

In the literature there are reports describing that premolars are the teeth most frequently affected by evaporative and tactile stimuli (9, 14). In the present study, CDS was found in all types of teeth by evaporative stimuli but was most commonly in premolars (42%). It is interesting to note that there was a similarity between our results and these earlier described studies (9, 14). Over-zealous brushing can cause gingival recession and root surface abrasion, and this may account for the high incidence of CDS, particularly in teeth at the 'corner' of the dental arch, in a region that is perhaps most vulnerable to toothbrush trauma (20). In a previous study of the intraoral distribution of CDS it was reported that recession and sensitivity were significantly greater on the left side of the dental arch. This could be explained by the predominance of right-handed persons in the general population (3). In the beginning of our study every test persons were questioned about which hand they used to hold their toothbrush during tooth-brushing and on which side they felt more pain / discomfort. The majority of the patients (85%) answered

that they were right-handed tooth brushers which agrees with earlier reports (3), but only 22% of this selected group had felt more pain /discomfort from their left side. Even the results from the intra-oral test showed that the mean of VAS value from the left side, 28, was lower than from the right side, 31. These differences in the results can be due to which patient group that has been studied and which evaluation method that has been used. Additionally, patients were questioned about their tooth brushing method, the type of toothbrush and the number of brushing times daily they used. The majority of right-handed tooth brushers answered that they used horizontal a tooth brushing method (74%), soft or extra soft toothbrush (91%) and brushed their teeth twice a day (87%).

As a matter of fact, the reliability could be questioned of the results based on only intra-oral tests or patient's subjective evaluation. In an earlier study the patient's own assessment was not considered to be a reliable index due to the fact that some patients tended to blame other types of pain than the investigated ones (8). The stimuli, for instance air or probe, are not exact reproductions of daily life stimuli. Therefore, in this study, we used two evaluation methods i.e. the intra-oral air test in combination with the questionnaire in an attempt to get more clinically reliable results. Since this investigation was a pilot study the material was small. We have chosen a sample size of 30 patients. By using t-test with the significant difference of 5%, a power of 67% is obtained. In order to reach 80% power with standard deviation of 15, a difference of a mean value of 16 in VAS values is needed, and with a standard deviation of 5 a difference of 5,3 is needed at the same power. However, the high standard deviation of VAS values in this study reduces the power, which in itself is an innate property of VAS scales. Even though the Wilcoxon signed rank test and Mann-Whitney U-test give a little less power than the t-test, they are the proper methods to use due to the distribution of the variables. Thus, the results in this pilot study can be discussed regarding the sample size, and therefore this will be considered for future studies using multivariate analysis in our research group.

Conclusion

In light of the small number of participants in this pilot study, we make the following conclusions;

- A significant reduction of CDS was achieved after six months by using either VivaSens® or Seal&Protect®.

- The patient's experience of an improved oral health/life quality after the treatment was significant.
- No significant differences in pain alleviation effect were found between the products used. Hence, both agents may be effective in decreasing CDS over a six month period.

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Socio-economic and lifestyle factors in relation to priority of dental care in a Swedish adolescent population

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Abstract

© The aim of this epidemiological survey was to describe and analyze oral health habits and life-style factors in relation to the priority of regular dental care in 19-year old individuals with specific reference to gender, residential area and socio-economic grouping.

The data were generated from a randomized sample of 758 (63%) individuals in three residential areas in Western Sweden (two rural, one urban) who answered a set of questionnaires prior to a dental examination.

The analysis revealed that males had significantly less favourable oral health habits than females. Forty-one % of the males and 30% of the females did not plan regular dental visits after the age of 20 when they will be charged for the care ($p=0.002$). There were no statistically significant differences in oral health habits and dental care priorities with regard to residential areas and socio-economic groups. In a multivariate model, three significant factors for the probability of “not planning for future regular dental visits” were identified: toothbrushing less than twice daily (OR 1.94; 95% CI 1.28-2.94), smoking (OR 1.68; 95% CI 1.10-2.56) and male gender (OR 1.54; 95% CI 1.05-2.24).

The findings emphasize the need for promotion of favourable oral health habits and smoking prevention among adolescents. There is also a need for dental personnel to recognize differences with regard to oral health-related attitudes and behaviours between males and females.

Key words

Adolescents, behaviour, gender, general health, oral health, socioeconomic

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Socioekonomiska och livsstilsfaktorer i relation till prioritering av tandvård bland 19-åringar i Västra Götaland

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Sammanfattning

☉ Syftet med denna epidemiologiska tvärsnittsstudie var att undersöka socioekonomiska faktorer, munvårdsvanor och livsstil i relation till prioritering av tandvård hos 19-åringar med fokus på eventuella skillnader i relation till kön och socioekonomisk gruppering. Ett randomiserat urval om 758 individer i tre regiondelar av Västra Götaland (Fyrbodalsregionen 249, Skaraborgsregionen 256, Göteborgsregionen 253) besvarade en enkät i samband med en klinisk undersökning. Analysen visade att män hade signifikant sämre munvårdsvanor än kvinnor; till exempel var det 33% av männen och 17% av kvinnorna som borstade tänderna mindre än två gånger per dag ($p < 0.001$). Fyrtio procent av männen och 30% av kvinnorna planerade inte regelbundna tandvårdsbesök efter 20 års ålder, när de själva måste betala för vården ($p = 0.002$). Det fanns inga statistiskt signifikanta skillnader i munvårdsvanor och prioritering av tandvård med avseende på regiondel eller socioekonomisk grupp. I en multivariat modell identifierades tre signifikanta riskfaktorer för att inte prioritera framtida tandvårdsbesök: tandborstning mindre än två gånger per dag (OR 1.94; 95% CI 1.28-2.94), rökning (OR 1.68; 95% CI 1.10-2.56) och manligt kön (OR 1.54; 95% CI 1.05-2.24). Sammanfattningsvis visar resultaten att det finns ett behov att främja goda munvårdsvanor och att arbeta med tobaksprevention bland ungdomar. Det är också viktigt att tandvårdspersonal uppmärksammar att män och kvinnor kan ha olika attityder och beteenden avseende tandvård.

Introduction

The oral health among children and adolescents in Sweden has improved dramatically and since the 1980's followed by comprehensive epidemiological registrations of dental caries. However, during recent years there are signs that the trend of continuous improvements is slowing down, in Sweden and other Scandinavian countries (12, 26, 29). Recent Swedish studies revealed poor oral hygiene and gingival conditions among adolescents (1) and poor knowledge about oral health (16). Also, for a minor group the oral health is continuous poor (11, 29).

The reduction in caries prevalence has been attributed to the organized prophylactic measures of the dental care organization, specifically the use of fluorides (24). The allocation of prophylactic routines has though in recent years often been reduced due to tightened economy. Other scientific papers have pointed to the substantial contribution of changes in social, economic, and physical environment to the improvements in oral health (23). This is of particular interest regarding young people, today an age period with often prolonged studies and significant unemployment. In Sweden, children and adolescents up to the age of 20 have been provided dental care free of charge since more than half a century. For adult patients, a general dental care insurance reimburses part of the patients' costs. The frequency of dental visits has declined among young adults during recent years, especially among males (7). The reason for this could be economy (21), but there are also other possible explanations. Källestål & Wall found that the risk of having caries was greater in urban than in rural teenagers (19). Individual characteristics, as age and sex, are likewise important and recent studies have shown that the attitudes of a person influence both the self-perceived oral health, dental habits and dental care utilization (31, 4, 35).

To understand the oral health of young people, we thus need a more comprehensive picture of their social and individual situation than the mere gathering of clinical data from dental check-ups. The associations between these background factors and the oral health of young people are however little studied. Hence, the aim of this epidemiological survey was to describe and analyze oral health and life-style factors in relation to the priority of regular dental care in 19-year-olds with specific reference to gender, residential area and socio-economic grouping.

Material and methods

Study objects and data collection

The survey was performed during the period August 2005 to September 2006 and comprised a computer-based random selection of 10% of all individuals born in 1987 and living in three different areas of the county council of Västra Götaland, Sweden: Skaraborg, Fyrbodal (both rural) and Göteborg (urban). All together 1208 adolescents (Skaraborg 352, Fyrbodal 356, Göteborg 500) were invited by mail to participate. Questionnaire data were gathered on socio-economy, oral health aspects and attitudinal and behavioural issues prior to a dental examination. The time required for answering the set of questionnaires was about 25 minutes. The Ethics Committee of Göteborg University reviewed and approved the study protocol and all participants provided informed consents (Dnr 146-05).

Socio-economic grouping

A socio-economic (SE) characterization of the population sample was performed according to an index used by the Public Dental Service (PDS) in the Västra Götaland region. The SE-index is based on the percentage of individuals between 18 and 64 years (i) having a native country other than the Scandinavian countries, (ii) receiving social allowance, (iii) being unemployed, and (iv) having a low education level (only compulsory school) in relation to corresponding figures for the total population in the community. The adolescents were socio-economically classified according to the SE-index assigned to the PDS clinic at which they were listed as patients. In accordance with a previous epidemiological study (1), three SE-groups were defined; SE-1 (SE-index <8%), SE-2 (SE-index >8% - <19.5%), SE-3 (SE-index >19.5%), ranging from the most favourable (SE-1) to the least favourable socio-economic index (SE-3). In Skaraborg and Fyrbodol, 56% and 50% respectively, were classified as belonging to SE-1 and 44% and 50%, respectively, to SE-2, while none of the participants was classified as belonging to the SE-3 group. The corresponding distribution in Göteborg was 36% (SE-1), 45% (SE-2) and 19% (SE-3).

Questionnaire

Socio-economic status for individual subjects was represented by ethnicity (born in Scandinavia/ other country), study program at upper secondary le-

vel (theoretical/ vocational/ other), residence (with both parents/ with one parent/ on one's own/ other), mother's and father's education (≤ 9 years/ upper secondary school or post-graduate education). The lifestyle factor included was tobacco habits, i.e. smoking (yes or party-smoking/ no) and snuffing (yes/ no).

The participants considered from whom they had received the best information about how to take care of their teeth (parents/school/peers/media/dental personnel/other). Further, they were asked to rank in descending order their priorities with regard to "how to spend time and money": clothes and leisure time activities/ travelling and holidays/ own apartment or housing / regular dental care/ other. The dental care priority was dichotomized with rankings 1 and 2 as high, else as low. One question addressed the intention to have regular dental check-ups after the age of 20 years, when they will be charged for the care (yes or no). These two variables related to the priority of dental care were used as dependent variables in logistic regression calculations.

From the files at the dental clinics, information about the numbers of missed dental appointments during the two most recent treatment periods was noted (0-1/ ≥ 2).

Data analysis

The SPSS (Statistical Products Service Solutions) version 15.0 was used for the data management and analyses (30).

The clinics comprising the quintile with the highest SE-index, e.g. with the least favourable socio-economic status in each residential area, were classified as the 'poor SE-index group' and used for comparisons in individual scores: in Skaraborg represented by SE-index 8.5-9.5 (4 clinics of 15), in Fyrbodal SE-index 8.9-9.8 (5 clinics of 15) and in Göteborg SE-index 19.5-33.8 (5 clinics of 24). All other clinics were classified as the 'affluent SE-index group'.

Descriptive statistical methods were used to describe socio-economic and questionnaire data. Differences in proportions of individuals with regard to gender, residential area and SE-group, were statistically tested by χ^2 -analysis. Bivariate and multivariate logistic regression analyses were used to explore associations between various subject characteristics and the priority of regular dental care. In bivariate analyses, the independent variables were individual socioeconomic variables and health habits. Associations were expressed as odds ratios (OR) with 95% confidence intervals (CI). Statistical significance was

assumed when $p < 0.05$ or when the 95% confidence interval excluded 1.0.

Results

Out of the 1208 randomly selected subjects, 758 (63%) agreed to participate in the survey. However, the participation rate differed between the areas: Skaraborg 73%, Fyrbodal 70% and Göteborg 51% (rural areas versus urban area $p < 0.001$). Fifty-four % of the respondents (407) were females. Reasons for not participating in the study ($n=450$, 261 males and 189 females) were (i) no time/not interested (34%), (ii) moved from the area (6%), (iii) deceased (one individual), (iv) no contact/unknown (60%). The proportion of males was greater among the non-respondents than the respondents (58% versus 46%, $p=0.025$). Internal dropouts in the questionnaire were low, i.e. 0.2-3.4% of missing answers in separate items and there were no differences between genders in this respect.

The distribution of the participants in the three residential areas with regard to gender and indivi-

© **Table 1.** Participants in the three county areas with regard to gender and socio-economy.

Variable	Skaraborg (rural) n (%)	Fyrbodal (rural) n (%)	Göteborg (urban) n (%)
Gender			
Females	145 (57)	127 (51)	135 (53)
Males	111 (43)	122 (49)	118 (47)
Ethnicity			
Scandinavia	237 (93)	232 (93)	218 (86)
Other countries	19 (7)	17 (7)	35 (14)
Study program			
Theoretical	113 (46)	115 (49)	109 (59)
Vocational	127 (52)	103 (44)	62 (34)
Other	6 (2)	17 (7)	13 (7)
Residence			
Living with both parents	161 (63)	140 (56)	145 (58)
Living with one parent	62 (24)	66 (27)	83 (33)
Living on one's own	17 (7)	27 (11)	16 (6)
Other	16 (6)	15 (6)	8 (3)
Mother's education ≤ 9 years	50 (20)	43 (20)	35 (16)
Father's education ≤ 9 years	83 (35)	54 (27)	36 (17)

Each county area is compared to the other two areas, respectively.

Differences between county areas tested with χ^2 -test.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. All other associations displayed non-significant p-values.

dual socio-economy are shown in Table 1. Ninety-one % of the individuals were born in Scandinavia. The proportion of respondents who were born in other countries differed significantly between the urban area (Göteborg) and the rural areas (Fyrbodalen and Skaraborg) (14% vs 7%; $p=0.003$), and was significantly greater in the poor than in the affluent SE-index group (31% vs 10%, $p<0.001$) in Göteborg but not in Fyrbodalen and Skaraborg.

The vast majority of the participants were still studying. Fewer participants in the rural areas attended a theoretical study program than in the urban area (46-49% vs 59%). As shown in the table, the fathers' educational level was significantly lower in the rural areas, whereas no difference in this matter was seen for the mothers.

The proportion of smokers was higher for females than males; however the difference was not statistically significant (Table 2). Smoking was significantly more common among the participants in Göteborg (31%) compared to Fyrbodalen (16%, $p<0.001$), but not to Skaraborg (24%, $p=0.092$). There was no

significant difference in the prevalence of smokers between poor and affluent SE-index groups. Snuff usage differed between genders (females 7%, males 30%; $p<0.001$), but not between residential areas or SE-groups. Females showed significantly more favourable oral health habits, i.e. more favourable oral hygiene habits and less frequency of missed dental appointments, than males (Table 2). No other differences between residential areas or SE-index groups were found regarding health habits.

The dental service was the most common source for oral health information, and this was stated by 58% of the participants with no gender differences. Another 27% considered that they had obtained the best information from their parents, while the school and media were indicated as the main information source by 6% and 4%, respectively, and peers by 1%. Individuals in Göteborg more often than those in the rural areas indicated the dental service (67% versus 53%; $p=0.002$) and their parents (33% versus 24%; $p=0.036$) as their main source for oral health information. There were no differences between SE-groups.

© Table 2. Health habits according to gender.

Variable	Males N=351 n (%)	Females N=407 n (%)	p
Smoking	65 (20)	99 (27)	0.057
Snuffing	98 (30)	28 (7)	<0.001
Toothbrushing < 2 times a day	115 (33)	67 (17)	<0.001
Floss usage seldom or never	299 (85)	304 (75)	<0.001
Missed dental appointments	41 (17)	25 (9)	0.004

© Table 3. The participants' priorities today and to regular future dental care according to gender.

Variable	Males N=351 n (%)	Females N=407 n (%)	p
Options			
Main priority for spending time and money today			
Clothing / leisure time activities	115 (33)	125 (31)	0.611
Travelling / holidays	28 (8)	65 (16)	0.001
Own apartment / housing	134 (38)	155 (38)	0.943
Regular dental care	23 (7)	24 (6)	0.822
Other	46 (13)	37 (9)	0.954
Planning regular future dental visits			
Yes	203 (59)	276 (70)	0.002

Priorities

Housing, clothes and leisure time were most often the top priorities considering how to spend time and money among both genders, while dental care was rated at a lower level (Table 3). A high ranking of regular dental care (first and second priority) was given by 20% of the males and 22% of the females ($p=0.411$). A majority (63%) of the respondents planned to attend regular dental visits in the future. However, 41% of the males and 30% of the females did not plan such visits ($p=0.002$). No differences between residential areas or SE-index groups were noted with respect to priority of dental care or attitude to future dental visits.

Regression analyses

For the total study group, the bivariate regression analyses showed that the father's education level, smoking, snuffing and toothbrushing habits were statistically significantly associated with the "planning of future regular dental visits" (Table 4). However, no such associations were found for the mother's education. In regression analyses stratified for gender, residential area and SE-index group, respectively, the overall observation was that participants in the urban area (Göteborg) more often did not plan future regular dental visits. For gender and SE-index group, the corresponding associations were less consistent

(Table 4). Individual residence, ethnicity, and missed dental appointments, were not found to have an influence on the planning of future dental visits (bivariate regression analyses).

Including the variables identified as statistically significant in the bivariate analyses (the father's education, smoking, snuffing, toothbrushing habits) and gender, residential area and SE-index, in a multivariate logistic regression model, three statistically significant independent variables for the probability of "not planning future regular dental visits" were identified: male gender (OR 1.54; 95% CI 1.05-2.24), smoking (OR 1.68; 95% CI 1.10-2.56) and toothbrushing <2 times/day (OR 1.94; 95% CI 1.28-2.94). Residential area and SE-index grouping were not identified as significant explanatory factors. With regard to dental care priority as determined by the question "how to spend time and money", none of the explanatory factors (gender, residential area, SE-index grouping, the father's education, the mother's education, smoking, snuffing, toothbrushing, individual residence, ethnicity, and missed dental appointments), was found to be significant.

Discussion

The findings in the present study revealed that females showed more favourable oral health attitudes than males, and that toothbrushing less than twice a day, smoking and male gender were statistically significant factors with regard to "not planning future regular dental visits". The differences between residential areas (rural, urban) and SE-index groups (poor, affluent) were less consistent with regard to the planning of future regular dental visits.

The subject sample was based on a computerized random selection from a wide area, representing both urban and rural contexts. The age of 19 years was selected, as this is the final year of free-of-charge dental care for young individuals in Sweden. The overall participation rate was similar to that in other studies in recent years (16), however it was considerably lower in the urban area Göteborg. This was in concordance with an earlier study with the same target age in this area (1). The reason remained unknown for those who could not be reached, mostly in the urban area where geographic relocation was common. The higher

© **Table 4.** Estimated odds ratios and 95% confidence intervals of five independent variables in bivariate regression analyses for "not planning regular future dental visits" in the total group and in specified sub-groups. Numbers (n) and percentages (%) given for subgroups. Statistically significant associations in bold.

	n (%)	Not planning regular future dental visits OR (95% CI)							
		Total group	Males	Females	Skaraborg (rural)	Fyrbodal (rural)	Göteborg (urban)	Poor SE-index	Affluent SE-index
Mother's education ≤ 9 years	128 (19)	1.46 (0.98-2.18)	1.70 (0.95-3.04)	1.24 (0.71-2.19)	1.17 (0.61-2.21)	1.53 (0.76-3.10)	1.82 (0.86-3.86)	0.99 (0.38-2.53)	1.60 (1.03-2.49)
Father's education ≤ 9 years	173 (27)	1.56 (1.08-2.24)	2.28 (1.32-3.91)	1.15 (0.70-1.91)	1.19 (0.68-2.06)	1.25 (0.65-2.43)	2.85 (1.36-6.01)	0.95 (0.41-2.18)	1.75 (1.17-2.63)
Smoking (yes)	164 (24)	1.59 (1.11-2.30)	1.70 (0.98-2.96)	1.66 (1.01-2.74)	1.88 (0.95-3.73)	0.81 (0.38-1.74)	2.21 (1.26-3.88)	2.36 (1.03-5.44)	1.45 (0.97-2.18)
Snuffing (yes)	126 (18)	1.69 (1.13-2.51)	1.46 (0.90-2.37)	1.30 (0.56-3.02)	1.45 (0.71-2.94)	1.25 (0.60-2.57)	2.43 (1.26-4.68)	2.28 (0.90-5.80)	1.58 (1.02-2.45)
Tooth brushing <2 times a day	182 (24)	2.17 (1.54-3.06)	2.47 (1.56-3.92)	1.51 (0.87-2.63)	2.02 (1.13-3.60)	1.79 (0.97-3.29)	2.83 (1.55-5.16)	2.57 (1.21-5.49)	2.09 (1.42-3.07)

proportion of males among the non-participants than among the participants corresponds with the earlier study in this urban area (1). Also, young males have been shown to have less favourable oral health behaviours than females, which was confirmed in our study (14, 15, 28, 34). Social and individual expectations for males and females are different and also recognized as an important factor for health (10).

Young people judged dental problems to be of low importance (3). *Crossner & Unell* found in the middle 1990s that most 25-year-olds (9 of 10) visited the dental care (6). However, later studies in Sweden showed lower prevalence in young adults, with every third man and every fifth women not visiting the dentist in the last two years (7). Irregular dental care habits have been shown to be connected with poor oral health and may thus be seen as a risk for future oral health problems (27). Regular dental care had low priority among the majority of the respondents in the present study. They were in late adolescence, a period marked by a more matured ability to think than in earlier ages, but they might still have had a short perspective in these issues (32). Also, as most young people in Sweden have low caries experience today (24), the participants could have experienced less motivation for regular dental care. Periodontal diseases are mostly developed over a long time and hence possibly not a risk considered by a young person.

The range in SES grouping for different clinics in the two rural areas was narrow, while it was wide in the urban Göteborg. Still, there were no differences in the participants' dental care priorities between residential areas or SE-groups. However, on the individual level, socio-economic aspects were of significance. Hence, the father's educational level, but not the mothers', was significantly associated with the priority of future dental visits in the study. Recent studies showed that the educational level of both parents was important for the oral health in adolescents (17, 19, 20). The role of the mother has often been emphasized as being a "health provider" (9), however, our findings indicate that her educational level is less important for adolescents' dental priorities.

Two health risk behaviours appeared to be of significance for not planning future dental visits: toothbrushing less than twice a day and smoking. Almost one fourth of the respondents brushed their teeth less than twice a day, which in other studies has been shown to be a predictor of the development of dental caries (2, 18). Smoking is a major health

problem and well-known to cause a great number of diseases (8, 25). The association between smoking and oral diseases is well documented (22, 33). However, young people might have difficulties to imagine the consequences of risky behaviours in the future (5). The stratified analyses also indicated that urban adolescents with health risk factors (for instance smoking and snuffing habits) might not plan for future regular dental care. These findings are of great importance for health promotion and prevention work among young people (13).

To summarize, toothbrushing less than twice a day, smoking and male gender were statistically significant factors for not planning regular future dental visits. The findings emphasize the need for promotion of favourable oral health habits and for smoking prevention among adolescents. There is also a need for dental personnel to recognize differences with regard to oral health-related attitudes and behaviours between males and females.

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Self-perceived orthodontic treatment need and prevalence of malocclusion in 18- and 19-year-olds in Sweden with different geographic origin

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Abstract

© Orthodontic treatment need and demand in 19-year-olds in Sweden has not previously been analysed in relation to geographic origin. The aim of this follow-up study was to examine the prevalence of self-perceived treatment need, malocclusion, earlier orthodontic treatment, self-perceived dental aesthetics and prevalence of symptoms indicative of temporomandibular disorders in 18-19 year-olds and to analyze any differences between native born and immigrants. Body esteem and psychological wellbeing were also evaluated.

The subjects, n=316, were grouped according to family origin: Group A: both parents born in Sweden (98 girls, 80 boys); Group B: the subject or at least one parent born in Eastern /South Eastern Europe (24 girls, 26 boys) and Group C: Asia (44 girls, 44 boys). Twohundred and sixty-eight participants presented for clinical examination and answered the full questionnaire, and 48 who rejected clinical examination, were interviewed by telephone using selected questions from a questionnaire. The results show that adolescents of Asian origin had a higher self-perceived treatment need than adolescents of Swedish origin. There were negligible inter-group differences with respect to frequency of malocclusion. Forty-four per cent of all participants had previously undergone orthodontic treatment, significantly more Swedish than Asian subjects. Dissatisfaction with dental aesthetics was attributed primarily to tooth colour (38 per cent) and irregular anterior teeth (34 per cent). Adolescents of Asian origin had a higher frequency of headache than those of Eastern/South Eastern European origin. Compared to boys, girls had a higher self-perceived treatment need, a higher frequency of headache and TMD and were more concerned about body appearance. Psychological wellbeing was reduced in nearly one quarter of the participants, predominantly girls: girls of Asian origin had the highest frequency. No association was found between self-perceived orthodontic treatment need and psychological wellbeing.

Key words

Orthodontics, treatment need, malocclusion, immigrants

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Självupplevt ortodontiskt behandlingsbehov och förekomst av malockklusion hos 18- och 19-åringar i Sverige med olika geografiskt ursprung

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Sammanfattning

⊙ Ortodontiskt behandlingsbehov och efterfrågan på vård bland 19-åringar i Sverige i relation till ursprunglig geografisk bakgrund, har ej tidigare studerats. Syftet med den här uppföljande studien var att undersöka förekomst av självupplevt behandlingsbehov, malockklusion, tidigare erfarenhet av ortodontisk behandling, uppfattning om egna tändernas utseende, och förekomst av funktionsrelaterade symtom i käksystemet hos 18-19-åringar och att analysera eventuella skillnader relaterade till ursprunglig geografisk bakgrund. Dessutom studerades kroppsuppfattning och psykologiskt välbefinnande. Ungdomarna, n= 316, indelades i tre grupper efter familjens geografiska ursprung: Grupp (A): Båda föräldrarna födda i Sverige (98 flickor, 80 pojkar); Grupp B: person född i, eller med minst en förälder född i Östra /Sydöstra Europa (24 flickor, 26 pojkar) och Grupp C: Asien (44 flickor, 44 pojkar). 268 deltagare genomgick en klinisk undersökning och besvarade hela frågeformuläret, och fyrtioåtta som avböjde klinisk undersökning, intervjuades per telefon varvid delar av ett frågeformulär användes. Resultaten visade att ungdomar med asiatiskt ursprung hade ett högre självupplevt behandlingsbehov jämfört med ungdomar med svenskt ursprung. Endast obetydliga skillnader förelåg mellan de tre grupperna när det gällde förekomst av bettavvikelser. Fyrtiofyra procent av alla ungdomar hade tidigare genomgått ortodontisk behandling, signifikant fler svenska ungdomar än asiatiska ungdomar. Tändernas färg (38%) och ojämna framtänder (34%) var de särdrag gällande tändernas estetik som orsakade mest bekymmer. Ungdomar med asiatiskt ursprung uppvisade en högre frekvens av huvudvärk jämfört med ungdomarna med ursprung från Östra /Sydöstra Europa. Flickorna hade ett högre självupplevt behandlingsbehov, högre frekvens av huvudvärk och TMD och var mer bekymrade över kroppsutseendet jämfört med pojkarna. Nästan en fjärdedel av individerna, fler flickor än pojkar, hade ett lägre psykologiskt välbefinnande. Högsta frekvensen fanns bland flickor med asiatiskt ursprung. Något samband mellan självupplevt ortodontiskt behandlingsbehov och psykologiskt välbefinnande förelåg ej.

Introduction

The publicly funded dental services in Sweden include orthodontic treatment of objectively assessed treatment need, which is free of charge up to 20 years of age. Ideally only minor orthodontic anomalies should remain untreated at this age. An earlier study of orthodontic care in three different Swedish counties showed that by 20 years of age, 28 to 42 per cent had undergone orthodontic treatment (2). Residual orthodontic treatment need and demand when these young adults leave the Public Dental Service have also been investigated: 22 per cent had a definite orthodontic treatment need (12) and 7 per cent had a residual subjective treatment need (13).

During the past decades, Sweden has experienced a great influx of immigrants. From 2000 to 2008, the proportion of children and adolescents (0-17 years of age) of non-Swedish origin increased from 24 to 28 per cent (22). In earlier Swedish studies of the impacts of cultural origin on orthodontic treatment need and demand among 12 and 13-year-olds, Swedish girls had the highest treatment demand; adolescents of Swedish origin also had a slightly higher frequency of malocclusion than those of immigrant background (7, 8).

There are no previous Swedish studies of residual orthodontic treatment need and demand in 19-year-olds in which geographic origin (immigrant/non-immigrant background) is taken into account.

Therefore, the aim of this follow-up study was primarily to determine self-perceived treatment need and the prevalence of malocclusion in 18-19 year-olds and to analyze any differences between native born and immigrants. A secondary aim was to document earlier orthodontic treatment, present interest in treatment, the subjects' satisfaction with their dental appearance and the prevalence of some signs and symptoms of temporomandibular disorders. Body esteem and psychological wellbeing were also evaluated.

Subjects and methods

The subjects comprised students born in 1988 and 1989 who had previously attended one of six schools in two towns in the south of Sweden and had been recruited for a study six years earlier (7, 8). The subjects were recruited from areas with higher proportions of immigrants than the average for Sweden. In 2001, the initial study sample had comprised 553 subjects: 71 had left the district or had changed their surname since the earlier study in 2001. The

remaining 482 were invited to attend the orthodontic department for a follow-up examination and to answer a questionnaire: 296 accepted. Of those who did not accept, 53 were interviewed by telephone. Five individuals currently undergoing fixed appliance therapy were excluded. Thus the final study sample comprised 344 subjects, 52 per cent girls (n=180) and 48 per cent boys (n=164), grouped according to the family's geographic origin:

Group A: both parents born in Sweden n=178 (98 girls, 80 boys). One subject was adopted and the father of another was born in Denmark

Group B: subject or at least one parent born in Eastern /South Eastern Europe (Albania, Bosnia-Herzegovina, Kosovo, Croatia, Hungary, Former Yugoslav Republic of Macedonia, Poland, Romania, Serbia) n=50 (24 girls, 26 boys), 90 per cent from former Yugoslavia

Group C: subject or at least one parent born in Asia (Cambodia, China, Lebanon, India, Iran, Iraq, Pakistan, Syria, Turkey, Vietnam) n= 88 (44 girls, 44 boys), 82 per cent from The Middle East

Group D: subject or at least one parent born in other countries (Africa, America, Western Europe outside Scandinavia) n=28 (16 girls, 12 boys).

The characteristics of the dropouts were analysed. Fifty-three of those who did not accept the offer of examination were contacted by telephone, and asked selected questions from the questionnaire (questions 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14). Question 10 "Do you think you need a brace today?" was selected as a particularly important item. Comparison of positive responses to this question in the examined group and the group contacted by telephone showed no significant differences and these two groups were merged with respect to responses to these questions.

It was not possible to analyse the number of dropouts in the different groups (A-D) in relation to the original study base, but comparison with the 2001 study showed the following attrition rates: Group A, 32 per cent; Group B, 22 per cent; Group C, 25 per cent and Group D, 42 per cent. There were no significant inter-group differences with respect to attrition.

Analysis of the group "Other countries" (Group D) and the other groups (A, B and C) disclosed no differences in the questionnaire answers or in the clinical examination. Because of its heterogeneity, this group was excluded from the study. Finally, 316 students were enrolled: 48 were interviewed by telephone as described above and 268 presented for

clinical examination and completed the entire questionnaire.

Clinical examination

The clinical examination was conducted in an orthodontic department, using a mouth mirror, a ruler and sliding calliper. The examination comprised interiorly inspection of the teeth and occlusion and palpation of the temporomandibular joint and muscles. The following variables were recorded:

Occlusion

- Sagittal occlusion - inter-maxillary relationship of first permanent molars and canines to the nearest half cusp width. An overriding assessment of the sagittal occlusion was made for each subject and was then classified to one of three groups.
 - 1= Class I occlusion
 - 2=Class II occlusion
 - 3= Class III occlusion.
- Anterior crossbite – of 1 to 4 teeth. When the incisal edge of maxillary incisors occluded lingual to the incisal edge of the corresponding mandibular teeth.
- Posterior crossbite - registered when the buccal cusps of the maxillary premolars and/or molars occluded lingually to the buccal cusps of the mandibular antagonists.
 - I - one or two pairs of teeth, uni- or bilateral
 - II - at least three pairs of teeth, uni- or bilateral
- A scissor bite - registered when any of the maxillary premolars or molars occluded completely to the buccal surface of the mandibular antagonist teeth.
 - I - one or two pairs of teeth, uni- or bilateral
 - II - at least three pairs of teeth, uni- or bilateral
- Deep bite with gingival contact – registered if present palatal to the maxillary incisors or buccal to the mandibular incisors.
- Overjet - the distance from the most labial point of the incisal edge of the maxillary incisors to the most labial surface of the corresponding mandibular incisor. Measured to the nearest half millimetre, parallel to the occlusal plane.
- Overbite - measured vertically from the incisal edge of the most inferior maxillary incisor to the incisal edge of the corresponding mandibular incisor. Measured to the nearest half millimetre.

Anterior available space and contact point displacement

- Available space in the anterior segment - measured with a sliding calliper, the relative space from the mesial surface of the right canine to the mesial surface of the left canine, to the nearest half millimetre. These measurements were made in both arches.
- Contact point displacement in the anterior segment - measured between the normal anatomical contact points in a buccolingual direction from the mesial surface of the right canine to the mesial surface of the left canine, to the nearest millimetre. The highest value for each jaw was registered.

For these above variables, the genders were pooled

for analysis, as no sex differences have been disclosed in other studies of occlusal traits (6).

Temporomandibular signs

- Temporomandibular joint (TMJ) pain on palpation, giving rise to palpebral reflex
- Muscle tenderness in M Masseter (origin) and M Temporalis (abutment), pain giving rise to palpebral reflex.

Tooth wear

- Tooth wear was evaluated on the most worn canine or incisor in the maxilla (13-23) and the mandible (33-43) according to a 5-point scale: 1 = no or slight wear; 2 = wear of enamel only; 3 = wear into the dentin, "single spots"; 4 = dentin exposed >2 mm; 5 = wear > 1/3 of the crown (5).

Clinical examination reliability

The reliability of the clinical examination of occlusion was tested in an earlier study published in 2005 (7). Variables with good and very good reliability (values 0.61–1.0) were retained for inclusion in this study. The examiner (EJ) was calibrated with an experienced specialist in stomatognathic physiology with respect to muscle and TMJ palpation and tooth wear.

Questionnaire study

The questionnaire comprised seven domains: 1 Demographic data, 2 Experience of orthodontic treatment, 3 Self-perceived treatment need, attitude to orthodontic treatment (21), 4 Satisfaction with dental appearance (21), 5 Temporomandibular symptoms, 6 Body esteem and general appearance (20), 7 Psychological wellbeing (16). The responses were designed as a mix of visual analogue scales (VAS), multiple choice, five point ordinal scales and fixed statements. (See Appendix page 106)

Psychological wellbeing

Questions 15 to 26 constituted the domain "Psychological wellbeing". These questions are used by the Swedish National Institute of Public Health (general health questionnaire 12) and have been validated and described by McDowell & Newell (16). The aim is to indicate psychological wellbeing and rate psychological reactions to stress rather than psychological ill-health. The instrument focuses on disruption to normal function. The measure of wellbeing is calculated by a summary index of the twelve questions. The first two choices of response to each question are given a score of zero, and the third and fourth choices are given a score of 1. The summary variable ranges between 0 and 12. A dichotomous variable

is constructed. If the summary is lower than 3, the index value is 0. If the summary is 3 or more, the index value is 1. Subjects with an index value of 1 are denoted as having reduced psychological wellbeing.

Questionnaire reliability

Thirteen subjects answered the questionnaire a second time, after an interval of four weeks. The association between the first and second rounds of responses was calculated by Spearman's ranking correlation test. Questions and answers with a correlation of 0.6 to 1.0 were included in the study. Question 9, with moderate reliability, was also included.

Statistical methods

The non-parametric methods chi-square and Kruskal-Wallis test were used to test for significant intergroup differences. The Kruskal-Wallis test was used to compare the median value on VAS scales for the three groups. When applicable, the parametric method analysis of variance was used. Significance was set at $p < 0.05$.

Results

Questionnaire validity

"Do you think that the questions you have answered allow you to express your perception of your teeth?" This question was constructed as a VAS and the result shows an overall mean value of 76.3 and a median value of 80. The median value was 83 for girls and 77 for boys, $p = 0.050$ for differences between sexes.

"Do you think the questions you have answered allow you to express your perception of your general appearance"? This question was constructed as a VAS and the result shows an overall mean value of 78.3 and a median value of 80. There was a significant difference between the sexes: the median was 84 for girls and 77 for boys ($p = 0.021$).

Frequency of malocclusion

The mean values for overjet, overbite, anterior available space in the maxilla and the mandible and the highest value for contact point displacement are shown in Table 1. The mean overjet ranged from 3.0 to 3.6 millimetres, with no significant intergroup differences. The mean overbite ranged from 2.8 to 3.3 mm and the mean anterior available space was -1.4 to 0.1 millimetres. The differences in contact point displacements were also minor (Table 1).

With respect to distribution of Class II and Class III malocclusions, there were significant differences between subjects of Swedish and Asian origin: 21.6

per cent, 32.3 per cent ($p = 0.042$) and 3.7 per cent and 10.8 per cent respectively ($p = 0.016$). No significant differences were disclosed for the variables deep bite with gingival contact, posterior crossbite and anterior crossbite (Table 2).

© **Table 1.** Mean value (mm) and standard deviation (SD) of overjet, overbite, available space and the highest value for contact point displacement in the anterior part of the maxilla and the mandible.

Variables	Groups						P
	A (n=162)		B (n=41)		C (n=65)		
	Mean	SD	Mean	SD	Mean	SD	
Overjet	3.6	1.7	3.0	2.0	3.2	1.7	n.s
Overbite	2.8	1.8	3.3	1.6	2.9	1.9	n.s
Anterior available space							
Maxilla	-0.1	1.0	0.1	1.7	-0.1	1.8	n.s
Mandible	-1.4	2.1	-0.5	2.3	-0.1	1.8	n.s
Contact point displacement							
Maxilla	1.9	1.4	1.7	1.3	2.1	1.1	n.s
Mandible	1.9	1.4	1.8	1.6	2.0	1.0	n.s

A – Sweden, B – Eastern/South Eastern Europe, C – Asia
n.s non significant

© **Table 2.** Distribution of subjects with respect to sagittal, transverse and vertical relationship

Variables	Groups						P
	A		B		C		
	n	(%)	n	(%)	n	(%)	
Class I occlusion (186)	121	(74.7)	28	(68.3)	37	(56.9)	n.s
Class II occlusion (67)	35	(21.6)	11	(26.8)	21	(32.3)	A#C*
Class III occlusion (15)	6	(3.7)	2	(4.9)	7	(10.8)	A#C*
Anterior crossbite							
I - Posterior crossbite -	14	(8.6)	2	(4.9)	7	(10.8)	n.s
One or two pairs of teeth	23	(14.2)	4	(9.8)	12	(18.5)	n.s
uni- or bilateral							
II - Posterior crossbite -	5	(3.1)	2	(4.9)	3	(4.6)	n.s
At least three pairs of							
teeth uni- or bilateral							
Deep bite with gingival							
contact	15	(9.3)	7	(17.1)	8	(12.3)	n.s

A - Sweden, B – Eastern/South Eastern Europe, C – Asia
n.s non significant, * $p < 0.05$

Orthodontic treatment

Of all subjects, 44.4 per cent had undergone orthodontic treatment with removable or fixed appliances or orthodontic extraction: 50.6 per cent of Group A, 38.0 per cent of Group B and 35.6 per cent of Group C. The difference between groups A and C was significant ($p=0.047$). The distribution between sexes, 48.8 per cent in girls and 39.5 per cent in boys, showed no significant difference.

Of the subjects who had not previously received treatment with fixed appliances, 37.9 per cent of the girls and 24.1 per cent of the boys would have accepted treatment today if it had been offered: 23.2 per cent in Group A, 35.7 per cent in Group B and 46.5 per cent in Group C. The difference between groups A and C was significant ($p=0.022$).

Dental aesthetics

Eighteen per cent (17.9%) of all students thought that the appearance of their teeth was worse or much worse than that of their peers: 19.3 per cent in Group A, 14.3 per cent in Group B and 17.0 per cent in Group C. There were no significant differences among the groups or between girls and boys.

Dissatisfaction with tooth colour, irregular teeth, increased overjet and spaced teeth is shown in Fig 1. In response to the question "Are you dissatisfied with the colour of your anterior teeth?" 38.5 per cent answered "Yes": 45 per cent of the girls and 32 per cent of the boys. The difference was significant ($p=0.020$). However, there were no significant intergroup differences.

Thirty-four per cent (34.4%) were dissatisfied with their irregular teeth, 25.0 per cent with their large overjet and 18.1 per cent with their spaced teeth. There were no significant differences between the sexes or among groups A, B and C in the responses to any of these questions.

More boys of Eastern/South Eastern European origin believed that straightened teeth would improve career prospects: median value 50, compared to 22 for the Swedish boys and 45 for the boys of Asian origin. The difference between boys of Swedish and Eastern/South Eastern European origin was significant ($p=0.030$). No difference was found between girls and boys.

Sixty-three per cent ($n=200$) of the subjects considered their teeth to be important or very important for self-esteem. The difference between girls and boys (72.5 and 53.0 per cent respectively) was significant ($p=0.002$). However, there were no significant intergroup differences (Table 3).

Self-perceived treatment need

To the question "Do you think that you need braces now?" 11.8 per cent ($n=37$) answered "yes" and 12.8 per cent were uncertain. The self-perceived need for treatment was 7.9 per cent in group A, 10.0 per cent in group B and 20.5 per cent in group C, with a significant difference between groups A and C ($p=0.016$). Self-perceived need for treatment was higher in girls than in boys: 15.1 and 8.2 per cent respectively ($p=0.050$) (Table 4).

Temporomandibular symptoms

Twenty-five per cent of all students, 32.5 per cent of the girls and 14.2 per cent of the boys, suffered from headache at least once a week ($p=0.000$) (Table 5) and 5.1 per cent suffered from facial pain at least once a week. Fully opening the mouth was difficult for 9.2 per cent and painful for 5.1 per cent. There were no differences between boys and girls with respect to facial pain or difficulty or pain associated with opening wide.

Table 3. Distribution of positive responses to the question "Are your teeth appearance important for your self esteem?", in relation to origin group and gender

Groups	Girls		Boys		P
	n	(%)	n	(%)	
A	67	(67.7)	36	(45.6)	*
B	21	(87.5)	19	(73.1)	n.s
C	33	(75.0)	24	(54.6)	n.s
A+B+C	121	(72.5)	79	(53.0)	**

A – Sweden B – Eastern/South Eastern Europe C – Asia
n.s no significance * $p<0.05$ ** $p<0.01$

Table 4. Distribution of positive responses to the question "Do you think that you need braces now?", related to origin group and gender

Variables	Groups						P	
	A		B		C			A+B+C
	n	(%)	n	(%)	n	(%)		
Girls	11	(11.2)	3	(12.5)	11	(25.0)	n.s	25 (15.1)
Boys	3	(3.9)	2	(7.7)	7	(15.9)	n.s	12 (8.2)
P	n.s		n.s		n.s		*	
Girls+Boys	14	(7.9)	5	(10.0)	18	(20.5)	A#C*	

A – Sweden B – Eastern/South Eastern Europe C – Asia
n.s non significant * $p<0.05$

In relation to geographic origin, 23.0 per cent of the Swedish group suffered from headache at least once a week, compared to 12.0 per cent in Group B and 31.8 per cent in Group C. The difference between groups B and C was significant ($p=0.027$). The highest frequency of headache was noted in the Asian girls, 45.4 per cent, compared to 30.6 per cent in the Swedish girls and 16.7 per cent in the Eastern /South Eastern European girls. The difference between groups B and C was significant ($p=0.019$) (Table 5).

Temporomandibular signs

Tenderness to palpation in the temporomandibular joint (TMJ) was recorded in all groups: Group A, 14.2 per cent, Group B, 9.8 per cent and Group C 18.5 per cent. The intergroup differences were not significant. TMJ problems were significantly more frequent in girls than in boys: 22.1 per cent and 5.7 per cent respectively ($p=0.000$). Tenderness to palpation in the masseter or temporalis muscles was noted in 42.8 percent of girls and 30.9 per cent of boys, $p=0.035$. There were no significant intergroup differences (A: 35.8 per cent, B: 36.6 per cent, C: 42.2 per cent) (Table 6).

© **Table 5.** Distribution of positive response to the question "Do you suffer from headache at least once a week?", in relation to origin group and gender.

Variables	Groups						P	
	A		B		C			A+B+C
	n	(%)	n	(%)	n	(%)		
Girls	30	(30.6)	4	(16.7)	20	(45.4)	B#C* 54 (32.5)	
Boys	11	(13.9)	2	(7.7)	8	(18.6)	n.s 21 (14.2)	
P	**		n.s		**		***	
Girls+Boys	B#C *							

A - Sweden, B - Eastern/South Eastern Europe, C - Asia
 n.s - non significant, * - $p<0.05$, ** - $p<0.01$, *** - <0.001

The distribution of tooth wear into the dentin in the maxillary and mandibular incisors and canines varied between 53.7 and 75.6 per cent among the three groups. There were no significant intergroup differences, nor between girls and boys.

Body esteem

Weight and waistline measurement were the physical features perceived by the subjects as least satisfactory. Satisfaction with overall facial features compared to overall physical appearance was higher: 80.0 per cent were satisfied or very satisfied with their facial appearance, while only 68.7 per cent expressed satisfaction with their overall physical appearance.

With respect to satisfaction with the appearance of hair, ears, eyes, nose, cheeks, lips and mouth, there were no intergroup differences or between the sexes.

Girls were significantly more dissatisfied with their height than boys, 14.5 per cent compared to 4.1 per cent ($p=0.003$). Comparing boys according to origin disclosed significantly greater dissatisfaction among those of Asian origin (12.5 per cent) than those of Eastern/South Eastern European (0.0 per cent) and Swedish origin (1.4 per cent), $p=0.015$. More girls than boys were dissatisfied with their weight: 30.8 and 13.1 per cent respectively, $p<0.000$.

With respect to waistline measurement, dissatisfaction was significantly greater among girls than boys in the Swedish group, (28.0 and 10.0 per cent respectively) $p=0.004$. No sex differences were noted in groups B and C and there were no intergroup differences.

Compared to the boys, the girls were more dissatisfied with their chin (11.6 and 2.5 per cent respectively), $p=0.040$. There were no intergroup differences.

In response to the question concerning the general facial appearance, 7.4 per cent of the Swedish subjects were dissatisfied, compared with 0.0 and 1.6

© **Table 6.** Clinical signs of TMD in relation to origin group and gender.

Variables	Groups						P	P				
	A		B		C			Girls		Boys		
	n	%	n	%	n	%		n	%	n	%	
Tenderness to palpation												
TMJ	23	(14.2)	4	(9.8)	12	(18.5)	n.s	32	(22.1)	7	(5.7)	***
M Masseter or M Temporalis	58	(35.8)	15	(36.6)	27	(42.2)	n.s	62	(42.8)	38	(30.9)	*

A - Sweden, B - Eastern/South Eastern Europe, C- Asia
 n.s non significant, * $p<0.05$, *** $p<0.001$

per cent respectively among those of Eastern/South Eastern European and Asian origin ($p=0.05$). There was no difference between the sexes. With respect to overall physical appearance, the Swedish girls (16.1 per cent) were significantly more dissatisfied than the Swedish boys (2.9 per cent), $p=0.004$. There were no significant sex differences in group B and C, but the overall sex difference (girls 15.8 and boys 5.7 per cent) was significant, $p=0.004$.

In response to the question about the importance to self-esteem of general physical appearance, 85.0 per cent of the girls and 77.1 per cent of the boys considered it to be important or very important. The difference between girls and boys was not significant, nor were the intergroup differences significant.

Comparing their appearance to that of their peers, 10.2 per cent of the girls and 8.7 per cent of the boys thought that their appearance was worse or much worse. The group distribution was 11.9 per cent in Group A, 8.0 per cent in Group B and 5.7 per cent in Group C. It was found that the Swedish subjects, Group A, were significantly more dissatisfied with their appearance than the subjects of Asian origin, Group C ($p=0.010$).

Psychological wellbeing

The overall result showed reduced psychological wellbeing in 23.2 per cent of the sample: 29.0 per cent of girls and 16.4 per cent of boys ($p=0.019$). There was also a significant sex difference in group C, subjects of Asian origin: girls 37.5 per cent and boys 15.6 per cent ($p=0.047$). No sex differences were recorded in groups A and B, and no differences among the groups A-C.

There was no significant association between reduced psychological wellbeing and a positive response to the question about self-perceived current orthodontic treatment need.

Discussion

Although there are some Swedish studies of orthodontic treatment need and demand in 19-year-olds (10, 12), the potential influence of geographic background on attitudes to orthodontic treatment has not been investigated. Because of the increasing proportion of immigrants in the Swedish population, over a quarter of children attending Swedish schools are now of immigrant background. In tailoring future orthodontic resources to meet predicted treatment need and uptake, it is therefore important to take into account the potential impact of origin-related differences in attitudes to orthodontic treat-

ment. The main purpose was to compare adolescents with Swedish and immigrant background, but we also wanted to estimate, roughly, the distribution between different origin groups.

A weakness in the present study was the sample size. It is difficult to motivate participation in a study by young adults aged 18-19 years. At this age, travelling is very popular, and some of the subjects had left the district or were away travelling or temporarily working abroad. It is difficult to ascertain whether - compared to non-participants - the participants were motivated by greater concern about their teeth, or if they were more dissatisfied with their teeth and anticipated that this examination might lead to treatment. As the comparison between the telephone interviews and the group which underwent examination disclosed no difference in self-perceived treatment need, it was assumed that the non-participants did not differ from the study group. A similar rate of attrition has been reported in a comparable investigation (3).

The major findings were greater self-perceived treatment need in Group C than in Group A and also in girls compared to boys, but only minor intergroup differences with respect to frequency of persisting malocclusion. Compared to subjects of immigrant background, the Swedish subjects had a higher frequency of previous orthodontic treatment, probably because at 12-13 years of age the Swedish subjects had a higher mean value for overjet and a lower mean value for anterior available space (8). Over time, the adolescents in the different groups have been treated and some malocclusions have been self-corrected. Therefore, on group level, the frequency of malocclusion in the three groups has evened out. The distribution of orthodontic treatment in this study is comparable to that of a German study of 11 to 13-year-olds, in which a lower proportion of immigrant than non-immigrant children received orthodontic treatment (4). This was attributed to lower dental awareness among immigrant parents, less attention given to these children by the dentist or communication/language problems. In contrast, Mandall *et al.* (15) found no difference in uptake of orthodontic services between Asian and Caucasian 14-15-year-old children in an English city. The fact that we still have high frequencies of some occlusal traits shows that not all of these malocclusions are assessed to treatment need.

Figure 1 shows the distribution of dissatisfaction with various dental features. The greatest dissatisfaction was with tooth colour but irregular anterior

teeth also caused dissatisfaction. These findings are in agreement with those of other reports (9, 23, 25, 27).

Earlier studies have shown that in adolescents, dental appearance is important for quality of life (18, 26). In the present study the perception was that satisfactory dental appearance is important for self esteem.

Self-perceived treatment need in the present study was 11.8 per cent, somewhat higher than the 7 per cent reported in a comparable study of Swedish 19-year-olds (13), and in another Swedish study by Prytz Berset et al. (19), where residual treatment concern in orthodontically treated 19-year-olds was 9 percent. The frequency of self-perceived treatment need was twice as high in subjects of Asian origin as in those of Swedish and Eastern/South Eastern European origin. However, this result was not confirmed by the frequency of aesthetically disturbing malocclusion, which was similar in the three groups.

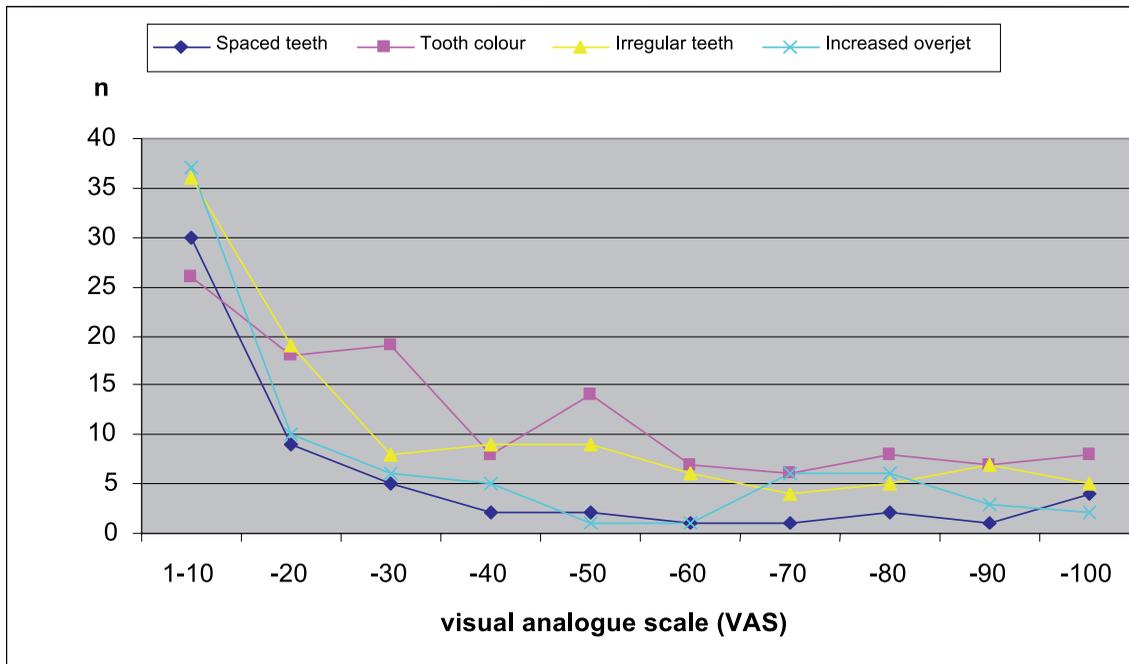
The frequency of self-perceived current treatment need was lowest among the Swedish subjects and highest in girls of Asian origin. In the earlier study of the same subjects at 12-13 years of age, the Swedish girls and the boys of Asian origin had the highest orthodontic treatment demand. Thus in the

ensuing six years of follow-up, the girls of Asian origin have become increasingly dissatisfied with their teeth. In contrast, Mandall et al. (15) found no differences between Asian and Caucasian adolescents or between girls and boys with respect to self-perceived treatment need, but a higher normative need in the Asian students and in girls.

The subjects perceived their overall physical appearance to be of greater concern than general facial appearance. As has been shown in other studies (17), height, weight and waistline measurement were of greatest concern. In the present study, more girls than boys were dissatisfied with their overall appearance. It is unclear why more Swedish than Asian subjects have a comparatively poor perception of their appearance. In a qualitative study of Scandinavian high-school students, almost all the girls claimed to be dissatisfied with their bodies and it was concluded that girls' "bad body talk" was both a form of social critique and a way of defining and materializing feminine gender (1).

There are no previous studies of temporomandibular symptoms and disorders in immigrant adolescents in Sweden. The highest frequencies of headache and TMD were found in subjects of Asian background, greater in girls than in boys. The rea-

© Fig 1. Distribution of ratings for those reporting dissatisfaction with spaced teeth, tooth colour, irregular teeth and increased overjet on a VAS, from 1="Disappointed" to 100="Much disappointed". The registrations have been allocated within deciles (1-10, 11-20....).



son is unclear. The frequency of headache in Swedish adolescents and also the sex difference for both headache and TMD correspond with the results of another Swedish study (14). *Lambourne et al.* (11) reported an association between posterior crossbite, deep bite and an increased risk of headache in children and adolescents. However, in the present study, no significant inter-group differences emerged with respect to these occlusal characteristics. In adolescents with TMD, stress, somatic complaints and emotional problems play an important role (28).

The results in the present study have increased the level of knowledge about immigrants in Sweden, which has not been presented earlier. This is an important information for future planning of orthodontic resources. Girls of Asian origin had a higher frequency of self-perceived orthodontic treatment need and headache, and poorer psychological wellbeing than the Swedish and East/South East European subjects. The self-perceived orthodontic treatment need could not be clinically verified. The results are in accordance with other reports showing reduced psychological wellbeing in young women (16-24 years of age) in Sweden and higher risk in those of immigrant background (24). There is no ready explanation for the relatively greater dissatisfaction among girls of Asian origin than among other girls of immigrant background. It is assumed that all have had similar experiences as immigrants or the children of immigrants. More indepth investigation will be necessary to gain an insight into the underlying factors.

Conclusions

From the results in this study it was concluded that:

- Frequency of malocclusion was similar in the three groups of different geographic origin
- Young adults of Asian origin had a higher self-perceived orthodontic treatment need than their Swedish counterparts and a higher frequency of headache than those of Eastern/South Eastern European origin
- Girls had a higher self-perceived orthodontic treatment need and a higher frequency of headache and TMD problems than boys.
- Perceived general physical appearance was of greater concern than perceived facial appearance. Girls were more concerned than boys.
- Psychological wellbeing was reduced in nearly one quarter of the sample, more frequently in girls than boys. The highest frequency was found in girls of Asian origin.

- No association was found between self-perceived orthodontic treatment need and psychological wellbeing.

Acknowledgements

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Self-perceived oral health among 65 and 75 years old in two Swedish counties

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Abstract

© The aim of this study was to investigate self-perceived oral health in two elderly populations, age's 65 and 75 years, and its relation to background factors, socio-economic, individual, and dental health service system factors. Another purpose was to investigate if there were any differences in these respects, between the two age groups, born in 1932 or 1942.

In two counties in Sweden, Örebro and Östergötland, all persons born in 1942 have been surveyed by mail every fifth year since 1992. In the year 2007 all persons born in 1932 were also surveyed using the same questionnaire. Those born in 1932 consisted of 3735 persons and those born in 1942 6078 persons. From an outline of a general model of inequalities in oral health data were analyzed with descriptive statistics and contingency tables with χ^2 analysis. Multivariable analysis was performed by using multiple regression analysis.

Factors related to self-perceived oral health were age group, social network, ethnicity, education, general health, tobacco habits, oral hygiene routines, dental visit habits and cost for care.

The self-perceived oral health was overall rather high, especially in view of the studied ages, although it was worse for those of age 75. Socio-economic factors, dental health service system as well as individual lifestyle factors affected self-perceived oral health. To have a satisfying dental appearance, in the aspect of how you are judged by other people, was important for these age groups. This presents a challenge for dental health planners especially since the proportion of older age groups are growing.

Key words

Questionnaire design, elderly, age groups, regression analysis

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Självupplevd oral hälsa hos 65- och 75-åriga ålderskohorter från två svenska län.

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Sammanfattning

☉ Syftet med föreliggande arbete var att undersöka självupplevd oral hälsa hos två äldre åldersgrupper, 65 och 75 år, i relation till bakgrundsfaktorer, socioekonomiska, individuella och tandvårdssystemfaktorer. Ett annat syfte var att undersöka eventuella skillnader därvidlag för de båda åldersgrupperna.

I två svenska län, Örebro och Östergötland, har alla personer födda 1942 studerats med hjälp av enkätundersökningar vart 5:e år sedan 1992. År 2007 undersöktes även alla personer födda 1932 med motsvarande enkät. Studiepopulationen bestod av 3735 personer födda 1932 samt 6078 personer födda 1942. Data analyserades såväl med deskriptiv statistik som med multivariat analys utifrån en förklaringsmodell för ojämlikhet i oral hälsa.

Faktorer relaterade till självupplevd oral hälsa var åldersgrupp, socialt nätverk, etnicitet, utbildningsnivå, allmänhälsa, tobaksvanor, munhygienvanor, besöksvanor till tandvård och kostnad för tandvård.

Den självupplevda hälsan var överlag ganska hög speciellt med hänsyn tagen till de relativt gamla åldersgrupperna, dock sämre för gruppen 75 år. Socioekonomi, bakgrund, individuell livsstil och tandvårdssystem påverkade den självupplevda orala hälsan. Att ha ett tillfredställande dentalt utseende, utifrån hur du blir bedömd av andra människor, var viktigt för denna äldre population. En utmaning för tandvårdsplanerare, speciellt med tanke på att proportionen äldre människor i samhället ökar.

Introduction

Globally, the proportion of elderly people is growing fast. According to the WHO, about 600 million people are presently aged 60 years and over, a number that is expected to be doubled in 2025 (26). This holds also for Sweden, where the number of people aged 65 and older are above 1.6 million in the year 2008 (34). This trend is a challenge for any society since chronic diseases as well as oral diseases historically have been more frequent in elderly age groups and probably will be so in the future.

Oral health patterns, as well as dental care, have changed considerably in Sweden as well as in other developed countries. A hundred years ago, those 65 and over had no or few own teeth preserved. Nowadays they have most or all teeth left, a progressive development seen specially in the last decades. At the same time, this development has been accompanied by an almost equal increase in received dental care, like fillings, crowns, bridges and so on (1, 2, 13, 14, 31). Present day oral problems/diseases seen in older people are the lifetime accumulated caries experiences, higher prevalence of periodontal disease, xerostomia, more tooth loss and to less degree tempero mandibular problems and disorders (16, 17). Oral health is related to quality of life at all ages but the negative impacts of poor oral conditions on the daily life is more common among edentulous people (26, 43). Oral health, especially edentulousness, is also related to socio-economic status. People of lower social class with lower level of education and income, and workers compared to white-collar workers, often report their oral health as being worse (5, 10, 26, 36). During the last decade, a number of studies have been done concerning the oral health impact on quality of life, but less is known about the impact of variables on self-perceived oral health, especially in older age groups.

During the period 1992 to 2007, several comprehensive studies have been carried out on an older population from two Swedish counties, Örebro and Östergötland. It was found that there were social inequalities in self-perceived oral health. For example, education, occupation, marital status and ethnicity were related to self-perceived oral health (36). In Sweden an official goal of equality in oral health and dental care has been declared in the "Dental Service Act" since 1985 (40). That goal was not fulfilled, at least not in the population studied in 1992 (36).

People born in the 1930's and 1940's in Sweden normally have had a lot of dental restorations, fillings, endodontic treatments, and different prosthetic restorations.

They grew up when free dental care in schools was introduced. They were in their forties and thirties when a national oral health insurance system for adults was introduced in Sweden in 1974. This was a social security system with generous contributions from the state to all patients. It paid at least 50% of the cost, and above an upper limit all cost, resulting in a lot of fillings, prosthetics and other forms of dentistry (1).

Self-perceived oral health is related to actual dental status and to opportunities to remedy problems, as well as to access to care. It is also strongly related to what generally is expected by the individual, which in its turn is affected by the social context. The measurement of oral health is a vital question, whether by clinical measures or by people's own perceptions of their health. Previously, clinical measures were more common but nowadays there has been a turn to measuring self-perceived health, which obviously relies on self-reports.

A sociological comprehensive model explaining inequalities in oral health by *Petersen (27)* is used as a framework in the analyses in this study. This model emphasizes four groups of explanatory factors. The model emphasizes both primary effects and the importance of normative factors in a society, there are paths going in diverse directions between the explanatory factors.

The aim of this study was to investigate self-perceived oral health in two elderly populations from Örebro and Östergötland. Applying the model, the relation to background, socio-economic, individual and dental health service system factors will be investigated. Another purpose was to find out if there were any differences in these respects between the two age groups.

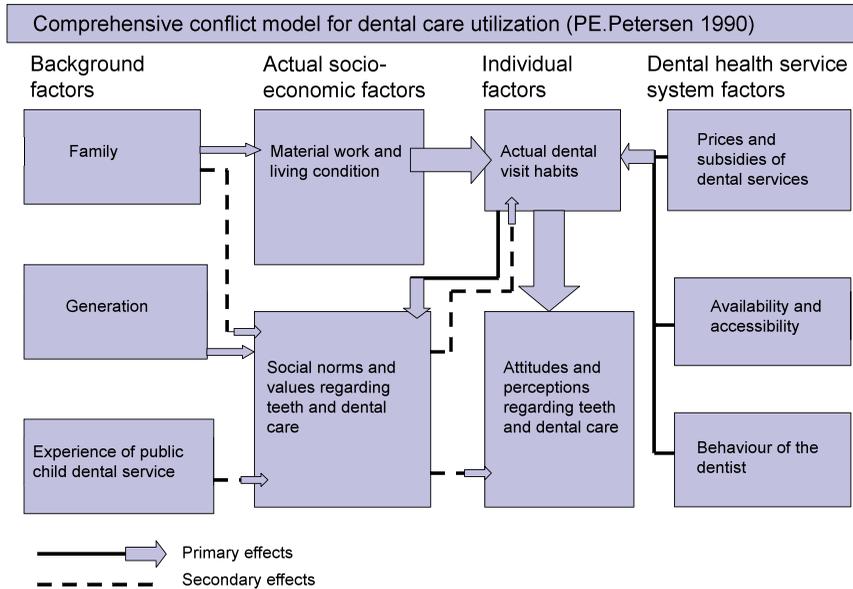
Material and methods

Population and response rate

Every fifth year since 1992 (1997, 2002 and 2007) all persons born 1942 and at the same time living in the counties of Örebro or Östergötland in Sweden have been sent a questionnaire. In 2007, all persons born in 1932 were also included in the study.

In 2007, a mail questionnaire was sent to all persons born in 1932 or 1942 in these two counties, altogether 13508 persons (Örebro county 5438 and Östergötland county 8070). Their names and addresses were obtained from public population records (Statistics Sweden). If a questionnaire was returned with unknown address, that person was excluded from

© Fig 1. Comprehensive conflict model of dental care utilization, explaining social inequalities in dental health (27)



the population. Individuals not responding within two weeks were given a reminder in the form of a letter. For those still not answering after an additional two weeks, a new questionnaire was issued. No further efforts were made. The response rate was 72.6%, giving a net population of 9813 individuals. The studied age group born in 1932 consisted of 3735 persons (response rate 71,9%) and those born in 1942 were 6078 persons (response rate 73,1%).

Non-response

Non-response analysis was done according to gender and county, presented in table 1. In analysis of the whole population, no difference was found concerning gender but there were significant differences controlling for age groups. Analysing county of origin showed no differences, neither for the whole population nor when controlled for the two age groups. In analysis of associations and differences, data can be used with greater confidence as long as it cannot be deemed probable that the differences or covariations are deviant in the non-response group.

Questionnaire

Dependent variable in the regression analysis, Self-perceived oral health index

In a previous study on the cohort born in 1942, carried out on the questionnaires from 1992 and 1997, an index for self-perceived oral health was constructed (36). The same index was used in this study. Satisfaction with teeth, chewing ability and number of teeth were used as a summed index approximating an interval level variable. Summing the response alternatives for the three used variables gave an index range of 3 to 13, the higher value the worse self-perceived oral health. The questions used, and their response alternatives were:

- Are you in general satisfied with your teeth:
1-yes, very satisfied; 2-yes, mostly satisfied; 3-no, not very satisfied; 4-no, absolutely not satisfied
- Can you chew all kinds of food:
1-very good; 2-rather good; 3-not so good; 4-poorly
- How many of your own teeth (except primary teeth) do you have left:
1-all teeth left; 2-missing some single tooth; 3-missing rather many teeth; 4-have almost no teeth left; 5-edentulous

Independent variables in the regression analysis

In the analyses, some of the questions were dichotomized. In the following presentation of questions used, dichotomizations are marked with // in the response alternatives.

Independent variable	Question	Response alternatives dichotomizations marked //
Background factors		
Age group	Age	Born in 1932 // 1942
Marital status	What is your present marital status	Married-cohabiting // Single – amended with sub question: unmarried; divorced; widow/widower
Social network	How many persons, that you know, do you meet or talk to during an ordinary week (Don't count people that you only meet temporary and hardly ever will see again, like customers in a shop)	None; 1-2; 3-5 // 6-10; 11-15; More than 15
Scaring experience	Did you have any really unpleasant or frightening experience from dentistry during childhood and youth (up to age 20)	Yes, several times; Yes occasionally //, No; Do not remember
Socioeconomic factors		
Gender	Sex	Male // Female
Residence	Place of residence	City // Town; Rural
Ethnicity	Country of birth	Sweden // Nordic country; Other country
Education	What education do you have	Primary education // Secondary education; High school/grammar school; College education; Other
Attitudes regarding teeth	Here follow some statements and opinions that can occur. We ask you to give your opinion 1.To have beautiful and perfect teeth is very important for how you are treated by other people 2.Minor imperfections in teeth are of no importance as long as they are functional 3.Visible toothlessness is something to be ashamed of 4.It doesn't matter how you look in your mouth, as long as you can chew the food you like	Absolutely agree; Mostly agree // Mostly disagree; Absolutely disagree Absolutely agree; Mostly agree // Mostly disagree; Absolutely disagree Absolutely agree; Mostly agree // Mostly disagree; Absolutely disagree Absolutely agree; Mostly agree // Mostly disagree; Absolutely disagree
Individual factors		
Perceived general health	Do you consider yourself as completely healthy	Yes, absolutely; Yes mostly // No, not particularly; No, absolutely not
Tobacco habits	What are your smoking habits What are your snuffing habits	Daily smoker // Occasional smoker; Have smoked but stopped; Never smoked Daily snuffer // Occasional snuffer; Have snuffed but stopped; Never snuffed
Alcohol habits	How often do you drink beer, wine or spirits	More than twice/week; About twice/week; About once/week; About twice /month // Never
Oral hygiene habits	Which of the oral hygiene products mentioned do you use; toothbrush; fluoride toothpaste; toothpick; dental floss; fluoride tablets and fluoride rinse	Seldom/never; Once a week; Once a day; Twice a day; More than twice a day
Visiting habits	About how often do you visit dental care	Twice or more per year; Once a year // Every second year; More seldom
Refrained from visit due to cost	Have you any time during the recent year been forced to refrain from visiting dental care because you could not afford it	Yes, several times; Yes, occasionally // No
Other dental visits than to GP	Have you ever been treated by a dental specialist Have you visited a dental hygienist during the last year	During the last year; During the past five years; More than five years ago // Never; Do not know Yes // No; Do not remember
Attitude	Do you believe that you can keep your teeth all life through	Yes, absolutely; Yes maybe // I don't know; No, probably not; No, absolutely not
Dental health service system factors		
Cost of care	About how much have you yourself paid for dental care during the last year	No cost; Cost SEK 1-2000 // Cost SEK 2001-8000; Cost > SEK 8000; Do not remember
Care organization	Where have you mainly received dental care during the last five years	Private dental care // Public dental care; (No dental care; Other open ended - both set as missing)

Two indices were formed from the questions regarding attitudes to teeth; “Appearance” and “Function”. Questions used forming the index appearance were number 1 and 3 and for function number 2 and 4. Both indices had a range going from 2–8.

Questionnaire data were scanned into a SPSS data file.

© **Table 1.** Non-response analysis

	Response %	Non-response %	Significance
Whole population			
Gender male	48,4	48,6	NS
County Örebro	39,8	41,5	NS
Born 32			
Gender male	46,8	41,3	S*
County Örebro	39,1	41,2	NS
Born 42			
Gender male	49,3	53,3	S*
County Örebro	40,2	41,7	NS

* P=< 0.05

© **Table 2.** Percent distributions, frequencies and percent unit difference in self-perceived oral health variables for born 1932 and 1942.

Variable	Born 1932	n	Born 1942	n	Per cent unit difference between those born in 1932 and in 1942
Satisfaction with teeth		3536		5929	
Very satisfied	15.5		12.5		-3.0
Generally satisfied	62.8		64.2		1.5
Not very satisfied	16.3		17.1		0.8
Not at all satisfied	5.4		6.1		0.7
Chewing ability		3578		5959	
Very good	55.2		63.9		8.7
Pretty good	36.3		29.6		-6.6
Not so good	6.1		4.7		-1.4
Poor	2.3		1.7		-0.6
Number of teeth		3488		5909	
All teeth remaining	7.5		13.7		6.2
Some single tooth missing	48.4		58.0		9.8
Rather many teeth missing	31.8		22.9		-8.9
Have almost no teeth left	4.5		2.6		-1.9
Edentulous	7.8		2.6		-5.2

Statistical analysis

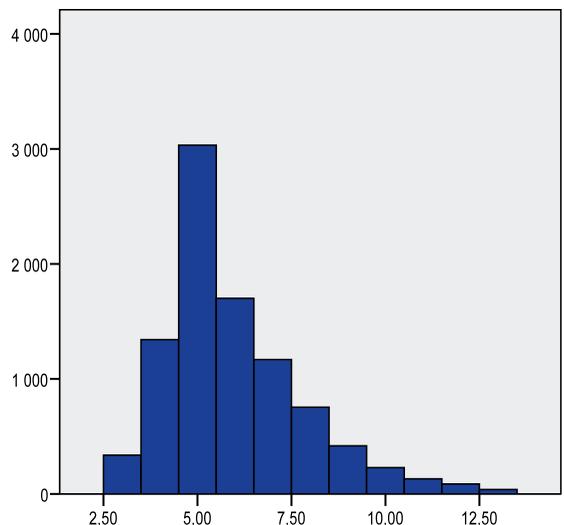
Data were analyzed with descriptive statistics and contingency tables with χ^2 analysis. In sample sizes as the present one, statistical significance becomes rather meaningless. Also trivial differences become significant. Multivariable analysis was performed by using multiple regression analysis. In the regression models, residual plots were inspected for the detection of heteroscedasticity. Test for multicollinearity was performed by inspection of bivariate correlations and by calculation of variance inflation factors. Inclusion of variables followed the checklist of *Studenmund* (35). Variables were introduced in blocks into the model, following the principles of hierarchical block regression (35). No particular findings would be seen compared to the final model, whence the steps are not reported here. Model fit was determined by the F-test and by calculation of R². Outliers were detected by using *Cook* distances. All data were processed in the statistics program SPSS.

Results

The self-perceived oral health was overall rather high, especially in view of the studied ages, 65 and 75 year olds. In Table 2, the variables constituting the oral health index are presented for each age group. Differences between the two generations were also compared for each variable. In Figure 2 the distribution of the index is presented.

In Tables 3 and 4, the distributions of the included variables are presented according to the model used.

© **Fig 2.** Histogram Self-perceived Oral Health index Range 3–19. Mean 5.95, SD 1.84, N 9244



For example it can be seen that from the explanatory box “Back-ground factors” that having few social relations per week is more common among those born in 1932 compared to those born in 1942, and from the explanatory box “Socio-economic factors” it is showed that there was a higher proportion living single in the age group born in 1932 (table 3).

In multiple regression analysis with the index of self-perceived oral health as dependent variable, “Background factors”, age group, social network and scaring experience from childhood dentistry affected the self-perceived oral health. Those born in 1932 perceived worse oral health. Having many social re-

lations per week affected self-perceived oral health to the better, while having had scaring experiences from childhood dentistry was strongly associated with impaired oral health. Among “Socio-economic factors”, ethnicity and education were related to the dependent variable. People being born outside Sweden perceived worse health, so did persons having lower levels of education. Among “Individual factors”, general health, tobacco habits, oral hygiene routines and actual dental visit habits all covaried with the dependent variable. Daily use of tobacco and worse perceived general health affected self-perceived oral health to the worse while daily use of

© Table 3. Study-population. Independent variables; Background and Socioeconomic factors

Background Factors						
Agecohort	N	%				
born 1932	5195	38%				
born 1942	8313	62%				
Marital status	Married/cohabiting	Single				
born 1932	68%	32%				
born 1942	77%	23%				
Social relations per week	None	1-2	3-5	6-10	11-15	>15
born 1932	1%	11%	30%	28%	12%	18%
born 1942	0.4%	5%	18%	25%	14%	38%
Frightening experiences from childhood dentistry	Yes, several times	Yes, occasionally	No	Do not remember		
born 1932	24%	27%	42%	8%		
born 1942	34%	29%	31%	5%		
Socio-economic factors						
Gender	Women	Men				
born 1932	53%	47%				
born 1942	51%	49%				
Country of birth	Sweden	Other Nordic country	Other country			
born 1932	92%	4%	4%			
born 1942	94%	3%	4%			
Place of residence	Rural	Town	City			
born 1932	15%	37%	49%			
born 1942	20%	35%	45%			
Education	Primary school	Secondary school	College	Other		
born 1932	56%	22%	10%	12%		
born 1942	40%	29%	21%	11%		
Attitude - appearance important	Yes, definitively	Yes, more or less	Not so much	Not at all		
born 1932	8%	68%	23%	0%		
born 1942	7%	68%	24%	0%		
Attitude - function important	Yes, definitively	Yes, more or less	Not so much	Not at all		
born 1932	22%	59%	18%	1%		
born 1942	15%	60%	24%	1%		

© Table 4. Study-population. Independent variables; Individual and Dental care factors

Individual Factors					
Perceived general health	Completely healthy	Mostly healthy	Not particularly healthy	Not healthy at all	
born 1932	13 %	57%	20%	11%	
born 1942	25%	54 %	13 %	8%	
Smoking habits	Daily smoked	Occasionally smoker	Have smoked but stopped	Never smoked	
born 1932	7%	37%	2%	54 %	
born 1942	13 %	40%	4 %	42%	
Snuffing habits	Daily snuffing	Occasionally snuff	Have snuffed but stopped	Never snuffed	
born 1932	3 %	4 %	1%	93 %	
born 1942	6%	7%	2%	86%	
Alcohol habits	> Twice a week	About twice a week	About once a week	About twice a month	Never
born 1932	6%	12%	16%	34 %	32%
born 1942	8%	19%	23 %	32%	18%
Oral hygiene habits	Daily use of toothbrush/floss-picks/fluoride	Daily use of toothbrush/floss-picks	Twice a day toothbrush	No daily use of toothbrush	
born 1932	8%	57%	81%	3 %	
born 1942	7%	55%	82%	2%	
Dental visiting habits	> Twice a year	Once a year	Every second year	More seldom	
born 1932	27%	56%	7%	11%	
born 1942	25%	59%	8%	7%	
Refrained from dental visit due to cost	Several times	Occasionally	No		
born 1932	5%	5%	90%		
born 1942	5%	6%	90%		
Visit to a dental hygienist	Yes	No	Do not know		
born 1932	45%	55%	0%		
born 1942	46%	53 %	1%		
Treatment by a dental specialist	During the last year	During the last 5 years	<5 years ago	Never	Do not know
born 1932	4 %	6%	18%	68%	4 %
born 1942	3 %	7%	22%	64 %	4 %
Attitude to possibility of keeping teeth all life through	Yes, all life through	Yes, maybe	Don't know	No, probably not	No, definitely not
born 1932	28%	49%	14 %	10%	0%
born 1942	31%	49%	13 %	7%	0%
Dental care factors					
Cost of care during last year	Nothing	1-2000 SEK	2001-8000 SEK	>8000 SEK	Do not remember
born 1932	11%	56%	20%	8%	6%
born 1942	9%	59%	24 %	5%	3 %
Care organisation	Public care	Private care	No dental care	Other	
born 1932	29%	66%	5%	0%	
born 1942	27%	69%	3 %	0%	

fluoride products gave the opposite response. Having visited dental care more seldom was related with worse self-perceived oral health as well as having refrained from care due to cost. Having visited a dental hygienist affected self-perceived oral health to the better, while having visited a dental specialist showed the opposite association. Having the attitude that there is no hope of keeping teeth all life through was strongly related to having worse perceived oral health. The last explanatory box "*Dental care system factors*" presented significant relations for both cost of care and care organisation. Private care organisation affected self-perceived oral health to the better while having had higher cost for care had the opposite relation (Table 5).

To control for interaction with age separate regression models analysis were made for the two age-groups, giving the same relations as when age was used as an independent variable in the presented model.

Discussion

Petersen's comprehensive explanatory model was useful as a framework in the analysis. In this study all four explanatory boxes; background, socio-economic, individual and dental health service system factors, were related to self-perceived oral health.

Background factors

The background factors in the model emphasise "family", "generation" and "experience of public child dental service". Relevant family factor was marital status, which did not affect the self-perceived oral health. This result contradicts an earlier study done on the cohort born in 1942 when they were 50 and 55 years old (36). In that study, married persons perceived a better oral health than single persons did.

In the explanatory box generation, being born in 1932 or 1942 have it's obvious appurtenant. There were differences in self-perceived oral health between the age groups, worse for the older groups. Another explanatory background factor is experience of child dental service. Having had scaring experiences from childhood dentistry covaried with worse self-perceived oral health. These experiences were reported by as many as 63% of the 65 year olds and 51% of the 75 year olds. It is rather fascinating that experiences going back maybe as long as 60-70 years still can have effect. In a qualitative interview study by McKenzie-Green et al it was concluded that "A dental visit surfaces hopes and fears based on past and present experiences" (23). Further more

they concluded "They do not 'just go' to the dentist; they bring with them their past dental experiences and their hopes for the future. It matters how one is treated at this vulnerable time" (23). One evident inference is that it is of the utmost importance that children and adolescents should be taking care of in the best possible way, in dentistry.

Socio-economic factors

Being born outside Sweden and having lower levels of education was related to perceiving worse oral health. Both factors are well known from previous studies as important covariates of oral health (5, 10, 26, 36). The most commonly used socio-economic variables are income and vocational status. In this study the majority of the population were pensioners, especially among those born in 1932, hence the variable "education" was used as a socio-economic indicator. Having no more education than primary school obviously has a life-long impact factor on oral health.

There is a primary association between the boxes *generation* and *social norms and values regarding teeth and dental care*. About three quarter of this population regard that dental appearance, in the aspect of how you are judged by other people, is important and more than 60% thought that edentulousness is something to be ashamed of. Other studies has also showed that having feelings of embarrassment is more frequent for those being edentulous, having missing teeth, severe malocclusions etc. (12, 21)

Individual factors

According to the model *actual dental visit habits* are explanatory factors, which were confirmed here. Visits less than once a year covaried with worse oral health. Refraining from dental visits due to cost, affected self-perceived oral health strongly to the worse, as can be expected. There was a self-evident relation between these factors. Having no money there will be no dental care. There was no difference between the two age groups according to this aspect. Having had visits to dental specialists was related to perceived worse health, probably due to having more serious dental problems, explaining the negative relation. Having had visits to dental hygienists was related to better oral health.

In the explanatory box *attitudes and perceptions regarding teeth and dental care* it was stated that no more than one third of this population was absolutely certain to keep their teeth all life through. Considering this together with the fact that the majority

© **Table 5.** Regression model of self-perceived oral health in cohorts born in 1932 and 1942.
Dependent variable: Self-perceived oral health, range 3-13. High value = Bad perceived oral health

Independent variables	B	95% CI	P
Background factors			
Age group - (ref.cat: born 1942)	-	-	
born in 1932	0.274	0.184 - 0.363	0.000
Marital status - (ref.cat: married/cohabiting)	-	-	
single	0.069	-0.028 - 0.166	0.162
Social network - (ref.cat: few social relations)	-	-	
many social relations/week	-0.118	-0.212 - -0.025	0.013
Scaring experience from childhood dentistry - (ref.cat: no such experience)	-	-	
have had scaring experiences	0.296	0.215 - 0.377	0.000
Socio-economic factors			
Gender- (ref.cat: male)	-	-	
female	-0.020	-0.105 - 0.065	0.643
Place of residence - (ref.cat: city)	-	-	
rural and small town	0.033	-0.047 - 0.112	0.420
Ethnicity - (ref.cat: born in Sweden)	-	-	
born outside Sweden	0.239	0.064 - 0.413	0.007
Education - (ref.cat: primary school)	-	-	
more than primary school	-0.181	-0.264 - -0.098	0.000
Attitudes regarding teeth -			
appearance important, (range 2-8)	0.023	-0.018 - 0.064	0.277
function important, (range 2-8)	0.003	-0.030 - 0.036	0.840
Individual factors			
Perceived general health - (ref.cat: healthy)	-	-	
not healthy	0.330	0.230 - 0.430	0.000
Tobacco habits- (ref.cat: no smoking/no snuffing)	-	-	
daily smoking	0.245	0.109 - 0.381	0.000
daily snuffing	0.207	0.002 - 0.413	0.048
Alcohol habits (ref.cat: no use of alcohol)	-	-	
use of alcohol	-0.012	-0.114 - 0.091	0.824
Oral hygiene habits - (ref.cat: less than twice a day or daily)	-	-	
tooth brushing with fluoride toothpaste >2 a day	0.012	-0.092 - 0.117	0.815
daily flossing or use of toothpick	0.051	-0.033 - 0.136	0.231
daily use of fluoride rinse or tablets	-0.191	-0.319 - -0.062	0.004
Visiting habits - (ref.cat >once a year)	-	-	
more seldom than once year	0.155	0.004 - 0.307	0.045
Refrain from visit due to cost - (ref.cat: not refrained)	-	-	
refrained from visit	0.544	0.377 - 0.710	0.000
Other dental visits than to GP - (ref.cat: no visits)	-	-	
visit to dental specialist	0.245	0.158 - 0.331	0.000
visit to dental hygienist	-0.136	-0.218 - -0.055	0.001
Attitude - (ref.cat: believe in keeping teeth al life through)	-	-	
no belief in keeping teeth all life through	2.186	2.070 - 2.302	0.000
Dental health service system factors			
Cost of care during last year- (ref.cat: < 2000 SEK)	-	-	
>2000 SEK	0.395	0.307 - 0.482	0.000
Care organization - (ref.cat: private care organization)	-	-	
public care organization	0.279	0.182 - 0.376	0.000
Adj R-square		0.421	
F/df1/df2		112,6/24/3663	
Model significance		P<0.000	

B = Regression coefficient. P = Statistical significance. CI = Confidence Interval

thought that dental appearance, in the aspect of how you are judged by other people, is important and that edentulousness is something to be ashamed of, it is vital to protect oral health also for older age groups. Having no belief in the possibility of keeping own teeth all life through had the strongest association in the regression model.

Individual life-style related factors as perceived general health, tobacco-habits and oral hygiene routines are also factors affecting the self-perceived oral health. Both daily smoking and snuffing was related to worse health. A number of other studies have showed the relation between oral health and smoking (19, 24, 29) Snuff is mostly used in the Nordic countries and for many years there has been, and still is, an ongoing discussion whether snuff affects oral health, as well as general health, or not (7, 11, 30). WHO, World Health Organization, has in the proposal for improving oral health underlined the importance of minimizing the use of tobacco (28). One factor self-evidently related to oral health, in all perspectives, is oral hygiene routines. So they were, but only considering daily use of fluoride rinse or tablets, but not for brushing teeth twice a day nor for daily flossing or use of toothpick's.

Dental health service system factors

Prices and subsidies of dental services are factors well known for influencing visiting habits. In this study high cost for dental care was related to worse perceived oral health. Others have showed that cost can be a barrier for dental care (4, 8, 37, 38). Another variable that can be put in either the explanatory box "availability and accessibility" or in the box "behavior of the dentist" is care organization. Attending private care organization was related to perceiving better oral health. However, a contributing reason for that can be that private and public care often has different types of patient clientele (9). It was showed in an earlier study that having private care provider gave higher probability of more frequent visiting habits (37). One may suspect, although not uncontested, that there is a connection between good oral health and high utilization to dental care (22, 32, 39).

The methods used here of course have strengths and weaknesses. It is mostly agreed that self-reported oral health measures have good validity, although that is not wholly uncontested (6, 25, 33, 41). In a study by *Unell et al*, the congruence between clinical and questionnaire findings was investigated. It was done by comparing clinical findings with self-reported status from questionnaires on 1041 subjec-

ts. There were good agreements between subjective self-reports of oral health and clinical findings, especially for those conditions being easy for patients to observe, like number of teeth (41).

Validation of the information about visiting habits could be done if considerable resource were available, as well as those questions concerning lifestyle questions and oral hygiene habits, although these are even more complicated. Such resources have not been available. However, bias in estimates is less when calculating correlations than for point estimates. The questionnaire has been used in four comprehensive studies, every fifth year, during 15 years with reliable results. Showing stable results for variables that should not change, like gender and country of birth as well as being sensible to changes in variables like lifestyle question and perceived health questions (39, 42). The results concerning oral hygiene habits and visits to dental care in this study are in agreement with another study in Sweden for these age groups (15). A weakness is of course the design itself, consisting of self-reported data, which always have some amount of bias, both underestimating and exaggerating (6, 20). On the other hand, the only way to study perceptions and opinions is by asking people. You might ask questions either the way done here, by questionnaire or by different interview methods. Using interviews would be extremely costly in a population study like this and interviews have biases and problems too (3, 18).

Two other forthcoming studies are planned based on these older age groups. The first one will investigate dental care utilization habits and what factors are related to this. The other one will be studying satisfaction with dental care for these groups, if the dental care system can provide the care and treatments they need. Older people are a valuable resource to society and all efforts done to prevent diseases and disabilities among them are important.

Conclusions

There are still social inequalities in self-perceived oral health despite the goal of equality in oral health in the Swedish dental act. Socio-economic factors affected self-perceived oral health in the group studied here. So did social factors like people's network, life-style factors, attitudes regarding teeth and actual dental visit habits. To have satisfying dental appearance, in the aspect of how you are judged by other people, was important for these age groups, a challenge for dental health planners especially since the proportion of older age groups are growing. There

were differences in self-perceived oral health being 65 or 75 years old, with worse health for the older persons. It remains to be seen if such a generation gap will continue to be present in coming generation, with their better oral health starting position. Further research is required to find out if and how their oral health status can be preserved and also what can be done to support oral health in older subjects.

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