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DENTAL FEAR AMONG
ADULTS IN FINLAND

FACULTY OF MEDICINE,
INSTITUTE OF DENTISTRY,
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**DENTAL FEAR AMONG ADULTS
IN FINLAND**

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Abstract

The aim of this study was to evaluate the association between dental fear and dental attendance, oral health habits and dental condition. A further aim was to study the association between subjective oral impacts and dental fear.

The nationwide two-stage stratified cluster sample (n=8028) represented Finnish adults aged 30 years and older. The data were collected in interviews, with questionnaires and at clinical dental examinations. Dental fear was measured with the question: "*How afraid are you of visiting a dentist?*" and subjective oral impacts with the OHIP-14 questionnaire. Multiple logistic regression analyses were used to determine the association between dental fear and dental attendance, oral health habits, dental condition and subjective oral impacts, taking into consideration the possible confounding and/or modifying factors (e.g. age, gender and education).

Of Finnish adults aged 30 years and older, 10% were very afraid and 30% somewhat afraid of visiting a dentist. Those with high dental fear were more likely to report subjective oral impacts than were those with lower fear. Age modified the effect of the association between dental fear and dental attendance, oral health habits and dental condition. Among all age groups, except the 30- to 34-year-olds, irregular attenders were more likely to be very afraid of visiting a dentist than regular attenders were. Dental condition was also poorer among those with high dental fear than among those with lower fear. The association between dental fear and number of decayed teeth was positive in all age groups. Among the age group 65+ years, the numbers of missing and sound teeth were positively, and among the age group 30-34 years negatively, associated with dental fear. Among the age group 65+years, those who brushed their teeth less than twice a day were more likely to have high dental fear than were those who brushed at least twice a day. Regular smokers were more likely to have high dental fear than were those who smoked occasionally or not at all.

Dental fear is very common among adults in Finland. Because those with dental fear use dental services irregularly, they are likely to need emergency care. However, those for whom oral health services have been provided regularly since childhood seem to continue to use these services regularly in spite of high dental fear. Dental teams should be aware of the increased oral health risks that smoking, irregular attendance and poor tooth-cleaning habits cause among those with dental fear. Treating dental fear could have positive effects on subjective oral impacts by reducing psychological and social stress as well as improving regular dental attendance and oral health. Birth cohort or age should be taken into account when associations between dental fear and dental attendance, oral health habits and dental condition are studied.

Keywords: age, dental attendance, dental fear, dental health, education, gender, oral health habits, subjective oral health

Pohjola, Vesa, Suomalaisten aikuisten hammashoitopelko

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Tiivistelmä

Tutkimuksen tarkoituksena oli selvittää hammashoitopelon ja hammashoitopalveluiden käytön, suunterveyteen liittyvien tapojen sekä hammasterveyden välisiä yhteyksiä. Tavoitteena oli myös tutkia suunterveyteen liittyvien ongelmien yhteyttä hammashoitopelkoon.

Kaksivaiheinen ryvästetty otos (n=8028) edusti suomalaista 30 vuotta täyttänyttä väestöä. Tutkimuksessa käytetty tieto koottiin haastattelujen, kyselyjen ja suun kliinisen tutkimuksen avulla. Hammashoitopelkoa selvitettiin kysymyksellä ”*Onko hammaslääkärissä käynti mielestänne: ei lainkaan pelottavaa, jonkin verran pelottavaa, erittäin pelottavaa?*” ja suun terveyteen liittyviä ongelmia OHIP-14-kyselyllä. Logististen regressioanalyysien avulla tutkittiin hammashoitopelon ja palveluiden käytön, suunterveyteen liittyvien tapojen ja ongelmien sekä hampaiden terveyden välistä yhteyttä huomioiden mahdollisia sekoittavia ja/tai vaikutusta muovavia tekijöitä (mm. ikä, sukupuoli, koulutus).

Suomalaisista aikuisista 10 % pelkäsi hammashoitoa kovasti ja 30 % jonkin verran. Kovasti hammashoitoa pelkäävät raportoivat suunterveyteen liittyviä ongelmia useammin kuin vähän tai ei lainkaan pelkäävät. Ikä vaikutti siihen, millainen yhteys oli hammashoitopelon ja hammashoitopalvelujen käytön, suun terveyteen liittyvien tapojen ja hammasterveyden välillä. Kaikissa muissa ikäryhmissä paitsi ikäryhmässä 30–34 epäsäännöllisesti hoidossa käyvät pelkäsivät hammashoitoa todennäköisemmin kuin säännöllisesti hoidossa käyvät. Kovasti pelkäävillä oli myös huonompi hammasterveys kuin vähemmän pelkäävillä. Kaikissa ikäryhmissä kovasti hammashoitoa pelkäävillä oli useampia reikiintyneitä hampaita kuin jonkin verran tai ei lainkaan pelkäävillä. Poistettujen hampaiden lukumäärän lisääntyessä kovan hammashoitopelon todennäköisyys pieneni ikäryhmässä 30–34 ja kasvoi ikäryhmässä 65+. Näissä ikäryhmissä sama ilmiö oli havaittavissa myös terveiden hampaiden lukumäärän muuttuessa. Ikäryhmässä 65+ hampaansa harvemmin kuin kahdesti päivässä harjanneet pelkäsivät hoitoa todennäköisemmin kuin vähintään kahdesti päivässä harjanneet. Säännöllisesti tupakoivat pelkäsivät hammashoitoa todennäköisemmin kuin epäsäännöllisesti tai ei lainkaan tupakoivat.

Hammashoitopelko on yleistä Suomessa. Koska pelkäävät käyvät hoidossa epäsäännöllisesti, hammaslääkärit kohtaavat pelkääviä potilaita usein akuuttivastaanotolla. Ne, jotka ovat tottuneet hammashoitopalveluiden säännölliseen käyttöön lapsuudesta alkaen, näyttävät jatkavan palveluiden säännöllistä käyttöä pelosta huolimatta. Hammashoitotiimien tulee huomioida hammashoitoa pelkäävien epäsäännöllisen hoidossa käymisen, puutteellisten kotihoitotottumusten ja tupakoinnin suunterveydelle aiheuttama kohonnut riski. Hammashoitopelon hoitamisella olisi positiivisia vaikutuksia suunterveyteen liittyvään elämänlaatuun, koska pelon hoito vähentää psykologista ja sosiaalista stressiä, lisää säännöllistä hoidossa käyntiä ja parantaa suun terveyttä. Syntymäkohortti tai ikä pitää huomioida tutkittaessa hammashoitopelon yhteyttä hammashoitopalveluiden käyttöön, suunterveyteen liittyviin tapoihin ja hammasterveyteen.

Asiasanat: hammashoitopelko, hammashoitotavat, hammasterveys, ikä, koulutus, palveluiden käyttö, sukupuoli, suun terveyteen liittyvät ongelmat

***“People do not care how much you know, but they know
how much you care.”***

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Landerneau August, 2009

Abbreviations

CER	Conditioned Emotional Responses
CS	Conditioned Stimulus
DT	Decayed teeth
DAS	Dental Anxiety Scale
DBS	Dental Belief Survey
DFS	Kleinknecht's Dental Fear Survey
DMF(T)	Sum of decayed, missing and filled teeth
FT	Filled teeth
G'sDFS	Gatchel's 10-point single-item Dental Fear Scale
HRQoL	Health Related Quality of Life
MT	Missing teeth
MDAS	Modified Dental Anxiety Scale
OHIP	Oral Health Impact Profile
OHIP-14	Oral Health Impact Profile, short version (14 questions)
OHRQoL	Oral Health-Related Quality of Life
OR	Odds ratio
QoL	Quality of life
STAI	Spielberger's State-Trait Anxiety Inventory
UR	Unconditioned Response
US	Unconditioned Stimulus
WHO	World Health Organization

List of original papers

This thesis is based on the following articles, which are referred to in the text by Roman numerals I-IV.

- I Pohjola V, Lahti S, Vehkalahti MM, Tolvanen M & Hausen H (2007) Association between dental fear and dental attendance among adults in Finland. *Acta Odontol Scand* 65: 224–30.
- II Pohjola V, Lahti S, Vehkalahti MM, Tolvanen M & Hausen H (2008) Age-specific association between dental fear and dental condition among adults in Finland. *Acta Odontol Scand* 66: 278–285.
- III Pohjola V, Lahti S, Tolvanen M & Hausen H (2008) Dental fear and oral health habits among adults in Finland. *Acta Odontol Scand* 66: 148–153.
- IV Pohjola V, Lahti S, Suominen-Taipale L & Hausen H (2009) Dental fear and subjective oral impacts among adults in Finland. *Eur J Oral Sci* 117: 268–272.

In addition to analyses presented in the original articles, some new analyses have been performed for this thesis.

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1 Introduction

Fear is a normal emotional response to a threat or danger. Fear can be seen as adaptive, because it prepares and mobilizes the body to face the threat or to escape from it. Dental fear is a specific fear that is common throughout the population. However, dental fear is socially more acceptable than most other fears are. This social acceptability makes it easy to recognize dental fear, but it also makes maintenance of dental fear and rationalization of the behavior related to dental fear easier than with fears that are socially less acceptable. This makes it difficult for dentists to help their patients to overcome dental fear. (Milgrom *et al.* 1995.)

The etiology of dental fear is more complicated than just a painful or unpleasant dental visit. It has been suggested that dental fear has endogenous and/or exogenous components. Endogenous components refer to dental fear as part of a more generalized anxiety disorder. Exogenous components refer to dental fear acquired as a function of direct or vicarious experiences to which people have been exposed. (Weiner & Sheehan 1990, Rachman 1991.) Dental fear may be socially more acceptable than most other fears are, but is often irrational. It may be nearly impossible to discover the original source of a patient's dental fear, but most patients with dental fear can be treated or managed without knowing the original cause of their fear. (Milgrom *et al.* 1995.)

Since dental fear is subjective and multidimensional, it can be difficult to study. Several anxiety questions and questionnaires have been developed for measuring dental fear. When one plans to study this type of fear, the choice of measuring instrument should be considered carefully, since the choice may affect, e.g. the observed prevalence of dental fear in the sample. The choice of measuring instrument should be based on the dimension of dental fear that one wants to explore and also on the study design. (Moore *et al.* 1991, Schuurs & Hoogstraten 1993, Newton & Buck 2000.)

Gender, age and socio-economical position are examples of potential confounders or effect modifiers of the association between dental fear and oral health (Schuurs *et al.* 1985, ter Horst & de Wit 1993, Locker *et al.* 1996a, Armfield *et al.* 2006). Dental fear and oral health problems may affect patients' oral health-related quality of life (McGrath & Bedi 2004, Mehrstedt *et al.* 2007, Ng & Leung 2008, Vermaire *et al.* 2008). Those with high dental fear are likely to have poorer oral health habits and more often have oral health problems than

those with lower dental fear (Milgrom *et al.* 1988, Stouthard & Hoogstraten 1990, Wisloff *et al.* 1995, Ragnarsson 1998, Schuller *et al.* 2003, Ng & Leung 2008). It has been shown that dental fear correlates positively with the length of intervals between dental visits and frequent use of emergency care (Milgrom *et al.* 1988, Locker & Liddell 1991, Abrahamsson *et al.* 2001). This can make the treatment of patients with dental fear challenging. The endogenous or exogenous etiology of fear also affects the treatment of dental fear (Weiner & Sheehan 1990). By increasing the dental teams' knowledge of dental fear, their stress related to treatment of fearful patients could be reduced and the treatment of "difficult" patients be made easier.

2 Review of literature

2.1 Definitions

Most people know intuitively what fear is; but what is the difference between dental fear, anxiety and phobia? Dental fear, anxiety and phobia can be seen as a continuum reflecting the intensity of a patient's fear reaction. Fear is an individual's emotional response to a threat or danger. Fear prepares and mobilizes the body to face (fight) the threat or to escape from it (flight). In this way the arousal of fear is seen as adaptive. The response of fear is composed of three related components: (1) Unpleasant cognitive state (feeling that something terrible is going to happen); (2) Physiological changes including activation of the sympathetic branch of the automatic nervous system (tachycardia, profuse respiration, hyperventilation, muscle tension, gastrointestinal upset, and other physiological signs of emotional arousal); and (3) Overt behavioral movements (shakes, pacing, jitteriness, and attempts to escape or avoid the perceived threat). Dental fear is a normal emotional reaction to specific threatening stimuli in the dental situation. (Milgrom *et al.* 1995, Freeman & DiTomasso 2002, Klingberg & Broberg 2007.)

Anxiety is used to denote responses to situations in which the source of the threat to the individual is not well defined, is ambiguous or not immediately present. Anxiety is often used as a synonym for fear, but the major difference between fear and anxiety is the immediacy of the stimulus. Anxiety is used to denote reactions to non-immediate situations. Dental anxiety denotes a state of apprehension that something dreadful is going to happen in relation to dental treatment, and it is often coupled with a sense of losing control. (Milgrom *et al.* 1995, Freeman & DiTomasso 2002, Klingberg & Broberg 2007.)

Phobia represent a serve type of anxiety and can be defined as marked and persistent fear of a clearly discernable, circumscribed object or stimulus. Characterizations of phobias include the fact that they cannot be explained or reasoned away and that they are beyond voluntary control. According to American Psychiatric Association the criteria for a diagnosis of specific phobia are: (1) Marked and persistent fear that is excessive and unreasonable; (2) Exposure to the phobic stimuli almost invariably provokes an immediate anxiety response; (3) The person recognizes that the fear is excessive or unreasonable; (4) The phobic situation is avoided or else endured with intense anxiety or distress;

and (5) the avoidance, anxious anticipation, or distress in the feared situation(s) interferes significantly with person normal routine, occupational functioning, or social activities. (Harvey & Rapee 2002.) Dental phobia is severe type of dental anxiety and is characterized by marked and persistent anxiety in relation either to clearly discernible situations/objects (e.g. drilling, injections) or the dental situation in general. If avoidance of dental care is of such proportion that it causes significant distress or interferes with social functioning, the reaction can be identified as phobic. (Milgrom *et al.* 1995, Klingberg & Broberg 2007.)

Dental anxiety and phobia can also be distinguished by looking at the quantity or intensity of the anxiety experience and the patient's capacity to cope with it. Patients who have dental anxiety can cope with the intensity of their anxiety and receive dental treatment. Patients who have dental phobia cannot cope with the intensity of their anxiety and thus avoid treatment. (Coriat 1946, Freeman 2007.)

In this study, the term dental fear is used to cover also the terms dental anxiety and dental phobia.

2.2 Etiology of dental fear

It is commonly believed that dental fear is a result of negative experiences of dental visits, but why does an uncomfortable dental visit result in dental fear in one patient, have little effect upon another and cause dental phobia in a third? It is also believed that dental fear and anxiety develop in childhood, but some studies suggest that 30–50% of dental fear begins in adolescence or adulthood (Öst 1987, Milgrom *et al.* 1988). The etiology of dental fear may differ if the fear has been acquired during childhood or later in life (Milgrom *et al.* 1988, Locker *et al.* 1999). Direct modelling may make a greater contribution to child-onset anxiety than to adult-onset anxiety, and general psychological states contribute more to adult-onset than to child-onset fear (Locker *et al.* 1999). Weiner and Sheehan (1990) have suggested that dental fear can have both endogenous and exogenous components.

2.2.1 Endogenous etiology

Endogenous origin of dental fear indicates that dental fear is part of a more generalized anxiety syndrome involving multiple phobias and psychiatric diagnoses. Although dental fear is not considered to be an inborn reaction, an

association has been found between dental fear and increased levels of general anxiety, multiple fears or panic disorders. Dental fear has been associated with many specific fears such as fears of heights, flying, enclosure, mutilation and pain (Fiset *et al.* 1989, MacNeil & Berryman 1989, Abrahamson *et al.* 2000, Skaret *et al.* 2003a, Armfield 2008). Fearful patients may also be troubled by other psychopathology, such as behavioral problems, mood disorders, conduct disorders, agoraphobia, social phobia, alcohol dependence or substance abuse (Berggren 1992, Roy-Bryne *et al.* 1994, Kaakko *et al.* 2000, Locker *et al.* 2001, Elfström *et al.* 2007). Results of studies of association between phobias related to social situations and dental fear are inconsistent (Stouthard & Hoogstraten 1987, MacNeil & Berryman 1989). The endogenous etiology of dental fear suggests that some people may have internal personality vulnerability to anxiety disorders (Locker *et al.* 2001, Armfield 2006), and among adults there may be subgroups suffering from dental fears of different origin (Elfström *et al.* 2007).

2.2.2 Exogenous etiology

Exogenous origin of dental fear refers to fears that are acquired as a function of direct experience or through vicarious experiences that people feel to be threatening (Rachman 1991). Negative experiences in dental offices are the most common ways in which patients develop dental fear. It has been suggested that as much as 80% of all clinically significant dental fears are acquired directly (Öst 1987). Negative direct or vicarious experiences may include intense pain or fright, or may involve negative interpersonal interactions between dentist and patient. As a result, the patient may associate dentistry with unpleasant experience (Milgrom *et al.* 1995).

Direct negative experiences can cause dental fear (Milgrom *et al.* 1995, Locker *et al.* 1996a). Frightening and painful experiences can result in conditioned emotional responses (CER), which develop when an intensely negative or painful stimulus causes a reflective emotional response. The negative stimulus usually occurs in the presence of some other stimuli which are then associated with the original stimulus. The associated stimulus is called the unconditioned stimulus (US); and later it can automatically cause a response, pain or fear, which is referred to as the unconditioned response (UR). The US can cause an emotional response without the original painful or frightening stimulus, which is called the conditioned stimulus (CS). When an individual visits a dentist,

drilling (US) can cause a pain response (UR); and then a dentist or dental situation (CS) can cause fear and avoidance (CER). Later, merely thinking of a dentist or dental situation can cause an emotional response. One of the best ways to eliminate dental avoidance (CER) is to re-expose the person to a dental situation (CS) without experience of pain (US). (Davey 1989, Milgrom *et al.* 1995.)

Not all patients who are afraid of visiting a dentist report painful experiences (Milgrom *et al.* 1995, Locker *et al.* 1996a). A large percentage of fearful patients have reported that the personal and professional characteristics of the dentist were responsible for their fear (Milgrom & Weinstein 1993, Locker *et al.* 1996a, Abrahamson *et al.* 2000). The dentist-patient relationship, e.g. the interpersonal behavior and trust between patient and dentist, is a major issue for many of those who have dental fear and avoid dental treatment. People prefer to associate with other people who are interested in them and who make them feel comfortable. (Milgrom *et al.* 1995.) Also in children's acquisition of fear, the behavior-based dental experiences (e.g. dentist's behavior or child's temperamental traits) have been suggested to play a greater role than treatment experiences do (e.g. extractions or fillings) (ten Berge *et al.* 2002). Reduction in the patient's anxiety has been linked to the perception that the dentist was concerned about the patient's comfort, was empathic and supportive. Pain prevention, being friendly, working quickly, having a calm manner, giving moral support and being reassuring about pain are behaviors by the dentist that have been associated with reduction of dental fear (Corah *et al.* 1988). In addition, the consequences of traumatic experiences may be dependent on the context in which they occur. Pain inflicted by a dentist who is perceived as caring is likely to have less psychological impact than pain inflicted by a dentist who is cold and controlling (Milgrom & Weinstein 1993).

Patients who have never had painful or negative experiences in dentistry can have acquired dental fear based on indirect experiences (Milgrom *et al.* 1995, Abrahamson *et al.* 2000). These indirect experiences can be seen as exogenous reasons for dental fear. People can become emotionally aroused by observing other people's emotions, or fear can be learned by observing other people. The most common source of vicarious fear is probably from parent to children. By observing parents' behavior, their fear or dislike of dentistry, children can learn that "*dentists are to be avoided*". (Milgrom *et al.* 1995.)

Other ways of receiving fearful information are the many forms of mass media. For instance, cartoons in newspapers and magazines are full of

characterization of dentists as inflictors of torture. Also in many films and TV-series, visiting a dentist is portrayed as something unpleasant. Before even visiting a dentist, someone reading these cartoons and looking at these films can expect something traumatic to occur when she/he visits a dentist. During a dental visit she/he may perceive mildly uncomfortable stimulations as painful and her/his worst fears may be realized. (Milgrom *et al.* 1995.)

2.2.3 Other aspects related to development of dental fear

Cognitive aspects of anxiety

According to the cognitive model of anxiety (Beck *et al.* 1985) there are predisposing and precipitating factors that are associated with outset of anxiety disorders. The predisposing factors may make an individual potentially vulnerable and more prone to anxiety and/or anxiety disorders. These predisposing factors are: (1) genetic heritability – the role of genetic vulnerability cannot be fully appreciated without considering the interactive role of environment, psychological, and social factors; (2) physical disease states – a physical problem can coexist with anxiety problem; (3) psychological trauma – a single trauma or a series of traumatic experiences; (4) absence of coping mechanisms – defect in coping responses with a negative distorted view of ability to cope; and (5) dysfunctional thoughts, beliefs, assumptions, and cognitive processing – unrealistic beliefs about threat or danger. As a result of individual differences, an anxiety disorder may result from unique combination of predisposing and precipitating factors. The cognitive model points also several possible factors that may precipitate anxiety: physical disease or toxic substances, severe external stressors, long term stress, and stressors affecting a special emotional vulnerability of individual. (Freeman & DiTomasso 2002.)

The cognitive model of dental anxiety includes two major factors in development of dental fear: (1) the patients' earlier experience of dental treatment (see chapter "*Exogenous etiology*", above) and (2) the patients' perception of whether they have or could have control over what will happen during the dental visit (see chapter "*Lack of control and helplessness*", below). The model proposes that fear and avoidance behaviour are acquired through a variety of direct and/or indirect experiences. Past experience may lead patient to believe that

he will experience terrible things, beyond his coping ability, during the next visit to dentist. (Milgrom *et al.* 1995.)

Lack of control and helplessness

Lack of control and helplessness are fear-related features associated with visiting a dentist (Milgrom *et al.* 1995). If a person believes that she/he has no means of influencing negative effects, she/he will feel helpless and perceive a lack of control, which may cause fear. There are four types of control, which a dentist can increase among patients: (1) Behavioral (e.g. agreement about some behavioral signs); (2) Cognitive (e.g. recalling pleasant memories and comfortable places); (3) Informational (e.g. telling what is done); and (4) Retrospective (e.g. understanding that the uncomfortable feeling is a result of neglect of oral health care, not due to the dentist or the instruments). (Thompson 1981.) People are not likely to acquire dental fear if their experience of dental treatment is positive and they feel they are in control of the situation. Even negative experiences may not cause fear, if patients feel they have control. (Milgrom *et al.* 1995.)

Stimulus generalization

Stimulus generalization is a process by which a person conditioned to respond to one stimulus associated with pain or trauma will also respond emotionally to similar stimuli or situations. People who never have had direct negative experiences with dentistry might respond adversely to elements of dental situations that are similar to the situation in which they have been traumatized (e.g. medical / surgical procedures). (Milgrom *et al.* 1995.)

Latent inhibition

Latent inhibition can prevent an individual from acquiring dental fear because it is more difficult for a person to condition to fear or pain if several positive experiences occur before the negative ones. A dental patient might not acquire dental phobia if she/he has a traumatic experience after some years of relatively non-traumatic dental care (Davey 1989, ter Horst & de Wit 1993, de Jongh *et al.* 1995, ten Berge *et al.* 2002). The person's subjective evaluation of conditioned emotional responses (CER) can prevent her/him from acquiring dental fear. For instance, the patient may not acquire dental fear, because the pain is tempered by

the knowledge that painful experience will result in improved dental health. (Davey 1989.) The etiology of dental fear may vary according to the age of onset of dental fear, but it is not clear whether latent inhibition also applies to those who become dentally anxious during adolescence or adulthood (Locker *et al.* 1996a).

Psychodynamic aspects of anxiety

Psychoanalytic theory provides another perspective in order to understand patients with anxiety disorders. This theory includes two types of anxiety: traumatic anxiety and signal anxiety. In traumatic anxiety persons ego (psychic apparatus) is overwhelmed by psychologically meaningful danger: an excitation, which can not be dealt with. This results to an overwhelming, traumatic or automatic anxiety and the ego can not function or defend itself. Signal anxiety is an intrapsychic mechanism that generates small doses of anxiety to alert the ego to the presence of psychologically meaningful dangers and to act as a stimulus to mobilize defence. Signal anxiety prevents the experience of overwhelming traumatic anxiety, which is experienced during panic episodes. The psychoanalytic theory describes a developmental progression of central anxious fears in children. The traumatic or dangerous situations are: (1) Fear of the loss of the object (e.g. a loved parent – separation anxiety); (2) Fear of the loss of the objects love; (3) Fear of castration; and (4) Superego fear (fear of guilty conscience). The psychologically meaningful internal dangers that can potentially lead to the eruption of anxiety change with phase of life. With adults, several or all these developmental situational fears can operate simultaneously. (Milrod *et al.* 2002.)

According to the psychodynamic theory of dental fear, false connections and misunderstandings arising from previous dental treatment or from situations outside dentistry can be important in the experience of dental fear. False connections are simply misunderstandings when a person mixes-up what she/he has experienced in one situation and connects this in another situation. The confusion occurs because the two situations have something common, e.g. an inoculation injection and a local anaesthetic injection. The psychodynamic theory of dental anxiety explains dental fear as a neurotic anxiety and a consequence of the threat of an internal danger based on imagining what could happen during dental treatment. (Freeman 2007.) Dental work could precipitate emotional reactions leading to anxiety attacks with dental instruments being perceived as

objects of pain, violence and destruction (Sharma & Sharma 1976). A patient's ability to cope with intense fear would determine whether she/he is able to accept treatment. (Freeman 2007). Additionally, patients with high dental anxiety have reported positive events as being less likely to occur than patients with low anxiety have done (Kent 1985).

Vicious circle of dental fear

Dental fear or anxiety is suggested to lead to avoidance of dental care and, if treatment is neglected, to deterioration of oral health. The psychological effects of dental fear could be shame and embarrassment about poor oral health and avoidance of dental care. With time this might lead to a feeling of inferiority in social contacts with other people and increase dental fear. This could cause additional delay of dental care and further deterioration of oral health. (Berggren & Carlsson 1984, Berggren & Carlsson 1985, Armfield *et al.* 2007.)

Conclusions

The etiology of dental fear is multifactorial. The exogenous origin of dental fear can be seen as acquisition of fear as a function of direct or vicarious experiences. These experiences might not be the causes of the fear, but they might also be seen as possibilities for the development of fear among patients who have endogenous vulnerability to anxiety disorders and multiple fears (Armfield 2006). Development of fear can be seen as a continuum, at one end of the continuum requiring no learning and at the other end requiring a great deal of learning (Marks 2002). The endogenous or exogenous etiology of fear also affects the treatment of dental fear.

2.3 Measuring dental fear

Assessment of dental fear is important because it can assist dentists in the management of anxious patients. In addition, assessment of dental fear provides information on this psychological construct, which has been shown to predict dental attendance and to affect oral health. (Berggren & Carlsson 1984, Berggren & Carlsson 1985, Kvale *et al.* 2004.) Measurement of dental fear is important, but since dental fear is subjective and multidimensional it can be challenging to measure.

The criteria for an accurate measure of anxiety are identical to those essential for any measurement instrument: (1) Reliability, that the method yields consistent results over time; (2) Content validity, that the method measures unequivocally a specific dimension of anxiety (e.g. the intensity of the emotion); (3) That the method is relatively bias free (independent of procedural bias or patient/investigator responses biases); (4) That the method is versatile (applicable for clinical and laboratory use, practical in a variety of dental settings); and (5) That the method yields numbers on an identifiable number scale (statistical analyses can be conducted). (McGrath 1986.)

2.3.1 Questionnaires

Numerous measures have been developed for identifying dentally anxious people and for assessing their level of dental fear (Corah 1969, Kleinknecht *et al.* 1973, Kleinknecht *et al.* 1984, Moore *et al.* 1991, Schuurs & Hoogstraten 1993, Humphris *et al.* 1995, Newton & Buck 2000, Smith & Heaton 2003, Heaton *et al.* 2007). These range from single dental-anxiety questions (Milgrom *et al.* 1988) to multi-item scales, like Corah's Dental Anxiety Scale, DAS (Corah 1969), Kleinknecht's Dental Fear Survey, DFS (Kleinknecht *et al.* 1973), and the Modified Dental Anxiety Scale, MDAS (Humphris *et al.* 1995). The anxiety questions and scales measure different aspects of dental fear and are recommended to be used for different purposes.

The DAS is a four-item questionnaire that asks respondents to indicate their emotional reactions: anticipating dental visit, in the waiting room, anticipating drilling, and anticipating scaling. Each question has five response alternatives. In earlier research, DAS has been found to correlate highly with observed and reported dental anxiety (Corah 1969, Corah *et al.* 1978). Measuring dental fear with the DAS, scores of 13 and higher are supposed to indicate dental anxiety and scores 15 and higher phobic level of dental fear (Corah *et al.* 1978). The DAS lacks a question about dental fear of injections. It has also been argued that the DAS may miss or underestimate the anxiety levels of individuals who do not respond physically to dental treatment (Lindsay & Jackson 1993). The DAS can be used for screening dental anxiety and also as a brief measure in epidemiological studies (Moore *et al.* 1991).

The DAS has been modified to the MDAS by introducing a further question concerning local anaesthesia and by simplifying and standardising the answer

categories (Humphris *et al.* 1995, Humphris *et al.* 2000). The MDAS has five questions, each with five response alternatives, ranging from “*not anxious*” (score one) to “*extremely anxious*” (score five). The MDAS has been found to be a reliable and valid measure of dental anxiety. When the DAS and MDAS are compared, the results have been highly concordant. Conversion tables that have been presented for the DAS and MDAS make it easy to compare studies where the DAS and the MDAS have been used separately. (Freeman *et al.* 2007.) Measuring dental fear with MDAS, scores of 19 or higher are suggested to be indicative of phobic levels of anxiety (Humphris *et al.* 1995). When the Chinese version of MDAS was studied, it was found that MDAS consists of two factors; the two first items comprised anticipatory dental anxiety and the three last items comprised treatment-related dental anxiety (Yuan *et al.* 2008). The MDAS can be used in the same way as the DAS for screening dental anxiety and also as a brief measure in epidemiological studies. The DAS seems to measure situation-specific trait anxiety (Moore *et al.* 1991), and the MDAS seems to do the same. The DAS and the MDAS are perhaps the most popular instruments that have been used for studying dental fear (Corah 1969, Corah *et al.* 1978, Berggren & Meynert 1984, Stouthard & Hoogstraten 1990, Locker *et al.* 1991, Hakeberg *et al.* 1992, Moore *et al.* 1993, Vassend 1993, Thomsom *et al.* 1996, Bedi & McGrath 2000, Dailey *et al.* 2002, Freeman *et al.* 2007, Heaton *et al.* 2007, Humphris & Hull 2007).

Recently there have also been studies in which other multi-item questionnaires have been used (Kaakko & Murtomaa 1999, Skaret *et al.* 2003a, Heaton *et al.* 2007). Kleinknecht’s Dental Fear Survey (DFS) is an example of these questionnaires. The original DFS (Kleinknecht *et al.* 1973) has 27 items, but a 20-item version has been introduced (Kleinknecht *et al.* 1984, Schuurs & Hoogstraten 1993). DFS measures dental fear on a 5-point scale. (Kleinknecht *et al.* 1973.) The 20-item version of DFS has 3 dimensions: behavioral reports (patterns of making and keeping appointments), physiologic reports (e.g. heart rate, breathing, sweating) and cognitive reports of anxiety during typical events that occur at the dentist’s office (e.g. waiting in the waiting room, feeling the anaesthetic needle, seeing and hearing the drill) (Moore *et al.* 1991, Milgrom *et al.* 1995). In a review in which six scales of adult dental anxiety (including DAS, but not MDAS) were compared DFS was concluded to be the most sensitive, reliable and valid measure of dental anxiety. The greater number of items included in the DFS makes it more sensitive than shorter scales. (Schuurs & Hoogstraten 1993.) In a review comparing seven scales for measuring dental fear among adults (including DAS and MDAS) DFS was also recommended for use in

research (Newton & Buck 2000). The DFS has been shown to correlate positively and significantly with the MDAS, Gatchel's dental the Fear Scale (G'sDFS), and the Visual Analogy Scale (Heaton *et al.* 2007). DFS has been recommended for predicting anxiety, e.g. before treatment (Kaakko & Murtomaa 1999), and for measuring anxiety in research (Schuurs & Hoogstraten 1993, Newton & Buck 2000). The DFS seems to measure situation-specific trait anxiety (Moore *et al.* 1991, Heaton *et al.* 2007).

The Getz Dental Belief Survey (DBS) is another example of a long multi-item questionnaire. DBS measures dental fear with 28 items on 5-point scale and has been designed to complement the DFS. The DBS focuses on the dentist's behavior and on the process of how the care is delivered. The DBS explores three major areas: professionalism or ethics, communication, and lack of control. (Moore *et al.* 1991, Milgrom *et al.* 1995.) DBS can be used to measure confidence in relation to the dentist and situational fear associated with that relationship. DBS seems to measure the dental state anxiety. (Moore *et al.* 1991.) There are also interviews and several other questionnaires for assessing dental fear. The limitation of all long questionnaires and interviews is that the longer they are, the less willing people are to answer them.

Spielberger's State-Trait Anxiety Inventory (STAI) is an example of a general anxiety scale that has recently been used in dental research (Kaakko & Murtomaa 1999, Dailey *et al.* 2002, Heaton *et al.* 2007, Humphris & Hull 2007). Trait anxiety describes anxiety as a general aspect of personality and state anxiety as a response to a specific situation. STAI measures trait anxiety with 20 statements and state anxiety with 20 statements, each having four response alternatives. STAI has been tested extensively and found to be reliable and valid. A six-item version of the original STAI state anxiety scale has been devised, and it yields reliable and valid scores similar to those of the full version. (Newton & Buck 2000.)

2.3.2 Single questions

Single questions, e.g. "*How do you rate your own feelings towards dental treatment?*" (Milgrom *et al.* 1988, Neverlien 1990, Armfield *et al.* 2006, Lahti *et al.* 2007), or single-item scales, e.g. G'sDFS (Gatchel 1989, Hakeberg *et al.* 1992, Vassend 1993, Locker *et al.* 1996b), are easier and faster to use for measuring dental fear than multi-item scales are; but they lack specific information on what people are afraid of. In Norway, when the DAS and single dental-anxiety question

were compared, the single question was found to be a reliable and valid measure of dental anxiety (Neverlien 1990). Also in Finland, good validity, specificity and sensitivity were found for a single dental-anxiety question compared with the MDAS (Viinikangas *et al.* 2007).

Gatchel's Dental Fear Scale (G'sDFS) is a single-item scale that asks participants to rate their dental fear on a 10-point scale. A score of 1 indicates no dental fear; score of 8 or more is considered to indicate a significant degree of anxiety. Single anxiety questions, like G'sDFS, seem to measure general fear of dental treatment (Heaton *et al.* 2007), which is trait anxiety overlapping state anxiety. When a single dental-anxiety question, the DAS and the G'sDFS were compared, the association between the measures was statistically significant. It was also found, however, that the agreement between these measures was only fair to moderate. The G'sDFS used the most stringent and the single dental-anxiety question the most liberal cut-off point. The former seemed to include the most severe cases in the high fear group, and the later probably included those with both moderate and high levels of fear. (Locker *et al.* 1996b.) In two studies made in Sweden and Norway, when the DAS and G'sDFS were compared, small differences were found in the prevalence of high dental fear, but the differences were in opposite directions. (Hakeberg *et al.* 1992, Vassend 1993.) It has been suggested that DAS and G'sDFS, while related, measure different dimensions of dental fear (Locker *et al.* 1996b).

2.3.3 Many measures – advantages and disadvantages

There are both advantages and disadvantages to have several measures of dental anxiety. A disadvantage is that, since different studies have used different measures and different cut-off points for identifying who has or does not have dental fear, estimates of the prevalence of dental anxiety vary. According to different studies, 3% to 20% of adults report fear related to dentistry (Corah *et al.* 1978, Berggren & Carlsson 1984, Milgrom *et al.* 1988, Gatchel 1989, Stouthard & Hoogstraten 1990, Locker *et al.* 1991, Hakeberg *et al.* 1992, Moore *et al.* 1993, Vassend 1993, Thomson *et al.* 1996, Bedi & McGrath 2000, Ragnarsson *et al.* 2003, Armfield *et al.* 2006, Lahti *et al.* 2007, Nicolas *et al.* 2007). It is not clear whether these estimates reflect real differences among populations or whether they are due to differences in study sample or differences in study methods. On the other hand, since all measures of dental anxiety have limitations, it is an advantage to have several measures from which to choose. It has been

recommended that more than one measure of dental anxiety should be used in each study (Lindsay & Jackson 1993, Schuurs & Hoogstraten 1993, Locker *et al.* 1996b).

There has been concern that using questionnaires and asking about dental fear in a dentist's office might raise dental fear among dentally anxious patients. A recent study has shown that dental fear can be asked without causing anxiety in patients with or without dental phobia (Humphris & Hull 2007). In addition, a decrease in post-treatment anxiety was found among those patients whose dentist knew the pre-treatment dental anxiety scores of patients compared with patients whose dentist did not know their anxiety scores (Dailey *et al.* 2002). Thus, dentists should ask about dental fear when treating patients.

Conclusions

The choice of the instrument for measuring dental fear is not simple; and this choice affects the results and the interpretation of the results of different studies. The summary of the reviewed anxiety measures is presented in Table 1. When choosing an instrument for measuring dental fear, one should first know whether the purpose is to study trait anxiety or state anxiety. Single anxiety questions and short questionnaires are likely to measure trait anxiety overlapping with state anxiety. Long questionnaires are likely to measure state anxiety. Single questions and short questionnaires are useful for screening dental fear and can also be used in epidemiological studies. Long questionnaires can be used for measuring dental fear when fearful patients are being treated and can also be used in studies conducted in clinical situations (e.g. measuring dental fear before and after treatment of dental anxiety). (Moore *et al.* 1991, Schuurs & Hoogstraten 1993, Milgrom *et al.* 1995, Newton & Buck 2000.)

Table 1. Summary of anxiety measures.

Measure	Number of items	Reliability	Validity	Comment
Corah's Dental Anxiety Scale (DAS)	4	+	+	Most widely used questionnaire measure of dental anxiety. Measures situation-specific trait anxiety.
Modified Dental Anxiety Scale (MDAS)	5	+	+	Modified version of DAS, with increased range of scores and clinical relevance. Measures situation-specific trait anxiety.
Kleinknecht's Dental Fear Survey (DFS)	27 or 20	+	+	Three dimensions: avoidance of dental treatment, somatic symptoms and anxiety caused by dental stimuli. Measures situation-specific trait anxiety.
Getz Dental Belief Survey (DBS)	28	+	+	Designed to complement the DFS. Focuses on the dentist's behavior and on the process of how the care is delivered. Measures state anxiety.
Spielberger's State-Trait Anxiety Inventory (STAI)	20 + 20	+	+	Widely used in dental and other settings. Assesses specific fears (state) and general anxiety (trait).
Gatchel's Dental Fear Scale (G'sDFS)	1	-	+	Single anxiety question, participants rate their dental fear on a 10-point scale. Measures general fear of dental treatment.
Dental-anxiety question	1	+	+	Tends to overestimate severe dental anxiety, participants rate their dental fear on a 3-point or on a 5-point scale. Measures general fear of dental treatment.

+ Satisfactory

- Information not available

This table has been modified from a table presented by Newton & Buck 2000.

2.4 Dental fear and socio-demographic factors

Some people seem to be more vulnerable to dental fear than others are. Socio-demographic factors like gender, age or education might act as determinants of dental fear. The fact that women report dental fear more frequently than men do, seems to be universal (Schuurs *et al.* 1985, Milgrom *et al.* 1988, Stouthard & Hoogstraten 1990, ter Horst & de Wit 1993, Moore *et al.* 1993, Thomson *et al.* 1996, Armfield *et al.* 2006, Lahti *et al.* 2007). The differences between men and

women in reporting dental fear have been suggested either to reflect real gender differences in fear levels, or women might be socio-culturally more likely to admit dental fear than men are (Schuurs *et al.* 1985). Moreover, men and women might have different ways of showing fear.

Younger adults have been found to be more likely to report dental fear than older adults are (ter Horst & de Wit 1993, Moore *et al.* 1993, Ragnarsson 1998, Hägglin *et al.* 1999, Lahti *et al.* 2007), but the results reported in the literature concerning the association between dental fear and age are inconsistent. In a study by Locker *et al.* (1996a) the percentage of those having dental fear was higher among the age group 30–49 years than among the age group 18–29 years and lower still among the age group 70+ years. According to some other studies, dental fear was also lower among young adults, higher among the next age groups and again lower among the older groups (Milgrom *et al.* 1988, Stouthard & Hoogstraten 1990, Hakeberg *et al.* 1992, Thomson *et al.* 1996).

There have been very few longitudinal studies of dental fear. In New Zealand an increase in dental anxiety was observed when participants aged 15, 18 and 26 were followed over an eight-year period (Thomson *et al.* 2000). In a Swedish study where middle-aged and elderly women were monitored, dental anxiety decreased over the 28-year follow-up period. It is still unclear whether the differences in dental fear found between age groups reflect cohort effects, or whether dental fear really does decline with increasing age. In the longitudinal Swedish study, the difference in dental fear between age groups was concluded to be an age effect rather than a cohort effect. (Hägglin *et al.* 1999.)

Results of those studies that include the association between dental fear and level of education are inconsistent. In some studies, educational level and dental fear have not been found to be related (Milgrom *et al.* 1988, Hakeberg *et al.* 1992, ter Horst & de Wit 1993, Thomson *et al.* 1996). In other studies participants with lower education have been more likely than those with higher education to report dental anxiety (Hällström & Halling 1984, Schuurs *et al.* 1985, Moore *et al.* 1993, Ragnarsson 1998), but also controversial results have been obtained (Stouthard & Hoogstraten 1990, Lahti *et al.* 2007).

The association between dental fear and marital status is also inconsistent. In an American study dental fear and marital status were not related (Milgrom *et al.* 1988), but in a Dutch study divorced men and women reported higher levels of anxiety than married people did (Schuurs *et al.* 1985); and in a Finnish study cohabiting women reported higher dental fear than single women did (Lahti *et al.*

2007). In a Canadian study separated or divorced people were more likely to be dentally anxious than were married, single or widowed participants (Locker & Liddell 1991). A Swedish study compared the marital status among patients having agoraphobia, social phobia, claustrophobia, blood phobia and dental phobia. The proportion of single and divorced people was greatest among those with dental phobia. (Öst 1987.)

Other factors, such as socioeconomic position, have been associated with dental fear. People with high income have reported less dental fear than those with lower income (Stouthard & Hoogstraten 1990, Moore *et al.* 1993), but in a Swedish study no correlation was found between dental fear and income (Hakeberg *et al.* 1992). According to the results of a national study made in Australia, income was not associated with dental fear (Thomson *et al.* 1996), but another Australian study showed that people with higher socioeconomic position reported fear less often than those with lower socioeconomic position (Armfield *et al.* 2006).

According to the literature reviewed above, gender seems to be a strong determinant of dental fear. Age, education, marital status, and socioeconomic position also seem to be determinants of dental fear, although the strength and direction of the association seem to differ between countries and populations.

2.5 Dental fear and oral health

In many studies, dental fear has been associated with poor self-reported (Schuurs *et al.* 1985, Milgrom *et al.* 1988, Stouthard & Hoogstraten 1990, Locker & Liddell 1991, Thomson *et al.* 1996, Bedi & McGrath 2000, Ragnarsson *et al.* 2003) or clinically determined oral health (Berggren & Meynert 1984, Cohen 1985, Locker & Liddell 1992, Wisloff *et al.* 1995, Hägglin *et al.* 1996, Ragnarsson 1998, Hägglin *et al.* 2000, Schuller *et al.* 2003, Ng & Leung 2008). High dental anxiety has been associated with poor dental health measured as numbers of decayed, filled or missing teeth. Greater numbers of decayed teeth are found among people with high dental fear compared to people with low dental fear (Cohen 1985, Wisloff *et al.* 1995, Hägglin *et al.* 1996, Ragnarsson 1998, Hägglin *et al.* 2000, Schuller *et al.* 2003, Ng & Leung 2008).

When dental health is measured with the numbers of restored and missing teeth, the association between dental fear and dental health is inconsistent. In some studies, more missing teeth (Hällström & Halling 1984, Locker & Liddell 1992, Vassend 1993, Hägglin *et al.* 1996, Hägglin *et al.* 2000, Schuller *et al.*

2003, Ng & Leung 2008) and in other studies fewer restored teeth (Locker & Liddell 1992, Ragnarsson 1998, Hägglin *et al.* 2000, Schuller *et al.* 2003, Ng & Leung 2008) have been found among those with high dental fear than among those with low dental fear. There have also been studies in which those with high dental fear have had more restored teeth (Wisloff *et al.* 1995, Vassend 1993) than those with low dental fear, or in which no difference in the number of restored teeth (Cohen 1985, Hägglin *et al.* 1996) or missing teeth (Cohen 1985, Ragnarsson 1998, Hägglin *et al.* 1996) has been found between those with high and low dental fear.

Among adults with high and low dental fear, differences in the number of decayed (DT), missing (MT) and filled (FT) teeth have been found, but in most studies there has been no difference when dental health was measured with the DMFT-index (Locker & Liddell 1992, Thomson *et al.* 2000, Schuller *et al.* 2003). In a recent study made in Hong Kong those with high dental fear had on average higher DMFT than did those with lower fear (Ng & Leung 2008).

The results of studies of the association between dental fear and edentulousness are also inconsistent. Edentulous participants have been found to be more (Schuurs *et al.* 1985, Milgrom *et al.* 1988, Locker *et al.* 1991, Locker & Liddell 1992) or less likely (Hägglin *et al.* 1996) to have dental fear than dentate participants. There are also studies in which no difference in dental fear has been found between dentate and edentulous participants (Moore *et al.* 1993, Thomson *et al.* 1996, Ragnarsson 1998).

There have been only a few studies in which the periodontal health between groups with high and low dental fear has been compared. In two Swedish studies more alveolar bone loss was reported among those with high dental fear than among those with low dental fear (Hällstöm & Halling 1984, Hakeberg *et al.* 1993). In Canada no statistically significant difference was found in periodontal status between dentally anxious and non-anxious participants after controlling for age (Locker & Liddell 1992). Among general population in Hong Kong those with high dental fear were more likely to have poor periodontal health than those with low fear were (Ng & Leung 2008).

2.6 Dental fear, oral health habits and behaviors

Behaviors and habits are everyday activities people repeat many times. People usually act out their first-time experiences deliberately and consciously by

searching for information and planning the behavior. Afterwards they evaluate the outcome of the behavior and may plan to do the same again. The process changes when people start to repeat the behavior. They no longer plan, think or evaluate; but when the time has come to act, they simply act. Now the behavior can be called a habit. (Verplanken 2005.) According to another definition, habits are “... *learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining goals or end-states*” (Verplanken & Aarts 1999). According to these definitions, toothbrushing is a habit most people do daily without planning. Visiting a dentist requires planning and can be considered a behavior. It is widely believed that “*past behavior is the best predictor of future behavior*” (Verplanken 2005). Dental fear affects oral health behavior such as dental attendance and oral habits like dental cleaning. These associations will be reviewed in more detail in the next chapters.

2.6.1 Dental attendance

According to a model of utilization of dental services (Andersen & Newman 1973, Petersen 1990), factors related to background, socioeconomic aspects, the individual and the dental health system affect the utilization of services. Dental fear can be seen as an individual factor. Age, gender and previous experiences of dental care can be seen as examples of background factors, with education and perceived treatment need as examples of socioeconomic factors and substitution of dental care as an example of factors related to the system of dental health service. In Finland, until recently, subsidization of dental care has varied between age groups and may have affected dental attendance in different age groups. Many of the factors related to utilization of dental services are also related to dental fear.

It is well documented that dental fear has an impact on dental attendance. The most obvious consequence of dental fear is avoidance of dental care. It has been shown that dental fear correlates positively with the length of intervals between dental visits and frequent use of emergency care (Berggren & Meynert 1984, Milgrom *et al.* 1988, Locker & Liddell 1991, Hägglin *et al.* 1996, Bedi & McGrath 2000, Scheutz & Heidmann 2001, Skaret *et al.* 2000, Abrahamsson *et al.* 2001, Ragnarsson *et al.* 2003, Meng *et al.* 2007). On the other hand, some studies have shown that many patients with dental fear visit a dentist regularly (Schwarz 1990, Hakeberg *et al.* 1992, Vassend 1993).

It has been suggested that dental fear acts as a barrier to dental care and that social and environmental factors are predictors of dental attendance (Schuurs *et al.* 1985, ter Horst & de Wit 1993, Pavi *et al.* 1995, Scheutz & Heidmann 2001, Sanders *et al.* 2006). People with prolonged avoidance may report that their dental fear, dental health and avoidance of care cause feelings of shame and inferiority. This may have negative effects on their work and social life. (Berggren & Carlsson 1984, Berggren & Carlsson 1985.) Those who can cope with high dental fear and visit a dentist regularly can feel more socially acceptable than those who use dental services irregularly. In addition, a long pattern of regular attendance among those with high dental fear might work as latent inhibition (Davey 1989, ter Horst & de Wit 1993) and enhance regular dental attendance. Despite the fact that women report dental fear more commonly than men do, women visit a dentist on average more regularly than men do (Scheutz & Heidmann 2001, Skaret *et al.* 2003b).

2.6.2 Oral-cleaning habits

As described above, dental fear may act as a barrier to dental care (Milgrom *et al.* 1988, Stouthard & Hoogstraten 1990, Thomson *et al.* 1996, Bedi & McGrath 2000, Ragnarsson *et al.* 2003). Since good oral-cleaning habits reduce the need for treatment, it would be logical that individuals with high dental fear would try to avoid dental treatment by maintaining good oral hygiene.

There have been only a few studies of the association between dental fear and oral-cleaning habits (Stouthard & Hoogstraten 1990, Wisloff *et al.* 1995, Schuller *et al.* 2003). In daily toothbrushing only slight (Wisloff *et al.* 1995) or no differences (Schuller *et al.* 2003) have been found between those with high and low dental fear. Daily use of dental floss and toothpicks has not shown differences between dental-fear groups, but the overall hygiene score has been reported to be lower among those with high than among those with low dental fear (Schuller *et al.* 2003). People with high dental fear do not seem to take better care of their oral health than people with low dental fear do. In addition, people with high dental anxiety have been reported not to consider the preservation of teeth very important (Stouthard & Hoogstraten 1990).

2.6.3 Smoking

Smoking has adverse effects on both general and oral health (Winn 2001, Taybos 2003, Bergström 2004, Figueiredo *et al.* 2007, Morse *et al.* 2007, Heitz-Mayfield 2008). Current smokers have reported higher levels of anxiety than people who have never smoked or are ex-smokers (Jarvis 1994, Grillon *et al.* 2007). Anxiety in general has been associated with smoking (Jarvis 1994, Grillon *et al.* 2007), but very little is known about the association between dental fear and smoking.

Smoking can be seen as an indicator of a stressful lifestyle, and many smokers and some researchers believe that smoking has calming and relaxing effects (Jarvis 1994, West & Hajek 1997), but the evidence for this is inconsistent. According to some studies, nicotine may be an anxiogenic agent. Giving up smoking and removing nicotine from the body is rapidly followed by a reduction in anxiety. (West & Hajek 1997.)

2.7 Dental fear and oral health-related quality of life

There is a lack of consensus regarding the definition of Quality of life (QoL), but it has been recognized that QoL refers to something much broader than health (Locker 1997). In general terms, QoL is about goodness of life; and Health Related-Quality of Life (HRQoL) is the goodness of those aspects of life that are affected by health (Bowling 2005). Similarly, Oral Health-Related Quality of Life (OHRQoL) could be seen as goodness of those aspects of life that are affected by oral health. OHRQoL has been defined as *“The impact of oral disorders on aspects of everyday life that are important to patients and persons, with those impacts being of sufficient magnitude, whether in terms of severity, frequency or duration, to affect an individual's perception of their life overall”* (Locker & Allen 2007). The relationship between dental fear and OHRQoL is a rather new field of research and only a few studies have focused on it. These studies will be reviewed in the next chapter.

Oral health-related quality of life or Subjective oral health

Several questionnaires have been used to measure OHRQoL, e.g. Oral Health Impact Profile (OHIP), Geriatric/General Oral Health Assessment Index, Oral Impacts on Daily Performance, and The Oral Health Quality of Life Inventory. The two main criteria for measures of HRQoL are that they should be patient-

centered and incorporate aspects of daily living that patients find important. The questionnaires should adequately capture the views and concerns of those completing the questionnaires. The process of developing these questionnaires has almost always been expert-centered, and the questionnaires only partially fulfill the two main criteria for measures of health-related quality of life. The questionnaires might measure subjective oral health rather than OHRQoL, but they might also capture events which have an impact on general well-being and quality of life. (Locker & Allen 2007.)

There have not been many studies of the association between dental fear and subjective oral impacts. People with high dental fear have more commonly reported subjective oral impacts than people with low fear have (McGrath & Bedi 2004, Mehrstedt *et al.* 2004, Mehrstedt *et al.* 2007, Ng & Leung 2008, Vermaire *et al.* 2008). According to a random population sample in the UK, those with high levels of anxiety were about twice as likely to be among those most often reporting subjective oral impacts than were those with lower level of dental fear (McGrath & Bedi 2004). In a community study made in Hong Kong, those with high dental fear were more likely to report subjective oral impacts than were those with lower dental fear (Ng & Leung 2008). Also in two studies that included patients at a dental fear clinic, those with higher dental anxiety more often reported subjective oral impacts than did those with lower anxiety (Mehrstedt *et al.* 2007, Vermaire *et al.* 2008).

The combination of dental treatment and behavioral management has been shown to be effective in lowering dental fear (Kvale *et al.* 2004, de Jongh *et al.* 2005). According to a recent Dutch study that included patients at a dental fear clinic, treatment of dental fear and reduction of dental anxiety, rather than improved oral health, lowered the number of subjective oral impacts (Vermaire *et al.* 2008). Therefore, treatment of dental fear might be more effective in improving well-being of those with high dental fear than dental treatment is.

2.8 Perceived oral health and satisfaction with care

In addition to questionnaires, also single questions, like “*How would you describe the condition of your natural teeth?*” or “*How would you describe the health of your teeth and gums?*”, have been used to study subjective oral health. (Slade *et al.* 2005.) In the UK those who rated their oral health as good had on average lower level of dental fear than those who rated their oral health as moderate or

poor (Bedi & McGrath 2000). In the Netherlands similar results were found; those who reported bad oral health were among those who were most likely to experience dental anxiety (Stouthard & Hoogstraten 1990). Also in the USA persons with high dental fear were more likely to reported poor dental health and to require dental treatment compared to people with low dental fear (Milgrom *et al.* 1988).

There have also been studies in which dental fear has been associated with poor self-reported dental health measured with questions including information on dentate status, number of remaining teeth and toothache. Those with poor perceived dental health or many subjective oral impacts have been reported to be more likely to have high dental fear than those with good perceived dental health or few subjective oral impacts. (Schuurs *et al.* 1985, Locker & Liddell 1991, Thomson *et al.* 1996, Ragnarsson *et al.* 2003.)

Satisfaction with health care has been shown to be connected with individual characteristics and with the health care system (Sitzia & Wood 1997). Dental anxiety, experience of pain and the dentist-patient relationship as well as the technical competence of the dentist, the cost and accessibility of dental care have been shown to be parameters related to patient satisfaction with dental care (Corah *et al.* 1988, ter Horst & de Wit 1993, Sitzia & Wood 1997, Hakeberg *et al.* 2000, Ståhlacke *et al.* 2007, Vermaire *et al.* 2008). Satisfaction with dental visits has been found to correlate positively with regular use of services and negatively with dental anxiety (Liddell & Locker 1992, Thomson *et al.* 1999, Skaret *et al.* 2005, Ståhlacke *et al.* 2007, Vermaire *et al.* 2008). The patient-perceived dentist behaviors that have been reported to increase satisfaction and to reduce dental fear have been calm manner and dedication to preventing pain (Corah *et al.* 1988).

Patients' subjective satisfaction and well-being are included in the multidimensional concept of OHRQoL. For instance, the short version of the Oral Health Impact Profile (OHIP-14) questionnaire includes general satisfaction with life in the dimension of Handicap (Locker 1988, Slade & Spencer 1994).

2.9 Conclusions based on the literature reviewed

The etiology of dental fear is multifactorial and dental fear can have both endogenous and exogenous components. Some people may be more vulnerable to anxiety disorders and multiple fears than some other people are. Endogenous origin of dental fear indicates that dental fear is part of a more generalized anxiety

syndrome. Exogenous origin of dental fear refers to fears that are acquired as a function of direct experience or through vicarious experiences that people feel to be threatening. These negative experiences may include intense pain or fright, or may involve negative interpersonal interactions between dentist and patient.

Since dental fear is subjective and has many components, measuring it is challenging. The choice of the measuring instrument affects, e.g. the level of reported anxiety. Single anxiety-questions and short questionnaires are likely to measure trait anxiety overlapping with state anxiety. Long questionnaires are likely to measure state anxiety. Single questions and short questionnaires are useful for screening dental fear and can also be used in epidemiological studies. Long questionnaires can be used for measuring dental fear when fearful patients are being treated and can also be used in studies conducted in clinical situations.

According to the literature reviewed, gender seems to be a strong determinant of dental fear. Women report dental fear more commonly than men do. Age, education, marital status, and socioeconomic position also seem to be determinants of dental fear, although the strength and direction of the association seem to differ between countries and populations.

The most obvious consequence of dental fear is avoidance of dental care. It has been shown that dental fear correlates positively with the length of intervals between dental visits, episodic use of dental services and frequent use of emergency care. The overall oral hygiene has been reported to be lower among those with high than among those with low dental fear. Dental fear has been associated with poor self-reported or clinically determined oral health.

There have not been many studies of the association between dental fear and quality of life or rather subjective oral impacts. In these few studies, people with high dental fear have more commonly reported subjective oral impacts than people with low fear have. Additionally, those with poor perceived dental health or many subjective oral impacts have reported high dental fear more frequently than those with good perceived dental health or few subjective oral impacts have done.

In Finland dental fear among adults has not been a focus of many previous studies. In other countries, there have been many studies conducted among adults, but nationally representative data are rare, and the generalization of the results has been difficult. Many times the samples have been not large enough to consider simultaneously the possible confounders and/or effect modifiers. Large nationally

representative studies including a wide age range are needed. Also the association between dental fear and subjective oral impacts needs to be studied in the future.

3 Aim of the present study

The general aim of this work is to increase knowledge about dental fear among adults in Finland by investigating how dental fear affects dental health, oral health habits/behaviors, and oral health-related quality of life.

The specific objectives are to study the association between dental fear and

1. self-reported and clinically evaluated dental health
2. oral health habits/behaviors, including tooth cleaning, smoking and dental attendance
3. subjective oral impacts and perceived oral health

4 Material and methods

4.1 Study sample

A nationally representative Health 2000 survey was carried out in Finland in 2000–2001 by the National Institute for Health and Welfare (formerly National Public Health Institute). The two-stage stratified cluster sample represented the population aged 30 years and older living in mainland Finland. The frame of the study was regionally stratified according to the five university hospital regions, each containing about one million inhabitants. From each of these regions, 16 health care districts were sampled as clusters. The total number of health care districts was 80. The 15 largest health care districts, including the 15 largest towns, were in the sample. The rest of the health care districts were selected by systematic probability-proportional-to-size sampling within each university hospital region. To ensure sufficient data for those aged 80 years and older, the sampling fraction of these oldest subjects was doubled. Detailed information on the sampling method has been published elsewhere.

The original sample of the survey comprised 8028 participants. The final sample size was 7977; of these participants 6986 were interviewed, and 6335 participants attended the clinical oral examination. The questionnaire on subjective oral impacts was answered by 5947 participants. (Aromaa & Koskinen 2004, Suominen-Taipale *et al.* 2008.)

4.2 Measures of observation

The data were collected in interviews, questionnaires and clinical dental examinations. The interviews were made by professional interviewers from the Statistical Centre of Finland. The clinical oral examination was conducted by five dental teams, which were trained to perform the clinical oral examination according guidelines (see chapter 4.2.2).

4.2.1 Health interview and questionnaires

The participants were interviewed in their homes or institutions. Before the interview, the addresses of the participants were checked in a letter proposing a time for the interview. The interview was used to gather background socio-

demographic and economic information, information about health and illnesses, use of health services, lifestyle and health habits, functional capacity, work and work capacity, and need for help and rehabilitation. The interview lasted about 90 minutes and included a question about dental fear. The participants signed an informed consent form during the interview.

Questionnaires 1–3 were filled in before, during or after the examination and returned during the health examination or mailed back to the National Institute for Health and Welfare (formerly National Public Health Institute). Questionnaire 3 included questions on sleeping and living habits and health related quality of life variables such as OHIP-14 scale, which was used in the present study. Questionnaire 1 (questions mainly about functional capacity, symptoms and mental health), Questionnaire 2 (questions mainly about infections and vaccinations), symptom interview and dietary questionnaire were also parts of the Health 2000 study, but they were not used in the present study. For more information about the questionnaires see Aromaa & Koskinen 2004 and Suominen-Taipale *et al.* 2008.

4.2.2 Clinical dental examination

During the health examinations, clinical oral examinations were conducted by five teams, each including a dentist and a dental nurse. The teams were trained to perform the clinical oral examination. The clinical examination lasted 15 minutes and was based on WHO guidelines (World Health Organization 1977), which were modified to make the data comparable to the previous nationwide survey in 1980 (Vehkalahti *et al.* 1991).

The clinical oral examination included dental, gingival and mucosal health, temporo-mandibular function and denture status. An orthopantomogram was also taken. Dental status covered diagnoses on 32 teeth. For each tooth, one of the following options was recorded: sound, decayed (separately as crown caries only, root caries only, or both, whether filled or not), restored (filling or prosthetic crown, but no caries), fractured (with no caries), residual root (separately with or without caries), and missing. For this study participants' dental health was described as numbers of sound teeth, decayed teeth (including fractured teeth), restored teeth, missing teeth (including residual roots) and remaining teeth.

To evaluate the inter-examiner reliability of the diagnoses the dentists performing the oral health examination were calibrated during training given before the study. Parallel measurements on 269 participants were carried out

during data collection and inter-examiner kappa value for tooth-specific diagnoses was 0.87 (95% CI 0.84–0.89). (Suominen-Taipale *et al.* 2008.)

4.2.3 Data used in the original articles

Papers I and III included dentate participants and Papers II and IV dentate and edentulous participants. In Paper I self-reported dentate status was used. In Paper II results from clinical dental examination were used, and in Paper III participants were considered dentate if at least one natural tooth was found during the clinical examination. Also the number of remaining teeth, used in Paper IV, was determined during clinical dental examination. A summary of the number of participants used in Papers I-IV is presented in Table 2. The numbers of applicable participants vary due to missing data in the variables used in Papers I-IV.

Table 2. Summary of data used in Papers I – IV.

	Number of participants	Home Interview	Clinical examination	Questionnaire
Paper I	n = 5187	x		
Paper II	n = 6335	x	x	
Paper III	n = 5557	x	x	
Paper IV	n = 5897	x	x	x

4.3 Methods

A stratified, two-stage cluster-sampling design was used in the survey. To correct the effect of non-response, corresponding weights were used. These weights were based on gender, age, region and language. (Aromaa & Koskinen 2004, Suominen-Taipale *et al.* 2008.)

4.3.1 Categorization of variables

Dental fear

The variable “*dental fear*” was used in all Papers I-IV. During the interview this was determined by a single question: “*How afraid are you of visiting a dentist?*”. The response options: “*Not at all*”, “*Somewhat*” and “*Very*”, were first used as such. Later the options “*Not at all*” and “*Somewhat*” were combined into one category indicating low or no fear and “*Very*” was used as the category for high fear. Dental fear was used as a dependent variable in Papers I-III (very afraid = 1, and somewhat or not at all afraid = 0). Because dental fear was measured with a single question, it was not possible to distinguish between dental fear, anxiety and phobia, which reflect the continuum of the intensity of patient’s fear reaction. In this study the term dental fear is used to cover this continuum. A summary of the outcome and explanatory variables used in Papers I-IV is presented in Table 4.

Socio-demographic factors

Socio-demographic factors used in the present study were: age, gender, attained level of education and marital status. Age was rounded to the nearest full year and was first categorized into five age groups: 30–34 years, 35–44 years, 45–54 years, 55–64 years and 65+ years. This categorization was based on the observed age-specific percentages of people with dental fear and was used in Papers I, II and IV. The second way of categorizing age was to use three age groups: 30–34 years, 35–64 years and 65+ years. This categorization was used because the largest differences in dental fear were between the youngest and oldest age groups. The latter categorization was used in Papers I and III. The purpose of these categorizations was to form age groups among which the prevalence of dental fear would differ. The categorization of age also reflected the history of provision of dental services for different birth cohorts, seen as age groups in this study, during recent decades in Finland (Table 3).

Table 3. Characteristics of dental health care and its subsidization to which people in Finland belonging to different age groups / birth cohorts have been entitled before the study period.

Age group	Birth cohort	Characteristics of dental health care during childhood and school years	Subsidization of dental health care during adulthood before study period
30–34	1966-1970	Have been entitled to free, comprehensive and preventively oriented dental health care since 1972 until the age of 19 years.	Have been entitled to subsidized private dental care or in some areas to preventively oriented public dental care.
35-44	1956-1965	The younger participants have been entitled to preventively and the older to restoratively oriented school dental care.	Have gradually been entitled to subsidized private dental care or in some areas to preventively oriented public dental care.
44-55	1946-1955	Have been entitled to restoratively oriented school dental care during elementary school. The system lacked dentists, especially in rural areas.	No subsidization of dental health care after elementary school.
55-64	1936-1945	No organized dental care during school years.	No subsidization of dental health care.
65+	1935 or before	No organized dental care during school years.	No subsidization of dental health care.

In Papers I, III and IV the attained level of education was used to describe the study sample. Attained level of education was asked in the interview and was assessed using information on formal schooling and vocational training. For the analyses, level of education was first used as a categorical variable (basic, secondary, high) and dichotomized in two ways (basic = 1; basic or secondary = 1). In Paper I marital status was also used to describe the study sample. The question of marital status gave five response options, of which “*Divorced or Separated*”, “*Widowed*” and “*Single*” were later combined into the category “*Single*”, and “*Married*” or “*Cohabiting*” into the category “*Non-single*”. This was done in order to compare dental fear between the groups of single (= 0) and non-single (= 1) participants.

Perceived oral health, perceived treatment need and satisfaction

In Paper I information on perceived oral health, treatment need and satisfaction with dental services was used. In the interview the question about perceived oral

health gave five reply alternatives, of which “*Good*” and “*Rather good*” were combined into the category “*Good perceived oral health*” (= 0) and “*Moderate*”, “*Rather poor*” and “*Poor*” into the category “*Poor perceived oral health*” (= 1). The question on perceived need for dental care gave reply options “*Yes*” (= 1) and “*No*” (=0). The question about satisfaction with dental services during the last treatment period gave five reply alternatives, of which “*Very satisfied*” (=0) was kept as one category and the options “*Rather satisfied*”, “*Not satisfied but not dissatisfied either*”, “*Rather dissatisfied*” and “*Very dissatisfied*” were combined into the category “*Not satisfied*” (= 1). This was done because less than 4% of the subjects belonged to the last three categories.

Clinical findings

In Paper II the mean numbers of sound, decayed, missing and restored teeth were compared among those with high, moderate and low dental fear. Later the numbers of sound, decayed, missing and restored teeth were entered in to the multiple logistic regression analysis as discrete variables. In Paper IV the number of remaining teeth was used as a categorical variable (0, 1–19 and 20–32 remaining teeth).

Oral health habits and behavior

In Papers I-IV information about regularity of dental attendance was used. It was determined in the interview by the question: “*Do you usually visit a dentist?*”. There were three response options, of which “*Regularly for check-up*” indicated “*Regular attendance*” and “*Only when I have pain or other problems*” and “*Never*” were combined to indicate “*Irregular attendance*”. In Paper IV among edentulous participants the regularity of checking dentures was used. It was asked by the question: “*How often do you have your dentures checked?*”. Reply alternatives “*Once every year*” and “*At least once every five years*” were combined indicating “*Regular attendance*” and alternatives “*Less often than once every five years*” and “*Never*” were combined indicating “*Irregular attendance*”. To analyse dentate and edentulous participants together the answers indicating “*Regular attendance*” (= 0) were combined and the same was done with answers indicating “*Irregular attendance*” (= 1).

In Paper III oral cleaning habits were investigated. The categorization of cleaning habits was based on recommendations commonly used in Finland in oral

health education. The frequency of toothbrushing was determined in the interview by the question: “How often do you brush your teeth?”. The reply options “More than twice a day” and “Twice a day” were combined into the category “At least twice a day” (= 0) and “Once a day”, “Less than every day” and “Never” into the category “Less than twice a day” (= 1). The frequency of other tooth-cleaning habits was ascertained by the question “How often do you use dental floss or interdental brush, toothpicks and/or fluoride toothpaste for cleaning and caring for your mouth and teeth?”. The reply option “Daily” (= 0) was kept as such and the options “Weekly”, “Less than weekly” and “Not at all” were combined into the category “Less than daily” (= 1).

The question about regularity of smoking gave three reply alternatives, of which “Daily” indicated “Regular smoking” (= 1) and “Occasionally” and “Not at all” were combined indicating “Smoking occasionally or not at all” (= 0).

Subjective oral impacts

The OHIP-14 questionnaire used in Paper IV contained 14 questions that asked about the frequency of adverse oral impacts during the past month. The OHIP-14 questionnaire was included in Questionnaire 3, which was handed to the participants in connection with the health examination and returned by mail. The OHIP-14 questionnaire includes seven dimensions: “Functional Limitation”, “Physical Pain”, “Psychological Discomfort”, “Physical Disability”, “Psychological Disability”, “Social Disability” and “Handicap”, which all have two questions. When referring to these dimensions the expression “in the dimension” includes both of the questions and “within the dimension” includes one of the two questions in the dimension. The frequency of each impact was reported on a six-point scale: “very often”, “fairly often”, “occasionally”, “hardly ever”, “never” and “do not know”. “Prevalence”, “extent” and “severity” were constructed and used as outcome variables. Prevalence described the percentage of people reporting one or more items often (fairly often or very often); extent indicated the number of items reported “often” (range 0–14); and severity described the sum of ordinal responses, which takes into account the impacts also experienced occasionally or hardly ever (rang 0–56). In Paper IV the dependent variable was subjective oral impacts measured with the OHIP-14 questionnaire (at least one subjective oral impact “fairly often” or “very often” = 1 and “never”, “hardly ever” or “occasionally” = 0). The OHIP-14 questionnaire

has previously been used in national surveys in Australia, Finland, and UK and it has been found to be reliable for studying subjective oral impacts (Steele *et al.* 2004, Slade *et al.* 2005, Lahti *et al.* 2008).

Table 4. Summary of the outcome and explanatory variables in Papers I-IV.

Variables	Outcome variable in Paper	Explanatory variable in Paper
Dental fear	I, II, III	IV
Socio-demographic factors		
Gender		I, II, III, IV
Age		I, II, III, IV
Attained level of education		I, III, IV
Marital status		I
Health interview		
Perceived oral health		I
Perceived treatment need		I
Satisfaction of dental services		I
Clinical findings		
Number of teeth		IV
Number of sound teeth		II
Number of decayed teeth		II
Number of restored teeth		II
Number of missing teeth		II
Oral health habits		
Dental attendance		I, II, III, IV
Toothbrushing		III
Use of tooth picks		III
Use of dental floss		III
Use of fluoridated toothpaste		III
Smoking		III
OHIP-14 items		
Prevalence	IV	
Extent	IV	
Severity	IV	

4.3.2 Statistical analyses

Cross-tabulation was used to analyze bivariate associations between outcome and explanatory variables. Chi-square tests were used to evaluate the statistical significances of these associations. When distributions of explanatory variables

were skewed (Papers II and IV), Kruskal-Wallis and Mann-Whitney tests were used to evaluate the statistical significances of differences.

The etiologic fraction was calculated to estimate how large part of irregular dental attendance was due to high (or moderate) dental fear. The etiologic fraction among exposed (high or moderate dental fear) is the proportion by which the rate of the outcome (irregular dental attendance) among the exposed would be reduced if the exposure was eliminated (no dental fear). The etiologic fraction among population can be interpreted similarly as the etiological fraction among exposed.

To explore the associations between dental fear and dental attendance, dental fear and tooth condition, and dental fear and oral health habits, multiple logistic regression analyses were conducted. Simultaneously, the possible confounding and/or modifying factors (e.g. age, gender and education) were considered. Dental fear was used as dependent variable in Papers I-III and subjective oral impacts measured with OHIP-14 questionnaire in Paper IV. The results were expressed as odds ratios (OR) and their 95% confidence intervals (95% CI). In Papers I-III, to achieve sufficiently fitting models, the manual backward method was used for selection of variables. The initial models were full models that included all independent variables and their first-order interactions terms. In addition in Paper I, age-specific models were constructed using the manual backward method. In Paper IV logistic regression analyses were used to determine whether the number of remaining teeth modified the association between dental fear and subjective oral impacts. This was done by entering into the model the interaction between dental fear and the number of remaining teeth together with the independent variables. Statistical significance was set at $p < 0.05$.

4.4 Ethical aspects

Permission for the study was given by the ethics committees of the University Hospital Region of Helsinki and Surroundings and the National Institute for Health and Welfare (formerly National Public Health Institute).

5 Results

5.1 Prevalence of dental fear (Papers I & II)

Of the participants 9.5% were very afraid and 27.1% were somewhat afraid of visiting a dentist (Table 5). High dental fear was more often reported by women than by men. The percentage of those who were very afraid of visiting a dentist was higher among younger than among older age groups. Participants with high education were less often and participants with secondary education more often very afraid of visiting a dentist than were participants with basic education.

Table 5. Percentages of participants according to level of dental fear, gender, age, education, marital status and dentate status, n = 6335.

		n	Very afraid	Somewhat afraid	Not at all afraid	p
Gender	Men	2869	6.2	22.9	70.9	< 0.001
	Women	3466	12.4	31.1	56.5	
Age	30-34	694	13.3	33.7	53.0	< 0.001
	35-44	1454	10.8	33.5	55.7	
	45-54	1624	10.3	29.1	60.6	
	55-64	1103	8.2	24.2	67.6	
	65+	1460	5.9	16.5	77.6	
Education	High	1790	8.2	30.7	61.1	< 0.001
	Secondary	2020	10.8	27.5	61.7	
	Basic	2502	9.2	24.3	66.5	
Marital status	Single	1926	9.6	24.7	65.7	0.02
	Non-single	4390	9.4	28.2	62.4	
Dentate status	Dentate	5209	9.6	28.6	61.8	< 0.001
	Edentulous	940	8.9	19.4	71.7	
All		6335	9.5	27.1	63.4	

p-value refers to differences between levels of dental fear (chi square tests)

n represents the actual number of participants and percentages are based on weighted data

5.2 Dental fear and dental health (Papers I & II)

Those with high dental fear were more likely to have poor dental health than were those with low dental fear. This was found both with self-reported indicators and with clinical indicators of dental health. The largest difference in dental health

between those with high and low dental fear was in the number of teeth that needed treatment. The mean number of decayed teeth among those with high fear was twice that of those reporting low dental fear. The mean number of missing teeth was lower among those who were somewhat afraid compared to those who were very or not at all afraid of visiting a dentist. The mean number of sound teeth was higher among those who were somewhat or very afraid compared to those who were not at all afraid of visiting a dentist. (Table 6).

Table 6. Mean numbers and 95% confidence intervals (95% CI) of sound, decayed, restored and missing teeth according to reported level of dental fear.

	All	Very afraid	Somewhat afraid	Not at all afraid	p ³
Sound teeth ¹	9.5 (9.3-9.7)	9.8 (8.9-10.7)	10.0 (9.2-10.7)	9.2 (8.6-9.9)	< 0.001
Decayed teeth ¹	1.0 (1.0-1.1)	1.8 (1.4-2.1)	0.9 (0.8-1.0)	1.0 (0.9-1.1)	< 0.001
Missing teeth ²	12.4 (12.2-12.6)	12.5 (10.8-14.1)	10.6 (9.5-11.7)	12.8 (11.5-14.1)	< 0.001
Restored teeth ¹	12.0 (11.7-12.3)	11.3 (10.5-12.1)	12.4 (11.9-12.9)	12.6 (12.1-13.0)	0.001

¹n = 5502 (including dentate participants) ²n = 6335 (including dentate and edentulous participants)

³p-values refer to differences between levels of dental fear (Kruskal-Wallis-tests)

According to the logistic regression analysis, the numbers of decayed, missing and sound teeth were statistically significantly associated with dental fear. The number of restored teeth was not statistically significantly associated with dental fear. The association between dental fear and the numbers of sound and missing teeth were modified by age. These effect modifications will be explained in more detail in the next chapters.

Sound teeth

The number of sound teeth describes the level of dental health, but also describes indirectly how much experience of dental care the participants have had during their lives. The amount of experience of dental care might have an effect on dental fear.

Differences in the mean number of sound teeth between groups with high, moderate and low dental fear were small; but the association between dental fear and the number of sound teeth was modified by age. The odds ratio (OR) of having high dental fear and different numbers of sound teeth differed greatly between age groups. For instance, in the age group 30–34 years the OR of being very afraid of visiting a dentist and having 20 sound teeth was half of that for

those having only five sound teeth. Among the age group 55–64 years those who had more sound teeth were also less likely to be very afraid of visiting a dentist than were those who had fewer sound teeth. Among the other age groups those who had more sound teeth were more likely to be very afraid of visiting a dentist than were those who had fewer sound teeth. For instance, in the age group 65+ years the OR of being very afraid of visiting a dentist and having 10 sound teeth was more than two times that of those who had five sound teeth. (Fig. 1).

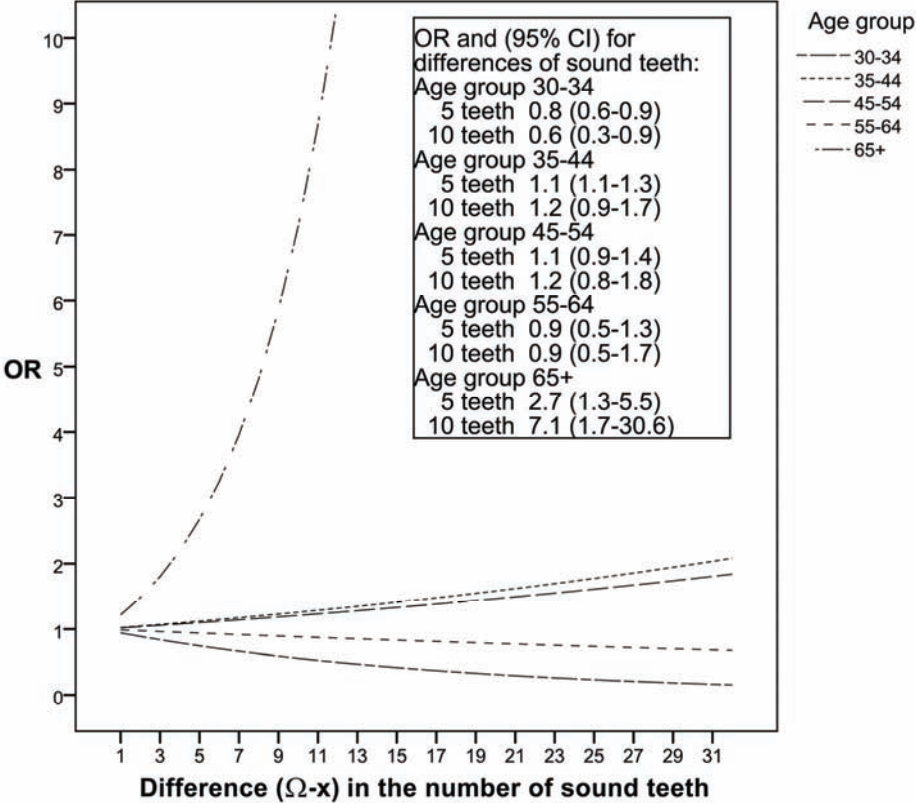


Fig. 1. The odds ratio (OR) of having high dental fear and different numbers of sound teeth, (odds of being very afraid and having Ω sound teeth in relation to the corresponding odds of having $\Omega-x$ sound teeth, where Ω may be any number of sound teeth (1–32) and x any chosen difference in the number of sound teeth).

Missing teeth

The association between dental fear and number of missing teeth was also modified by age (Table 7). Among the age group 30–34 years, those who had more missing teeth were less likely to be very afraid of visiting a dentist than were those who had fewer missing teeth. For example, the OR of having high dental fear and five missing teeth was twice the OR of those with high fear and 10 missing teeth. Among the age groups 35–44 years and 65+ years those who had more missing teeth were more likely to be very afraid of visiting a dentist than were those who had fewer missing teeth. Among the age group 65+ years, for example, the OR of having high dental fear and 5 missing teeth was one third of the OR of those with high fear and 10 missing teeth.

Table 7. Age-specific examples of the odds ratios (OR) and 95% confidence intervals (95% CI) of logistic regression analyses on the association between number of missing teeth and dental fear, adjusted for age, gender, numbers of sound, decayed, and restored teeth and dental attendance, n = 6335 (Paper II).

Age group	Difference in number of missing teeth	OR	95% CI
30-34	1 tooth	0.9	0.8-1.0
	5 teeth	0.7	0.4-1.2
	10 teeth	0.4	0.1-1.4
35-44	1 tooth	1.0	1.0-1.1
	5 teeth	1.2	1.0-1.5
	10 teeth	1.4	0.9-2.2
45-54	1 tooth	1.0	1.0-1.0
	5 teeth	1.0	0.9-1.2
	10 teeth	1.1	0.8-1.5
55-64	1 tooth	1.0	1.0-1.0
	5 teeth	1.0	0.9-1.2
	10 teeth	1.1	0.7-1.5
65+	1 tooth	1.2	1.1-1.3
	5 teeth	1.5	1.5-3.1
	10 teeth	4.6	2.2-9.7

Decayed teeth

Those who had more decayed teeth were more likely to be very afraid of visiting a dentist than those who had fewer decayed teeth (Table 8). For example, the OR

of having high dental fear and five decayed teeth was almost two times the OR of having high fear and one decayed tooth. The association between dental fear and the number of decayed teeth was not modified by age, gender or dental attendance.

Table 8. Examples of odds ratios (OR) and 95% confidence intervals (95% CI) of logistic regression analyses on the association between number of decayed teeth and dental fear, adjusted for age, gender, numbers of sound, missing and restored teeth and dental attendance, n = 6335 (Paper II).

Difference in number of decayed teeth	OR	95% CI
1 tooth	1.1	1.1-1.2
2 teeth	1.3	1.2-1.4
5 teeth	1.8	1.4-2.1
10 teeth	3.1	2.1-4.6
15 teeth	5.5	3.0-9.9

Dental attendance affected the association between dental fear and dental health. Among those with high dental fear, irregular attenders had higher mean numbers of decayed and missing teeth and lower mean number of restored teeth than regular attenders did. The mean number of decayed teeth was higher among those irregular attenders who were very afraid than among those who were somewhat or not at all afraid of visiting a dentist. Among groups with high or lower dental fear, regular attenders had almost the same mean numbers of decayed, missing and restored teeth.

5.3 Dental fear, oral health habits and behaviors (Papers I & III)

5.3.1 Dental attendance

Irregular dental attendance was more commonly reported by participants with high dental fear than by those with low dental fear (Tables 9 & 10).

Table 9. Percentages of dentate participants according to their self-reported dental attendance and dental fear, n = 5187.

	n	All	Very afraid	Somewhat afraid	Not at all afraid	p
Regular attendance	3055	58.9	37.1	57.5	62.9	
Irregular attendance	2132	41.1	62.9	42.5	37.1	< 0.001

p-value refers to differences between levels of dental fear (chi square tests)

n represents the actual number of participants, and percentages are based on weighted data.

The association between dental fear and attendance varied between age groups. Among younger groups the percentage of those who were very afraid of visiting a dentist was higher than among older groups. This association was found both among those who visited a dentist regularly and among those who did not. Regular dental attendance was more common among women than among men, among both those who were very afraid and those who were somewhat afraid of visiting a dentist. The percentages of participants who were very afraid of visiting a dentist were higher among irregular than among regular attenders. These differences were statistically significant among all other groups, except among men in the age groups 30–34 years and 65+ years. (Table 10).

In the logistic regression model the association between dental fear and dental attendance was modified by age, when added to the model together with perceived treatment need, perceived oral health, satisfaction with dental service, gender, marital status, attained level of education and age (Table 11). Irregular attenders were more likely to have high dental fear than regular attenders were. This association was much stronger in the age group 65+ years than in other age groups. In age-specific logistic regression models, dental attendance was associated with dental fear in all age groups except the group 30–34 years.

Table 10. Age-specific percentages of dentate participants according to gender, self-reported dental attendance and dental fear, n = 5187.

Age group	n	Regular dental attendance			Irregular dental attendance			p
		Very afraid	Somewhat afraid	Not at all afraid	Very afraid	Somewhat afraid	Not at all afraid	
All								
30-34	673	10.3	32.7	57.0	17.5	33.7	48.8	0.020
35-44	1388	7.8	32.5	59.7	16.0	34.4	49.6	< 0.001
45-54	1473	6.1	29.1	64.8	16.3	29.9	53.8	< 0.001
55-64	897	3.6	23.8	72.6	13.2	27.5	59.3	< 0.001
65+	756	1.0	15.7	83.3	8.6	20.7	70.7	< 0.001
All	5187	6.0	28.0	66.0	14.6	29.6	55.8	< 0.001
Men								
30-34	320	5.4	24.3	70.3	11.2	28.5	60.3	0.113
35-44	661	3.4	26.1	70.5	10.6	32.7	56.7	< 0.001
45-54	711	3.0	20.4	76.6	12.9	25.9	61.2	< 0.001
55-64	428	1.7	16.4	81.9	7.4	28.2	64.4	< 0.001
65+	332	1.3	13.0	85.7	5.7	12.3	82.0	0.104
All	2452	2.9	20.9	76.2	10.2	26.6	63.2	< 0.001
Women								
30-34	353	13.7	38.6	47.7	29.0	43.0	28.0	< 0.001
35-44	727	11.4	37.8	50.8	24.1	37.1	38.8	< 0.001
45-54	762	8.5	36.0	55.5	21.2	35.6	43.2	< 0.001
55-64	469	5.2	29.5	65.3	20.3	26.7	53.0	< 0.001
65+	424	0.7	17.7	81.6	11.2	28.4	60.4	< 0.001
All	2735	8.4	33.4	58.2	20.6	33.7	45.7	< 0.001

p-values refer to differences between regular and irregular attenders (chi square tests)

n represent the actual number of participants, and percentages are based on weighted data.

Table 11. Summary of statistically significant results of age-specific logistic regression analyses on the associations between dental fear and dental attendance adjusted for gender, education, marital status, perceived oral health, treatment need and satisfaction, n = 5187 (Paper I).

	Age group	OR	95 % CI
Dental attendance ¹	35-44	2.6	1.9 – 3.6
	45-54	2.3	1.5 – 3.4
	55-64	4.4	2.5 – 7.9
	65+	8.6	2.9 – 25.6

¹ Coding of dental attendance: 0 = regular; 1 = irregular

The most obvious consequence of dental fear was avoidance of dental care (Papers I –III). When dental fear and dental attendance were entered into logistic regression models together with socio-demographics or variables describing oral health habits or dental health, those with high dental fear were more likely to use dental services irregularly than were those with lower dental fear.

Etiologic fraction

To estimate how large part of irregular dental attendance was due to dental fear, the etiologic fraction among those experiencing high (or moderate) dental fear was calculated. The percentage of irregular dental attenders that can be attributed to high dental fear (etiologic fraction among exposed) was 41%, and the corresponding percentage attributed to being somewhat afraid of visiting a dentist was 13%. Among the dentate Finnish population aged 30 years or older, the percentage of irregular attenders that can be attributed to high dental fear (etiologic fraction among population) was 7%, and the corresponding percentage attributed to being somewhat afraid of visiting a dentist was 4%.

5.3.2 Oral cleaning habits

Tooth-cleaning habits differed between those with high and low dental fear. The association between dental fear and tooth cleaning was not strong, but among the age group 65+ years those with high dental fear were less likely to brush their teeth at least twice a day and to use dental floss daily than were those with low fear. Daily use of toothpicks was more common among those with low dental fear than among those with high fear; but, in general, interdental cleaning was uncommon.

A tendency for poorer tooth-cleaning habits was found more frequently among those with high than those with low dental fear. Among women, for toothbrushing and for use of dental floss, this difference was statistically significant ($p < 0.05$ level). Women had better tooth-cleaning habits than men did. People with high education were more likely to brush their teeth at least twice a day than were those with basic or secondary education. Education was more strongly associated with oral hygiene than with dental fear.

According to the results of logistic regression analysis, frequency of toothbrushing was associated with dental fear, but only among the age group 65+ years (Table 12). In that age group those who brushed their teeth less than twice a

day were more likely to be very afraid of visiting a dentist than were those who brushed their teeth at least twice a day. When added to the model simultaneously with age, gender, level of education and regularity of dental attendance, the frequencies of using toothpaste, dental floss or toothpicks were not associated with dental fear.

Table 12. Summary of statistically significant results of logistic regression analyses on the association between dental fear and toothbrushing and smoking adjusted for age, gender, education and dental attendance, n = 5557 (Paper III).

	OR	95 % CI
Toothbrushing¹		
Among the age group 30-34 years	1.0	0.6-1.6
Among the age group 35-64 years	1.0	0.8-1.3
Among the age group 65+ years	2.6	1.4-5.1
Smoking²	2.3	1.9-2.8

¹ Coding of toothbrushing: 0 = at least ones a day; 1 = less than twice a day

² Coding of regularity of smoking: 0 = irregularly ; 1 = regularly

5.3.3 Smoking

In all age groups and among both women and men, regular smoking was more common among those who were very afraid than among those who were somewhat or not at all afraid of visiting a dentist (Table 13). Dental fear and attained level of education were also associated with smoking. Among all levels of education those with high dental fear were more likely to smoke, but those with high level of education were less likely to smoke than were those with basic or secondary education. Among those with basic or secondary education, those participants with high dental fear were more likely to smoke regularly than were participants with low dental fear.

Smoking and dental fear were associated when added to logistic regression analysis together with age, gender, education, dental attendance and tooth cleaning habits (Table 12). Regular smokers were more likely to be very afraid of visiting a dentist than were those who smoked occasionally or not at all.

Table 13. Percentages of regular smokers according to gender, age, education and reported level of dental fear, n = 5557.

		n	Very afraid	Somewhat afraid	Not at all afraid	All
Gender	Women	2930	33.7 ^b	18.5 ^b	14.1 ^b	18.0
	Men	2627	52.9 ^b	27.4 ^b	25.9 ^b	27.9
Age group	30-34	724	45.7 ^a	25.7 ^a	29.0 ^a	30.2
	35-64	3970	40.1 ^b	23.1 ^b	22.4 ^b	24.3
	65+	863	22.9 ^b	6.9 ^b	8.0 ^b	8.4
Education	High	1763	31.3 ^b	13.7 ^b	14.0 ^b	15.3
	Medium	1914	41.1 ^b	27.3 ^b	24.6 ^b	27.1
	Basic	1875	45.3 ^b	25.5 ^b	22.9 ^b	25.7
All		5557	40.0 ^b	22.0 ^b	20.6 ^b	

^ap < 0.05 and ^bp < 0.001 for differences between levels of dental fear (chi square tests)

5.4 Dental fear and subjective oral health (Papers I & IV)

Those with high dental fear more often reported poor perceived oral health and greater treatment need than did those with lower fear. Subjective oral impacts were measured with prevalence of those reporting at least one OHIP-14 impact fairly often or very often (FoVo), extent (number of items reported FoVo, range 0 – 14) and severity (sum of ordinal responses, range 0 – 56). Those with high dental fear reported subjective oral impacts more often than those with low dental fear (Table 14). The association between dental fear and subjective oral impacts remained similar when the following groups were compared: women and men, different age groups, participants with different levels of education, those with different numbers of remaining teeth, and regular and irregular attenders.

Table 14. Prevalence of participants reporting poor perceived oral health, treatment need, prevalence and mean extent of OHIP impacts occurring fairly often or very often (FoVo) and mean severity of OHIP impacts according to reported level of dental fear.

	Very afraid	Somewhat afraid	Not at all afraid	All	p
Poor perceived oral health ¹	49.1	36.1	31.1	34.3	< 0.001
Perceived treatment need ¹	69.0	55.3	45.9	50.8	< 0.001
Prevalence of FoVo ²	14.7	8.3	10.2	10.3	< 0.001
Extent of FoVo ²	0.6	0.3	0.3	0.3	< 0.001
Severity ²	5.4	4.0	3.8	4.0	< 0.001

¹Paper I (p-values refer to chi square tests), n = 5187. ²Paper IV (p-values on prevalence refer to chi square tests and on 'extent' and 'severity' to Kruskal-Wallis tests), n = 5897.

According to logistic regression analysis, those with high dental fear were more likely to report poor oral health and greater treatment need than were those with lower dental fear when age, gender, level of education and marital status were considered. These associations were strongest among the age group 30–34 years (Table 15). When adjusted for age, gender, level of education, the number of remaining teeth and dental attendance, dental fear was also associated with subjective oral impacts. Those who reported high dental fear were more likely to report subjective oral impacts than were those with lower dental fear.

Table 15. Summary of statistically significant results of logistic regression analyses on the associations between dental fear and perceived oral health and treatment need adjusted for age, gender, education, marital status, dental attendance and satisfaction of dental care, n = 5187 (Paper I).

	Age group (years)	OR	95 % CI
Perceived oral health ¹	30+ (All)	1.4	1.2-1.8
	30-34	2.5 ³	1.5 – 4.2
Perceived treatment need ²	30+ (All)	1.6	1.3-2.0
	30-34	2.8 ³	1.6 – 4.8
	45-54	1.9 ³	1.2 – 2.9
	65 +	2.3 ³	1.2 – 4.5

¹ Coding of perceived oral health: 0 = good; 1 = poor

² Coding of perceived treatment need: 0 = no; 1 = yes

³ Age-specific logistic regression analyses

In the item-wise analyses of OHIP-14 (Table 16), those who were very afraid of visiting a dentist differed from those who were somewhat or not at all afraid in dimension of Psychological discomfort and within the dimension of Handicap, Psychological disability and Physical pain and discomfort. The item-wise differences were also examined according to the number of remaining teeth. Among participants with 20+ teeth, those with high dental fear more frequently reported problems in the dimension of Psychological Discomfort and within the dimensions of Psychological Disability, Handicap, and Physical Pain and Discomfort than did those with low fear. Among edentulous participants, those with high dental fear more frequently reported problems in the dimensions of Psychological and Physical Disability than did those with low dental fear. Edentulous participants also reported higher prevalence (FoVo) of subjective oral impacts than did those with 1–19 or 20+ teeth. In the item-wise analyses, among participants with 1–19 teeth, no difference was found between those having high and low dental fear.

Table 16. Prevalence of OHIP-14 items reported fairly often or very often (FoVo) according to level of dental fear, n = 5798.

	Very afraid	Somewhat afraid	Not at all afraid	p
Functional limitation				
Trouble pronouncing words	3.1	1.7	2.3	0.127
Worsened sense of taste	3.0	1.5	2.1	0.081
Physical pain and discomfort				
Painful aching	4.9	2.8	3.2	0.141
Uncomfortable eating any food	7.3	4.1	5.8	0.004
Psychological discomfort				
Been self conscious	7.5	4.4	5.3	0.020
Felt tense	5.2	2.7	2.8	0.036
Physical disability				
Unsatisfactory diet	3.3	1.6	1.6	0.053
Interrupting meals	2.3	0.9	0.8	0.060
Psychological disability				
Difficult to relax	3.0	1.5	1.3	0.085
Been a bit embarrassed	4.4	1.7	1.6	0.004
Social disability				
Been a bit irritable	2.4	1.1	1.0	0.113
Difficulty doing usual jobs	2.1	1.0	1.2	0.266
Handicap				
Life in general less satisfying	5.1	2.4	2.3	0.010
Totally unable to function	1.8	0.5	0.6	0.078

p-values refer to differences between levels of dental fear (chi square tests)

6 Discussion

6.1 Methodological considerations

6.1.1 Study sample

This study was part of large national Health 2000 survey, which was organized to study the health and functional capacity of Finnish adults aged 30 years and older. As part of this study, oral health and dental fear were studied in a nationally representative study sample. The rates of participation in the home interview (88%) and the clinical oral examination (78%), as well as the percentage return of the questionnaires (73%) were high. The high participation rate for the home interview was probably due to efforts to obtain responses from those who did not respond to the invitation letter. During the home visit, the interviewers conducted a comprehensive health interview and made appointments for the health examination. This probably helped to increase participation in the examination. The generalizability of the results of this study was further increased by the use of post-stratum weights for correcting the non-response bias. These weights were based on gender, age, region and language. The findings of this study can be generalized to the Finnish adult population aged 30 years and older. (Aromaa & Koskinen 2004, Suominen-Taipale *et al.* 2008.)

6.1.2 Measures of observation

In this study, dental fear was ascertained during a home interview. This might result in a more valid estimation of dental fear than asking about it in connection with a clinical examination, in which those with high dental fear might not participate. The single question (“*How afraid are you of visiting a dentist?*”) used in this study to measure dental fear has been shown to be a valid and reliable measure of dental fear in the Finnish adult population (Viinikangas *et al.* 2007). Single anxiety-question has also been shown to be valid and reliable in the adult Norwegian population (Neverlien 1990). Measuring dental fear with multi-item scales, like the DAS (Corah 1969) or MDAS (Humphris *et al.* 1995), could have given more detailed information that would have separated those Finnish adults with phobia or anxiety from those with other levels of dental fear. Since this study

was part of a large national study, limited space was available for assessing dental fear, and a single anxiety question had to be used. When the results of single-question and multi-item questionnaires are compared, it should be remembered that selection of a measure affects the observed prevalence of dental fear (Locker *et al.* 1996b). In this study interview was used for assessing dental fear. Interview has been considered to be more reliable than questionnaire, when collecting information (Joukamaa 2008).

In this study, clinical dental examinations were used to ascertain oral health. These examinations were based on WHO methods (World Health Organization 1977) and conducted by five trained and calibrated teams each of which included a dentist and a dental nurse. Most other national studies of dental fear have used self-reported dental health (Stouthard & Hoogstraten 1990, Thomson *et al.* 1996, Armfield *et al.* 2006). A clinical dental examination should be more reliable for studying oral health than participants' subjective information would be. In this study, to evaluate the inter-examiner reliability of the diagnoses during a clinical examination, parallel measurements were made. During data collection, a reference dentist examined 269 participants after one of the five field dentists had examined them. Agreement of the measurements was described by kappa values. The agreement between the measurements was high, particularly for determination of the condition of the teeth. (Suominen-Taipale *et al.* 2008.)

Subjective-oral health impacts were measured with the Oral Health Impact Profile (OHIP-14) questionnaire, which contains 14 questions about the frequency of adverse impacts caused by oral conditions. Originally the OHIP-14 was used with a 12-month reference period. (Slade & Spencer 1994.) In this study a reference period of one month was used. The results of studies using a one-month reference period have been comparable to those using a 12-month reference period (Sutinen *et al.* 2007, Lahti *et al.* 2008). In questionnaire surveys, non-response can include bias that distorts the results. Item non-response may introduce considerable error even though the response rate among participants is high. (Locker 2000.) To minimize this bias, for those participants with one or two missing values for the OHIP-14 questionnaire items, the missing values were replaced with the mean computed for non-missing responses to the relevant OHIP item.

Regularity of dental attendance was ascertained during the home interview. For dentate participants, to study the regularity of visiting a dentist, there were three questions (“*Do you usually go to a dentist?*”, “*How many times during the last 12 months have you visited a dentist?*”, and “*When did you last visit a*

dentist?”). The replies to these questions correlated strongly with each other. Although there was a suspicion that the first question might not be in focus enough among dentate participants, it was the most valid of these questions for describing the regularity of attendance. Among edentulous participants, the regularity of checking dentures was asked by the question: “*How often do you have your dentures checked?*” In order to provide valid results for the entire group, the answers of the dentate and edentulous participants indicating “*Regular attendance*” were combined; the same was done for answers indicating “*Irregular attendance*”.

6.1.3 Methods

High dental fear has been shown to have more severe consequences for dental attendance and dental health than other levels of dental fear have (Milgrom *et al.* 1988, Stouthard & Hoogstraten 1990, ter Horst & de Wit 1993, Moore *et al.* 1993, Hägglin *et al.* 2000, Armfield *et al.* 2006). The single anxiety-question (“*How afraid are you of visiting a dentist?*”) was used for assessing dental fear. The options for answering (“*Not at all*”, “*Somewhat*” and “*Very*”) were first used as such. The reply options “*Not at all*” and “*Somewhat*” were combined into one category indicating low or no dental fear, and “*Very*” was kept as the category of high dental fear. This categorisation was later used in the analyses to compare those with high and lower dental fear.

Dental fear is multidimensional (Weiner & Sheehan 1990, Rachman 1991, Milgrom *et al.* 1995, Locker *et al.* 1999, Armfield 2006) and is associated with the personal, demographical, and socio-economical aspects of the participants as well as with several aspects of oral health care (Schuurs *et al.* 1985, Milgrom *et al.* 1988, Stouthard & Hoogstraten 1990, ter Horst & de Wit 1993, Moore *et al.* 1993, Hägglin *et al.* 2000, Schuller *et al.* 2003, Armfield *et al.* 2006, Lahti *et al.* 2007). To study these associations at the same time, multivariable models were needed. Since in Papers I-III the prevalence of dental fear and in Paper IV the prevalence of subjective oral impacts were used as dichotomized dependent variables, in this study logistic regression analyses were used. To study the simultaneous effects, between dental fear and socio-demographics, dental attendance, variables describing dental health, tooth cleaning, and subjective oral health, series of logistic regression analyses were conducted. The logistic regression models were also used to study whether the independent variables

modified or confounded each others' effect on dental fear (Papers I-III) or on subjective oral impacts (Paper IV).

As already explained, to minimize the non-response bias and to increase the validity of this study, post-stratum weights were used. They were also used when the data collected during the interview and clinical examination were analyzed. When a large sample is analyzed and many statistical tests are conducted, there is an elevated risk for Type I error. As a result of this some differences that were found among the sample might not exist among the population the sample represents. The risk for Type I error could have been reduced by setting the statistical significance at level $p < 0.001$ instead of $p < 0.05$ level that was used in some analyses.

6.1.4 Prevalence of dental fear

According to these results, 9.5% of the adults in Finland reported high dental fear. This is in agreement with some previous studies where a single anxiety question was used (Milgrom *et al.* 1988, Armfield *et al.* 2006). In comparison with other previous studies, it should be remembered that the use of single question has been shown to result in higher prevalence of dental fear than multi-item measures have (Locker *et al.* 1996b). Studies using a single anxiety question have reported 5%–20% prevalence of high dental fear (Milgrom *et al.* 1988, Moore *et al.* 1993, Ragnarsson 1998, Armfield *et al.* 2006) and studies using multi-item scales 5–13% prevalence of dental anxiety (Hakeberg *et al.* 1992, Moore *et al.* 1993, Wisloff *et al.* 1995, Locker *et al.* 1996a, Thomson *et al.* 1996, Schuller *et al.* 2003). Although differentiating dental fear, anxiety or phobia was not possible in this study, the group with high dental fear might have been identified as having dental anxiety, if multi-item scales had been used.

In this study, as in many previous studies (Schuurs *et al.* 1985, Milgrom *et al.* 1988, Stouthard & Hoogstraten 1990, ter Horst & de Wit 1993, Moore *et al.* 1993, Thomson *et al.* 1996, Armfield *et al.* 2006, Lahti *et al.* 2007), women were more likely than men to be very afraid of visiting a dentist. In this study high dental fear was reported more often by younger than by older participants. The same results has been found in many other studies (Milgrom *et al.* 1988, Stouthard & Hoogstraten 1990, Hakeberg *et al.* 1992, ter Horst & de Wit 1993, Moore *et al.* 1993, Locker *et al.* 1996a, Thomson *et al.* 1996, Ragnarsson 1998, Hägglin *et al.* 1999, Lahti *et al.* 2007). It is still unclear whether the differences in dental fear found between age groups reflect cohort effect or whether dental fear declines

with increasing age. However, it has been shown that psychological well-being does not change with increasing age and that age differences are merely due to the cohort effect (Costa *et al.* 1987). On the other hand, in a longitudinal study made in Sweden, the difference in dental fear between age groups was concluded to be an age effect rather than a cohort effect (Hägglin *et al.* 1999). Because the present study is cross-sectional, no causal interpretations can be made. The difference in prevalence of dental fear between age groups might reflect differences between birth cohorts in terms of the history of the provision, content and quality of dental health care in Finland.

An association was also found between dental fear and education. Subjects with higher educational attainment were less likely to be very afraid of visiting a dentist than were subjects with basic or secondary education. This finding is in agreement with the findings of some previous studies (Schuurs *et al.* 1985, Moore *et al.* 1993,) but contradicts the findings of some studies (Milgrom *et al.* 1988, Stouthard & Hoogstraten 1990, Thomson *et al.* 1996). In this study the question of education was also used to indicate the participant's socio-economic position. It has been found that people with higher socio-economic status have less dental fear than do those with lower socio-economic status (Armfield *et al.* 2006). Our results support these results. On the other hand, it has also been suggested that the irregular dental attendance among those with low economic status probably reflects the organization and subsidization of dental-care services more than the individual's needs, values (Sanders *et al.* 2006) or perhaps dental fear.

6.1.5 Dental fear and dental health

In this study those with high dental fear had poorer self-reported and clinically determined dental health than did those with lower fear. The associations between dental fear and the numbers of missing and sound teeth were modified by age, while the positive association between dental fear and number of decayed teeth was independent of age, gender and dental attendance. When adjusted for age, gender, dental attendance, and numbers of sound, decayed and missing teeth, the number of restored teeth was not significantly associated with dental fear.

The results of this study confirm the findings of earlier studies using self-reported (Milgrom *et al.* 1988, Stouthard & Hoogstraten 1990, Vassend 1993, Thomson *et al.* 1996, Ragnarsson *et al.* 2003) and clinical indicators of dental health. The mean numbers of decayed teeth have been reported to be higher

(Cohen et al. 1985, Wisloff et al. 1995, Hägglin et al. 2000, Schuller *et al.* 2003) and the mean number of restored teeth lower (Locker & Liddell 1992, Ragnarsson 1998, Hägglin *et al.* 2000, Schuller *et al.* 2003) among those with high dental fear compared to those with low dental fear. According to the multivariate analyses made in this study, those who had more decayed teeth were more likely to have high dental fear than were those with fewer decayed teeth. The number of decayed teeth describes the present treatment need, and these findings suggest that those who are very afraid of visiting a dentist might avoid or have difficulties completing their dental care.

The number of sound teeth describes the level of dental health, but indirectly it also describes how much experience of dental care participants have had during their lives. The more sound teeth the participants have, the less likely they are to have experienced dental care. According to the reviewed literature, the association between dental fear and number of sound teeth has not been the focus of earlier studies. The number of missing teeth describes the outcome of previous dental care. Dental fear is suggested to be caused by traumatic dental experiences (Davey 1989, ter Horst & de Wit 1993, Moore *et al.* 1993), and an extraction could be considered a psychologically traumatic experience. Number of missing teeth could be an indicator of the number of traumatic experiences. According to the results, the strength and direction of the association between dental fear and numbers of sound and missing teeth varied considerably according to age.

Differences in the mean number of sound teeth between the dental-fear groups were small, but there were large differences between age groups in the OR of having high dental fear and different numbers of sound teeth. Among the age group 30–34 years, the OR of being very afraid of visiting a dentist was lower among those who had many sound teeth than among those who had few sound teeth. The less experience of dental care they had had during their life, the less likely they were to be afraid of visiting a dentist. In Finland the age group 30–34 years had been entitled to free, comprehensive and preventively oriented dental health care until the age of 19, and after that to subsidized dental care; and they are likely to have had a long history of preventive treatment. In this age group the association between number of missing teeth and dental fear was negative. The patient might not acquire dental fear if she/he has a traumatic experience after some years of relatively non-traumatic dental care (Davey 1989, ter Horst & de Wit 1993, de Jongh *et al.* 1995, ten Berge *et al.* 2002). This latent inhibition might explain the association between dental fear and the numbers of sound and missing teeth among the age group 30–34 years.

Among the age group 65+ years those who had more sound teeth were more likely to be very afraid of visiting a dentist than were those who had fewer sound teeth. Those with more extracted teeth were also much more likely to be afraid of visiting a dentist than were those with fewer extracted teeth. In Finland the age group 65+ years has not been entitled to school dental care nor to subsidized dental care. Extraction, often several at the same time, has been a common treatment for this age group. It might be possible that people in this group, not having been entitled to subsidized dental care and having many sound or missing teeth, may not have a long history of visiting a dentist regularly. The high dental fear among those with many sound or missing teeth could reflect the lack of latent inhibition that could have prevented dental fear (Davey 1989, ter Horst & de Wit 1993, de Jongh *et al.* 1995, ten Berge *et al.* 2002).

Treatment history and treatment experiences differ considerably between the age groups 30–34 years and 65+ years. Regular attendance pattern and latent inhibition might partly explain the differences between age groups in the association between dental fear and numbers of sound and missing teeth. Other reasons that might have reduced the psychological trauma of extraction could be the improved techniques of injecting local anesthesia and/or performing extractions, including patients' improved feeling of control over the situation (Milgrom *et al.* 1995).

In this study, instead of DMFT, the numbers of decayed, missing and restored teeth were used separately. In most previous studies among adults, dental fear and DMFT seemed not to be associated (Locker & Liddell 1992, Thomson *et al.* 2000, Schuller *et al.* 2003). In a recent study, however, those with high dental fear had on average higher DMFT than those with lower fear (Ng & Leung 2008). DMFT might not be a useful measure for studying the associations between dental fear and dental health among adults, because this cumulative index combines the signs of current treatment need and previous treatments (e.g. decayed teeth and extractions) and experiences related to them. These experiences may have different effects on dental fear.

The poor dental health among those with high dental fear (Cohen 1985, Locker & Liddell 1992, Wisloff *et al.* 1995, Ragnarsson 1998, Hägglin *et al.* 2000, Schuller *et al.* 2003, Eitner *et al.* 2006, Ng & Leung 2008) can also be explained by the vicious cycle of dental fear. Dental fear or anxiety is suggested to lead to avoidance of dental care and, if treatment is neglected, to deterioration of oral health. Shame and embarrassment about poor oral health and avoidance of

dental care could be the psychological effects of dental fear. With time this might lead to a feeling of inferiority in social contacts with other people and increase dental fear. This in turn could cause additional delay of dental care and deterioration of oral health. (Berggren & Carlsson 1984, Berggren & Carlsson 1985.)

6.1.6 Dental fear and oral health habits and behaviors

Dental attendance

Among adults in Finland those with high dental fear were more likely to use dental services irregularly than were those with lower dental fear. This association was strongest in the age groups 55–64 years and 65+ years and was not found in the age group 30–34 years. According to many previous studies, those with high dental fear are more likely to use dental services irregularly than those with lower dental fear are (Berggren & Meynert 1984, Milgrom *et al.* 1988, Locker & Liddell 1991, Hägglin *et al.* 1996, Bedi & McGrath 2000, Skaret *et al.* 2000, Abrahamsson *et al.* 2001, Scheutz & Heidmann 2001, Ragnarsson *et al.* 2003, Meng *et al.* 2007).

The etiological fraction was calculated to estimate how large part of irregular dental attendance was due to dental fear (Kleinbaum *et al.* 1982). Almost half (41%) of irregular attendance among those with high dental fear can be attributed to dental fear. It may be roughly estimated that in the Finnish dentate population aged 30 years and older, about 145 000 people visit a dentist irregularly because of dental fear. Irregular attendance seems to be the most obvious consequence of dental fear and affects dental and oral health among those with high dental fear. It has also been suggested that irregular attenders are more anxious than regular attenders because they believe that they require more extensive treatment, not because they have greater fear of dentistry per se (Kent 1985).

In this study among the age group 30–34 years those with high dental were not more likely to visit a dentist irregularly. There have also been some other studies according to which many patients with dental fear visit a dentist regularly (Schwarz 1990, Hakeberg *et al.* 1992, Vassend 1993). A patient's ability to cope with the intensity of fear would determine whether patient is able to accept treatment (Coriat 1946). Thus, good coping skills may have helped those with

high dental fear to visit a dentist regularly. Those with high dental fear may also have experienced social norms in favor of using oral health services regularly.

In addition to coping skills and social norms, a long pattern of regular attendance might have worked as latent inhibition of dental fear (Davey 1989, ter Horst & de Wit 1993, de Jongh *et al.* 1995, ten Berge *et al.* 2002) and in this study enhanced regular dental attendance among the age group 30–34 years. As already explained, in Finland participants in the age group 30–34 years have been entitled to free dental care, including annual recalls for check-ups, until 19 years of age. In this way those with high dental fear may also have learned to visit a dentist regularly and may continue this behavior.

The differences in the association between dental fear and attendance among the age groups might also reflect the subsidization of dental health care. In Finland during the study period the age groups 45–54, 55–64, 65+ years had not been entitled to subsidized dental care, except for some age groups during school years. The age group 35–44 years had gradually been included in the subsidization system according to age. The age group 30–34 years had been entitled to free dental health care until the age of 19 years, and after that they have been entitled to subsidized dental care. According to the results of an Australian study, it was suggested that the “*failure*” of poor adults to seek dental care is probably more a reflection of the subsidization and organization of dental care services than an expression of individual needs or values (Sanders *et al.* 2006). Although income was not used as an exploratory variable in this study, it can be supposed that the subsidization of dental care plays an important role in dental attendance and partly explains the differences between age groups found in this study.

Oral cleaning habits

According to the results of the present study, there was a tendency for poorer tooth-cleaning habits among those who were very afraid than among those who were less afraid of visiting a dentist. Age modified the association between dental fear and toothbrushing. Among 65+-year-olds those who brushed their teeth less than twice a day were more likely to be very afraid of visiting a dentist than were those who brushed their teeth at least twice a day.

Dental fear and toothbrushing were not associated among age the groups 30–64 years. This might reflect a difference in attitude towards dental health between

age groups. The age group 65+ years might never have learned toothbrushing habits similar to those learned by the age groups 30–64 years. The age groups 30–64 years are taking an active part in working life and might also be more interested in the appearance of their teeth than the age group 65+ years is. Among the age groups 30–64 years those with high dental fear could have stronger social pressure for tooth cleaning than among the age group 65+ years.

The number of studies including information on dental fear and tooth cleaning habits is surprisingly small. In a Norwegian study among age groups 35–64 years only slight differences were found in oral health behavior between groups with high and low dental fear (Schuller *et al.* 2003). In another study made among Norwegian military recruits, the level of oral hygiene seemed to be poorer among those with high dental fear than among those with low dental fear (Wisløff *et al.* 1995). Neither our results nor the results of these earlier studies support the hypothesis that individuals with high dental fear try to avoid dental treatment by maintaining good oral hygiene.

Smoking

According to the results of this study, those with high dental fear were more likely to smoke regularly than were those with lower levels of dental fear. Because this was a cross-sectional study, no causal interpretations of the association between dental fear and smoking can be made.

According to the literature reviewed here, the association between dental fear and smoking has not been the focus of earlier studies. The finding that those who were very afraid of visiting a dentist were more likely to smoke regularly is in agreement with those results according to which, in general, smokers report higher levels of anxiety than non-smokers do (Jarvis 1994).

Smoking can be seen as an indicator of a stressful lifestyle. Many smokers and some researchers believe that smoking has a calming effect (Jarvis 1994, West & Hajek 1997). However, the evidence for the calming effect of smoking is inconsistent. Some researchers think that nicotine is an anxiogenic agent and that giving up smoking is rapidly followed by a reduction in anxiety, which may be due to removal of nicotine. (West & Hajek 1997.) Since both smoking (Jarvis 1994) and dental fear (ter Horst & de Wit 1993) have been associated with psychological lack of wellbeing, there might be increased psychological vulnerability among people who smoke regularly and have high dental fear.

As smoking and irregular attendance have been associated both with dental fear and oral health, there is an increased risk for oral diseases among those with high dental fear. Dentists should be aware of this increased risk when examining and treating people with high dental fear.

6.1.7 Dental fear and subjective oral health

According to the results of this study, when measured with single question or multi-item questionnaire, subjective oral health was associated with dental fear. Those with high dental fear were more likely to report poor oral health and subjective oral impacts than were those with lower dental fear. The increased frequency of subjective oral impacts among those with high dental fear could have been caused by impaired dental health. This was expected, because in this study an association between dental fear and number of missing teeth was found, and in previous studies associations have been found between the number of remaining teeth and subjective oral impacts (Steele *et al.* 2004, Lahti *et al.* 2008). However, when adjusted for the number of remaining teeth, dental attendance, age, gender and attained level of education, the association between dental fear and subjective oral impacts was not significantly modified by the number of remaining teeth.

In this study the greatest differences in subjective oral impacts between those with high and low dental fear were in the psychological, social and handicap dimensions of OHIP-14. The item-wise analysis also indicated that psychological and social factors may play an important role in the association between dental fear and subjective oral impacts. Psychological and social factors have previously been found to be related to dental fear (ter Horst & de Wit 1993, Abrahamsson *et al.* 2000, Cohen *et al.* 2000, Locker 2003). The shame and embarrassment of poor oral health and avoidance of dental care could be psychological and social consequences of dental fear (Cohen *et al.* 2000, Locker 2003, Moore *et al.* 2004), and they could also have an effect on subjective oral impacts. In the association between dental fear and subjective oral impacts the role of psychological factors is supported by a study made in a group with high dental fear. The results indicated that the subjective oral impacts were enhanced by the reduction of dental fear rather than by improved oral health (Vermaire *et al.* 2008).

In this study the severity (the sum of the ordinal responses) of OHIP-14 impacts was lower than reported in a study that included the general population of

Hong Kong (Ng & Leung 2008). In the present study lower prevalence and severity of oral impacts were also found among participants with high dental fear than were found in two studies that included participants with high dental fear (Mehrstedt *et al.* 2007, Vermaire *et al.* 2008). Cultural and/or social differences between countries and populations might explain the difference between these results. Recent research in public health supports the view that health must be understood as an outcome of interactions between the social circumstances and physical environment in which the individual lives (Shahab 2007). Difficulties related to the physical environment, the pressure caused by the social environment, psychological stress caused by shame and embarrassment, and physical problems caused by poor oral health may all affect oral health-related well-being. All this together might increase subjective oral impacts among those with high dental fear.

6.1.8 Clinical applications

According to the results of this study, almost 10% of the adults in Finland were very afraid and almost 30% somewhat afraid of visiting a dentist. This means that each dentist in Finland is likely to meet fearful patients every day. Those with high dental fear were more likely to have poor dental health and to use dental services irregularly than were those with low dental fear. This means that dentists are likely to meet fearful patients, especially during emergency care when dentists usually are busy. Regular attendance pattern is essential for avoiding the need for emergency care, and dentists should increase the patient's motivation to visit a dentist regularly. Some ways of doing this are discussed briefly later in this chapter.

To make the contact easier both for the dentist and for the patient, the dentist should know if the patient has dental fear and what the patient is afraid of. It would be helpful for a dentist to know about the patient's dental fear before the patient arrives. The receptionist could ask about dental fear during the initial telephone call by planned questions, or the patient could fill out a questionnaire in the waiting room before visiting a dentist. Asking about dental fear could also be useful because the dentist's awareness of patient's dental fear has been shown to reduce his/her fear.

Those with high dental fear were more likely to use dental services irregularly, to have a tendency toward poor tooth-cleaning habits, and to smoke regularly than were those with lower dental fear. Irregular attendance, poor

cleaning habits and smoking have also been related to poor oral health. There is an increased risk for oral diseases among those with high dental fear. Dental teams should take this increased risk into account when they examine and treat people with high dental fear.

Many oral health problems can be prevented by favorable oral health habits. Patients with high dental fear would especially benefit from a dental visit concentrating on oral cleaning instructions and cessation of smoking. This oral health counseling could be conducted by a dental hygienist. Since the best way to reduce dental fear is to expose patients to dental situations, this visit to the dental hygienist could also be helpful also for reducing fear.

According to the results of this study, those with high dental fear were more likely to have poor dental health than were those with lower dental fear. When treating patients with dental fear, the dentist should know how to make the dental visit less frightening. Building a trusting relationship, providing pain control and increasing the patient's feeling of control in dental situation are ways of making the treatment of fearful patients easier. These same things are also helpful for creating a pattern of regular dental attendance.

Psychological and social factors may play an important role in the association between dental fear and subjective oral impacts. Treatment of dental fear might be more effective in improving the well-being of those with high dental fear than dental treatment without treatment of dental fear is. Since dental fear is common and all dentists are likely to meet fearful patients, it is necessary for all dentists to know how to treat fearful patients. In each community there should be at least one dentist who is trained in treating fearful patients and has a possibility to work with a psychologist when needed. For treating patients with the most severe dental fear, it would be useful to have a possibility to consult specialised dental-fear clinics.

6.2 Implications for future studies

Causal interpretations of the origin and consequences of dental fear have been difficult to make since most of the studies of dental fear are cross-sectional. It is still unsure, whether dental fear causes poor dental health or poor dental health causes dental fear. It is also unclear whether the lower prevalence of dental fear found among older age groups than among younger groups is due to a cohort or an age effect. To make this kind of interpretation, longitudinal data are needed.

For instance, a follow-up study to the Health 2000 survey could help to make causal interpretations.

The endogenous components of dental fear have not recently been the focus of research. It would be important to study the association between dental fear and other specific fears and psychopathologies. This could increase our understanding of internal personality vulnerability to anxiety disorders that also some people with dental fear might have.

It has been claimed that, in general, the level of anxiety has increased in some countries but that the level of dental anxiety has remained stable. In Finland, this needs to be studied. We also lack information about which aspects of dental care adults are afraid of. To study these, we need to include dental anxiety questionnaires and questionnaires of general anxiety as part of future studies. We also lack information about dental fear among young adults. The age group 18 – 29 years should be included in future studies. In addition, it would be important to see how changes in the subsidization of oral health care have affected the utilisation of services and oral health among Finns with dental fear.

Dental fear is known to be associated with subjective oral health impacts. The numbers of decayed, missing, restored and sound teeth are known to be associated with dental fear, and this association is known to vary according to age. As very little is known about the association between dental fear and periodontal health, this should be studied further. It would also be important to study whether, the number of decayed teeth or periodontal health modify the association between dental fear and oral health-related quality of life.

Dental fear causes avoidance of dental care, which can affect dental health. Poor dental health and irregular attendance may cause shame and embarrassment and further increase dental fear and delay dental care. This vicious circle of dental fear has been suggested in many papers. It would be important to study how large a part of those reporting high, moderate or low dental fear follow the vicious circle and whether those with high dental fear are likely to follow this vicious circle for a longer period of time than those with lower dental fear. To study this, a longitudinal set of data would also be needed.

7 Conclusions

According to this study, in a nationally representative sample, one tenth of Finnish adults aged 30 years or older were very afraid of visiting a dentist. The percentage of those who were very afraid was higher among younger than among older groups. Gender was a strong determinant of reported dental fear; women were more likely to report dental fear than men were. Dental fear is common in Finland, especially among women and in the age group 30–34 years.

The most obvious consequence of dental fear was avoidance of dental care. The association between dental fear and dental attendance varied between age groups. Among all other age groups, except for the age group 30–34 years, those with high dental fear were more likely to use dental services irregularly than were those with lower dental fear. Reducing dental fear would increase the number of regular attenders, especially in older age groups. Those for whom oral health services have been provided regularly since childhood seem to continue to use these services regularly in spite of high dental fear.

Those with high dental fear had a tendency toward poor tooth-cleaning habits and were more likely to smoke regularly than were those with lower dental fear. Those with high dental fear have increased risks for poor oral health habits and oral diseases. Dental teams should be aware of this increased risk for oral diseases when working with people who have high dental fear.

Those with high dental fear had poorer dental condition than those with lower fear. Neither gender nor dental attendance affected the association between dental fear and dental condition. The associations between dental fear and numbers of missing and sound teeth varied according to year of birth. When the association between dental fear and oral health is studied, age or birth cohort should be taken into account. There are other possible confounding factors, like subsidization of dental care that should also be considered.

According to the results of this study, subjective oral impacts were more likely to be reported by those with high than by those with low dental fear. Treating dental fear could have positive effects on subjective oral impacts by reducing psychological and social stress, and improving regular dental attendance and oral health. If we want to improve the oral health-related quality of life among those with high dental fear, we need to treat dental fear. By treating this fear, we can improve regular dental attendance, and also oral health, among those with high dental fear.

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