

# Periodontal health among Swedish adolescents

Clinical, psychosocial and behavioral perspectives

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*To Magnus, Beatrice & Sebastian* 



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*Study I*

*Study II*

*Study III*

*Study IV*



## Abstract

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In recent decades, considerable resources have been invested in oral health promotion programs directed to children and adolescents by the Swedish Public Dental Service. However, it is unclear to what extent such prevention programs have resulted in long-term beneficial effects in oral hygiene behavior and periodontal health status. There is limited knowledge regarding the periodontal health status of young individuals and interactional psychosocial and behavioral factors. The overall aim of this thesis was to investigate the periodontal health status among Swedish 19-year-old adolescents and to gain a deeper understanding of psychosocial and behavioral factors that interact with young people's periodontal health conditions.

All four studies in this thesis are based on epidemiological data from a study population consisting of a randomized sample of 10 % (1208 individuals) of all 19-year-olds (born 1987) living in three different areas of the county of Västra Götaland (Fyrbodol, Skaraborg, Göteborg), Sweden. The survey included an anamnesis interview and questionnaires for self-assessment of psychosocial and oral health behavioral aspects, as well as a clinical and radiographic examination. 758 individuals (63 %) from the three areas participated in the questionnaire part of the study. 506 individuals (72 %) from Fyrbodol and Skaraborg also underwent the clinical examination. In study I, the periodontal health status of the 19-year-old participants was explored through a number of clinical and radiographic assessments. In study II, an anamnesis interview containing socio-demographic and lifestyle factors, and a questionnaire for self-assessment, the Self-Perceived Oral Health (SPOH) questionnaire, were used to explore the adolescents' oral hygiene habits, life-style priorities and how they planned for their future dental care. In study III, clinical data and selected items from the SPOH questionnaire were analyzed together in order to explore whether the adolescents' oral health-related perceptions, attitudes and behavior were reflected by their oral hygiene status. In study IV, a health-economic model was used as a framework. Variables and items expressing objective and subjective oral health, socio-demographic information and health/oral health-related behavior were extracted from the clinical questionnaire and anamnesis data and analyzed in order to explore the individual characteristics of importance related to demands for and investment in oral health.

The results showed that adolescents in the county of Västra Götaland have poor oral hygiene conditions with high amounts of plaque and gingivitis, with worse conditions among males and adolescents in Fyrbodol (Study I). Dental care in relation to other lifestyle factors was given high priority by 21 % of the adolescents; however, 35 % of the adolescents did not plan for regular dental visits in the future. Males were found to have less favorable oral health habits than females and three significant factors for not planning for future regular dental visits were identified in a regression model: toothbrushing less than twice daily, smoking and male gender (Study II). Oral health-related attitudes and behaviors were reflected in the clinical periodontal health status of the adolescents and, regarding these aspects as well, there were differences between genders, in favor of females (Study III). The results, based on health-economic theory and analysis, indicated that female gender, a high general self-efficacy score, living area (Skaraborg), and being a student in a theoretical upper secondary program were positively related to the demand for and investment in (oral) health (Study IV).

In conclusion, the results emphasize that a variety of factors related to the individual and the environment interact with the oral health-related behavior and periodontal health status of young individuals. Such factors should be considered in the development of cost-efficient oral health promotion programs and individual prevention programs.

**Key words:** Attitudes, behavior, epidemiology, health economics, oral health, periodontal status.

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## Preface

The present thesis is based on the following publications and manuscript, which will be referred to in the text by their Roman numerals.

- I. Ericsson JS, Abrahamsson KH, Östberg AL, Hellström MK, Jönsson K, Wennström JL. Periodontal health status in Swedish adolescents: an epidemiological, cross-sectional study. *Swedish Dental Journal*. 2009; 33(3):131-9
- II. Östberg AL, Ericsson JS, Wennström JL, Abrahamsson KH. Socio-economic and lifestyle factors in relation to priority of dental care in a Swedish adolescent population. *Swedish Dental Journal*. 2010; 34(2):87-94.
- III. Ericsson JS, Östberg AL, Wennström JL, Abrahamsson KH. Oral health related perceptions, attitudes and behavior in relation to periodontal conditions in an adolescent population. *European Journal of Oral Sciences*. 2012; 120(4):335-41
- IV. Ericsson JS, Wennström JL, Lindgren B, Petzold M, Östberg AL, Abrahamsson KH. Oral health behavior among Swedish adolescents - a cross-sectional health-economics study. Manuscript (2013).



## List of abbreviations

ABL = Alveolar Bone Level

CEJ = Cement Enamel Junction

GS= Gingivitis Score

GSE = General Self-Efficacy

PS= Plaque Score

SBU = Swedish Council on Health Technology Assessment in Health Care

SE index= Socio-Economic grouping

SPOH = Self-Perceived Oral Health

PPD = Probing Pocket Depth

WHO = World Health Organization



## Introduction

Gingivitis is characterized by plaque-induced inflammatory lesions in the soft tissues surrounding the teeth. Untreated and over time, the inflammatory process could lead to a destructive and chronic condition, i.e. periodontitis, with loss of tooth-supporting structures. The most important measure to prevent periodontal disease is to motivate the individual to adequate oral hygiene and by that, the establishment of periodontal infection control. What motivates individuals to such behavioral efforts is, however, a complex issue. For several decades, prevention has been the main focus for the free-of-charge dental care directed to all Swedish children and adolescents by the Public Dental Service. Even so, knowledge about the efficacy of such prevention programs on oral hygiene behavior and periodontal conditions is limited. Moreover, previous studies (Hugoson et al., 1998a; Abrahamsson et al., 2006) reveal some worrying signs with poor oral hygiene and gingival conditions in Swedish adolescents, despite the exposure to prevention and oral health promotion programs in schools and dental clinics. Studies focusing on the periodontal health conditions among adolescents are needed for the evaluation and planning of dental care, as well as to generate knowledge of importance for the cost effectiveness of prevention programs.

This thesis concerns periodontal health among adolescents and psychosocial and behavioral factors interacting with periodontal conditions in young people.

### *Health and oral health*

The World Health Organization (WHO) (1946) describes the concept of health as follows: “Health is a state of complete physical, mental and social well-being and not merely the absence of illness or infirmity.” According to Kay & Locker (1998), the concept of health includes not only the absence of disease but also the individual’s own perception of health and well-being.

Regarding oral health, The World Oral Health Report (2003) states that oral health is integral to general health and essential for well-being. It implies being free of chronic oro-facial pain, oral and pharyngeal (throat) cancer, oral tissue lesions, birth defects such as cleft lip and palate, and other diseases and disorders that affect the oral, dental and craniofacial tissues, collectively known

as the craniofacial complex and, moreover, oral health is a determinant factor for quality of life (Petersen 2003).

It is well described in the literature that the perception of having good oral health is an integral part for a person to experience good general health and wellbeing (Locker, 1997, Petersen & Yamamoto, 2005; Petersen, 2009). Hence, oral health is a broad concept and, as for general health, the term is used not only to describe the absence of disease but also the individual's subjective appreciation of wellbeing (Nordenfelt, 1991). Oral health is often discussed in relation to the two major oral diseases, caries and periodontal disease. In the present thesis, oral health and oral health-related attitudes and behavior are discussed in relation to periodontal condition/status.

It is important to bear in mind that what is considered healthy/unhealthy from a professional's point of view (clinical criteria), does not necessarily mean the same thing for the patient/individual. One should also keep in mind that the concept of (oral) health might vary over time and with age (Petersen & Yamamoto, 2005).

### *Gingivitis and periodontitis*

Periodontal diseases are divided into two main groups, gingivitis and periodontitis. Within these two entities there are different subgroups of the disease, associated with different etiologies (Armitage, 1999). All periodontal diseases are conditions that involve pathological processes affecting the periodontium: the gingiva, periodontal ligament and alveolar bone. In the present thesis, plaque-induced gingivitis will be discussed. This gingival disorder can be described as reversible inflammation of the gingiva, caused by films of bacteria (dental plaque) that form on the tooth surface. Clinically, gingivitis is characterized by redness, swelling and bleeding on probing (Løe et al., 1965; Theilade et al., 1966). If left untreated, gingivitis may progress to destructive chronic periodontitis, involving breakdown of the tooth-supporting structures (Schätzle et al., 2003, 2004).

Chronic periodontitis in young people is clinically similar to chronic periodontitis in adults (Albandar & Rams, 2002). Poor oral hygiene, local plaque-retaining factors and smoking are important factors in the initiation and progression of the disease (Albandar & Rams, 2002;

Albandar, 2002). However, despite great improvements in oral health in the populations in several countries, problems related to gingivitis and periodontitis still persist (Petersen, 2003). The prevalence of periodontal disease varies in different parts of the world, with prevalence figures for chronic periodontitis from 13-57 % in different populations (Rylev & Kilian, 2008). In a study by Hugoson et al. (1998b), it was shown that chronic periodontitis occurs in approximately 40 % of Swedish adults, with severe forms of periodontitis in 7-10 %. Other studies reported similar pattern; severe forms of periodontitis affect about 10 % of the individuals in different populations (Sheiham & Netuveli, 2002; Petersen & Ogawa, 2005). Concerning periodontal health in young populations, studies have shown that unhealthy periodontal conditions are common among adolescents in different populations worldwide, and for the great majority of young populations, plaque-induced gingivitis is the periodontal disease that occurs primarily (Table 1.)

Why gingivitis in certain individuals may progress to periodontitis is, at present, not fully understood. An individual's susceptibility to periodontitis is discussed in relation to a number of individual, lifestyle and environmental factors (Albandar, 2002). Gingivitis may be recognized as a harmless condition, which, in most cases, serves mainly to illustrate the oral hygiene condition of an individual. However, gingivitis is a pathological condition and should therefore be prevented and treated, to avoid later, potentially destructive periodontitis.

### *The Swedish dental health care policy and oral health conditions in Swedish children and adolescents*

According to the Swedish Dental Care Act (SFS 1985:125), "the goal of dentistry is good dental health and dental care on equal terms for the entire population." Specified demands in the Dental Care Act stipulate; "the dental care should be of good quality, and pay particular attention to prevention." Furthermore, §7 of the Dental Care Act states; "the county, through the Public Dental Service, shall provide regular and comprehensive dental care for children and adolescents up to 19 years of age." Hence, today, all Swedish individuals up to the age of 20 enjoy free-of-charge dental care and the main focus for the dental care provided to children and adolescents is the prevention of oral disease.

At the beginning of the last century, the caries prevalence among Swedish children and adolescent was high, the care provided was mainly symptomatic and tooth extractions were a common therapy (Lindblom, 2004). The first Swedish “school dental service” started in a private practice in the city of Köping in 1905. In 1907 and 1908, two “experimental school dental clinics” were opened in Stockholm and Göteborg (Sundberg, 1982). The expansion of the school dental service continued during the early 1900s, and in 1938, the Public Dental Service was established in Sweden, with the aim to provide free-of-charge dental care to all school children as a part of the Swedish welfare system. Preventive strategies were gradually introduced during the 1960s and the subsequent decline in caries prevalence has been associated with the fluoride prevention and information programs that were introduced during this period (Pettersson & Bratthall, 1996). Furthermore, Ordell (2012) discuss that during the 1970s-90s extensive resources were allocated to the Public Dental Service, to enable the expansion of the organized child and adolescent dental health care service.

Unell & Halling (2001) argues that during recent decades, the economic situation in Sweden has changed. This became evident also in the dental service, with increasing demand on efficiency and financial savings. It became obvious that the dental health of Swedish children and adolescents did not improve at the same rate as during previous decades (National Board of Health and Welfare 2006). Even so, in 2008, 30 % of Swedish 19-year-olds were free from caries, which represents an increase by 12.6 % from the year 2000. The number of caries-free 19-year-olds in the Västra Götaland county was 31 % in 2008 (National Board of Health and Welfare, 2010). Further, according to National Board of Health and Welfare data from 2011 (2013), 32 % of the 19-year-olds in Sweden were free from caries and the corresponding figure for Västra Götaland county was 33 %.

There is limited documentation about periodontal health conditions in young Swedes. However, there are some data on periodontal conditions in adolescents based on previous surveys (Table 1). In the so-called Jönköping studies, a series of cross-sectional surveys were conducted in the years 1973, 1983, 1993 and 2003; in 20-year-olds oral hygiene conditions were greatly improved between 1973 and 1983. In 1993, there was a relapse in oral hygiene conditions, with plaque and gingivitis scores comparable to those in 1973, and a gingivitis score of >50 % was seen in 30 % of the young individuals (Hugoson et al., 1998a). However, the Jönköping survey performed in 2003 revealed, again, improved oral hygiene conditions among 20-year-olds compared to the results 10 years earlier (Hugoson et al., 2008).



An epidemiological study by Abrahamsson et al. (2006) revealed poor oral hygiene in a Swedish city population of adolescents, with high scores of plaque and gingivitis in 19-year-olds living in Göteborg. These adolescents had a mean plaque score of 59 % and the mean gingivitis score was 44 %. Approximately 40% of the 19-year-olds had gingivitis at more than 50 % of the tooth surfaces. These results warrant further studies focusing on periodontal health conditions in young individuals, as well as studies designed to generate knowledge about factors that may be of importance in motivating young individuals to adequate self-performed periodontal infection control.

Table 1. Overview of publications on periodontal health conditions among adolescents/young adults.

Authors	Subjects	Aim	Methods	Findings	Authors conclusions
Hugoson et al., 1998	The study comprised individuals in the age groups 20, 30, 40, 50, 60, and 70 years, living in the county of Jönköping, Sweden.	The aim of this study was to assess trends in the prevalence and distribution of plaque and gingivitis, over a 20-year period and to analyze differences in general and local factors that could affect oral hygiene and gingivitis.	Cross-sectional studies. In 1973, a random sample of Swedish adults was examined clinically and radiographically. The study comprised 600 individuals in different age groups. In 1983 and 1993, new samples of subjects from the same parishes and from the same age groups were selected.	It was a reduction in plaque and gingivitis score between 1973 and 1983 in all age groups. Between 1983 and 1993, the increase in plaque among the 20-year-olds was significant. In the 20-year age group, 30 % of the individuals had more than 50 % gingivitis in 1993 vs. 9% of the individuals in 1983.	It was suggested that it is important to renew and direct preventive guidelines more towards young adults who have no previous extensive experience of oral disease so that they will not be excluded from dental care and their dental health thereby jeopardized. In addition to preventive programmes aimed at the population as a whole, individual programmes based on risk targeting are also necessary.
Abrahamsson et al., 2006	A population sample of 272 19-year-old individuals living in Göteborg, Sweden.	The aim of this study was to analyze the periodontal conditions of 19-year old individuals.	A randomly selected population. Clinical examination with regard to oral hygiene, gingivitis, deepened periodontal pockets, probing attachment loss (PAL) and gingival recession. Alveolar bone level and presence of dental calculus were assessed on bitewing radiographs.	The mean plaque and gingivitis scores were 59 % and 44 % respectively. Mean number of sites with a PPD of $\geq 4$ mm was 12.5. Calculus was observed in 3% of the adolescents.	It was concluded that Swedish adolescents has poor oral hygiene and gingival conditions, despite exposure to oral health promotion programs.
Hugoson et al., 2008	Samples of Swedish Individuals aged 20, 30, 40, 50, 60, 70, and 80 years, living in Jönköping county, Sweden.	The aim was to present findings of the prevalence and distribution of gingivitis and periodontitis in a Swedish population over the 30 years 1973–2003.	Four cross-sectional epidemiological studies in 1973, 1983, 1993, and 2003 were performed. The random samples of individuals in the different age groups were examined clinically and radiographically, with regard to number of teeth, plaque, gingival status, probing pocket depth, gingival recession, alveolar bone level, and classification according to periodontal disease status.	Over the 30 years, oral hygiene improved considerably in all age groups. Among the 20-year olds, the mean plaque scores decreased from 30% to 15% and gingivitis scores from 30 % to 11 %.	Oral hygiene and periodontal health improved significantly in the 20–80-year age groups over the 30 years, 1973–2003.

Authors	Subjects	Aim	Methods	Findings	Authors conclusions
Broadbent et al., 2011	The sample initially comprised 1,037 New Zealand children assessed within a month of their third birthdays and when they were aged 5, 9, 15, 18, 26 and 32 years.	The aim was to describe plaque levels through childhood and early adulthood, and to determine the association of those plaque levels with oral health in adulthood, and to investigate the extent to which social inequalities in adult oral health may be mediated by poor oral hygiene habits throughout childhood and into adulthood.	Collection of dental plaque data occurred at ages 5, 9, 15, 18, 26 and 32 years by means of the Simplified Oral Hygiene Index. The authors assessed oral health outcomes when participants were aged 32 years.	Three plaque trajectory groups, high, medium and low were identified. Significant differences were found in periodontal disease experience among those groups. Mean plaque score at age 15, 18, 26, 32 were: 1.11, 0.75, 0.87, 0.76, respectively.	It was shown that across the long term, participants in the high plaque-trajectory group were more likely to experience caries, periodontal disease and subsequent tooth loss than were those in the low- or medium-plaque-trajectory groups, and they experienced all those conditions with greater severity.
Vradias et al., 2012	1,224 12-year old and 1,257 15-year old Greek adolescents.	The aim was to investigate oral hygiene and periodontal status of 12- and 15-year old Greek adolescents, in relation to sociodemographic and behavioral parameters.	A stratified cluster sample. Periodontal (CPI), oral hygiene status (DIs), socio-demographic and behavioral data collected included region, location, gender, parental educational level, tooth brushing frequency and reason for dental attendance.	A majority of adolescents aged 12 (75%) and 15-years (61%) had fair oral hygiene (plaque) levels. The most frequently observed condition in both age groups was calculus with or without gingival bleeding (43% in the younger and and 53% in the older age group). The occurrence of shallow and/or deep periodontal pockets was very low (0.2%).	It was found that oral hygiene conditions among Greek children and adolescents are not satisfactory; the occurrence of gingivitis is high. More efforts on oral health education and oral hygiene instruction are needed to improve periodontal and oral hygiene status.

## *Socioeconomic and psychosocial determinants associated with periodontal conditions among adolescents*

Adolescence is the period in life between childhood and adulthood and, as such, a crucial part of life that includes physical and psychological maturation (Hwang & Nilsson, 2011). Many different definitions are used to describe the concept of ‘adolescence’. The World Health Organization (2013) identifies adolescence as the period in human growth and development that occurs after childhood and before adulthood, from ages 10 to 19. In The United Nations Convention on the Rights of the Child (1989), the word ‘child’ is used to describe a person under the age of 18. Older children, 13-19 years, are known as ‘teenagers’ or ‘young people’. Several other approaches to defining the concept of ‘adolescence’ can be found. Erling & Hwang (2001), for instance, discuss adolescents in terms of psychological, biological and social development and define adolescence as the age between 13 and 19 years. According to the WHO (2008), a huge proportion of the world's population is young, with more than 1.75 billion individuals between 10 and 24 years of age. In Sweden, more than 1.5 million individuals are between 13 and 25 years of age (Swedish National Board for Youth Affairs, 2010). In this thesis, ‘adolescent’ or ‘young adult’ are used interchangeably to represent the study population of 19-year-old individuals.

A variety of socioeconomic and psychosocial determinants has been associated with the periodontal health conditions and oral health behavior of adolescents (Table 2). Psychosocial determinants are characterized as: “factors that affect a person psychologically or socially,” and further; “psychosocial refers to interaction between psychological and social factors, meaning an interaction in both directions. It is therefore not possible to draw strict boundaries between what is psychological and social; we live “psychosocially” (<http://www.psykologiguiden.se> 2013). Psychosocial factors are, for instance, social support, family and friend relations, and meaningful leisure time activities.

Lopez et al. (2006) demonstrated in a group of Chilean adolescents that parental education and income were influential factors with regard to oral health related behavior and periodontal health. Further, in a study by Aleksejuniene & Brukiene (2012), it was revealed that socioeconomic status and toothbrushing frequency contributed to explaining the variation in oral hygiene level among a group of 12-13-year-old Lithuanian adolescents. Mak & Day (2011) showed in a group of 14-

15-year-old Chinese students that “non-traditional” living arrangements; i.e., not living with both parents or in non-private housing, and having two or more siblings were associated with lower odds of regular toothbrushing and annual dental visits. Moreover, peers and social networks have also been shown to have an impact on the toothbrushing behavior of young individuals; a study by Dorri et al. (2010) revealed that the quality and quantity of peer social networks were related to the toothbrushing frequency among 12-year-old Iranian children. Further, in a study by Yekaninejad et al. (2012), it was shown among a group of 11-12-year-old Iranian school children that improvement in oral (gingival) health was more significant in the group of children when parents and teachers were also included in the oral health promotion target, compared with the group of children where the parents and teachers were not included. These results are in line with a study by Al-Omiri et al., (2006) where the results point to the fact that including school and parents in oral health promotion activities could result in more beneficial oral health outcomes.

## Gender and oral health

It is well known that gender is associated with general health (Bird & Fremont, 1991; Riska, 2000). In medical research, two main explanatory models for gender differences in health and illness are recognized: (i) the biological/genetic model considering differences in genes, hormones and physiology, and (ii) the socio-cultural model, pointing at differences between gender regarding normative expectations on work and family life (Hammarström et al., 1996).

Gender has also been associated with oral/periodontal health status and related attitudes and behavior (Furata et al., 2011; Ababneh et al., 2012), and with self-perceived oral health (Östberg, 2002). In a review by Albandar (2002), it was shown that, among adults, males are at a higher risk than females of developing chronic periodontitis. Further, Albandar & Rams (2002) argue that there is considerable evidence showing that adult males are at a higher risk of developing chronic periodontitis compared with females. Concerning the prevalence of periodontitis in children and adolescents, there is, however, a lack of agreement in the data on whether gender is a risk factor for the occurrence of periodontitis in this age group (Albandar & Rams, 2002). Several studies reveal that females are often more concerned with their oral health, have more favorable oral hygiene conditions and better oral hygiene status than males (Furata et al., 2011; Hessari et al., 2008; Farsi et al., 2004). Moreover, Patussi et al. (2007) showed, among a group of 14-15-year-olds, that poor self-rated oral health was significantly associated with male gender. Differences between genders, regarding oral health-related attitudes and behavior should be more widely recognized.

## *Oral health promotion and prevention*

The Ottawa Charter (WHO 1986) defines health promotion as “the process of enabling people to increase control over, and to improve, their health.” Furthermore, health promotion is described as a social and political process, to make it possible for people to control factors that increase their health (Nutbeam 1998) and further: “health promotion is not something that is done *on* or *to* people, it is done *with* people, either as individuals or as groups.” Thus, health promotion aims to support the resources of the individual that will help him/her stay healthy.

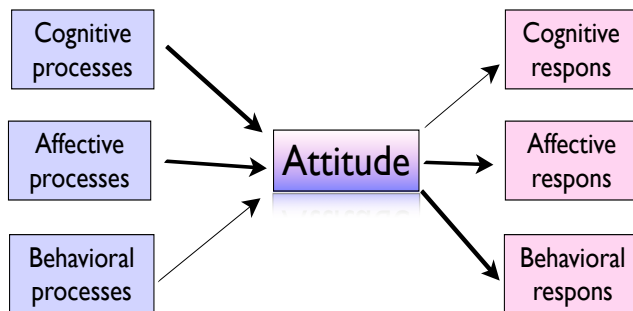
When discussing the concept of (oral) health promotion it is appropriate to also specify the term (oral) health prevention, as these concepts often overlap. Preventive action addresses a specific risk and known cause of a disease and is related to the pathogenic approach to disease. The word prevention is explained as “preventive medical or social action,” and is further described in three parts: “primary prevention refers to prevent illness or injury completely, secondary prevention involves measures to reduce the risk of disease worsening or recurrence, and tertiary prevention includes rehabilitative measures intended to eliminate or reduce disability in connection with the illness or injury” (SBU 2013).

Education, information and training are concepts that are closely related to health promotion (Nutbeam, 1998) and prevention models (Watt & Mahrino, 2005). Knowledge is important but not sufficient to promote health-oriented behavior, as many psychosocial factors influence oral health behavior and need to be considered (Mark & Day, 2011; Lopez et al., 2006). According to Kay & Locker (1998), knowledge can generally be improved by oral health promotion initiatives, but whether improved knowledge leads to changes in attitudes, behavior or clinical indices has not been established. In a review by Kallio (2001) focusing on health promotion and behavioral strategies in the prevention of periodontal diseases in children and adolescents, it was concluded that (i) good plaque control is the main issue to control periodontal diseases among children and adolescents, and (ii) that smoking was stronger than any other preventable factor in relation to the incidence of periodontitis. The author suggested that a common risk factor approach, based on population strategy, is the principal method for preventing periodontal disease among young individuals.

To develop new and more effective promotion and prevention programs, several factors need to be considered, such as a deeper understanding of the individuals' perceptions, attitudes and experiences of oral health, as well as oral health-related education, information and training (Nutbeam, 1998; Watt & Mahrino, 2005).

### *Attitudes and behavior*

The factors that determine an individual's feelings, attitudes and behavior towards different objects and/or situations have been the focus of many theories. One definition of attitude has been proposed by Eagly and Chaiken (1993), who describe an attitude as “a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor.” Further, an attitude is assumed to consist of three components: cognition (knowledge, beliefs and experiences), affection (feelings) and behavior (Eagly & Chaiken, 1993; Bohner & Wänke, 2002). (Figure 1). Similar definitions have been proposed by Angelöw & Jonsson (1990) and Helkama (2000).



Källa: Eagly & Chaiken 1993 and Bohner & Wänke 2002

Fig 1. Theoretical model of an attitude. (Retrieved from Jagers et al. 2009).

Attitudes are established in social contexts; for instance, by parents, family and friends, and adapted to the individual by learning (Helkama, 2000). To influence an individual's attitude or even achieve a change in attitude and/or behavior is a difficult target (Ajzen, 1991). During life, important social persons and situations may affect the individual and even change the individual's attitudes. New knowledge, beliefs and experiences about objects and/or situations can change the individuals' perceptions and feelings towards the object and further, people tend to infer with attitudes that are consistent with their behavior (Eagly & Chaiken 1993). Angelöw & Jonsson (1990) discussed attitude changes in relation to the transmitter (the source) and the receiver (the audience) and suggest that the transmitter is extremely important for the possibility to achieve an attitude change. Helkama (2000) focuses more on the receiver and his/her possibility to adapt to the information/material.

It is important to remember that changing an attitude is not enough in itself, but it must lead to active behavioral change; i.e., the motivation to make an active change in behavior is the most crucial factor. In a study by Macgregor et al. (1997), it was shown that people perform their dental hygiene for different reasons; the authors investigated the relationship between some lifestyle factors and the motivation for toothbrushing in a population of 14-15-year-olds in the UK. Their questionnaire-based study revealed that motivation for toothbrushing was related to health (i.e., to avoid dental problems), as well as to appearance and social participation. Furthermore, the motivation for toothbrushing varied significantly with smoking behavior; committed smokers were more inclined to brush for cosmetic reasons whereas never-smokers were more concerned with brushing in order to avoid dental problems.

Several psychosocial theories and models of health behavior can be found in the literature. In behavioral models with a social cognitive approach, the individual is placed in a social context, with normative influences by others (Ogden, 2000; Ajzen, 2002; Bandura, 2004). One central model is Bandura's Social Cognitive Theory (Bandura, 1977, 1986, 2004). The Social Cognitive Theory provides a framework for understanding, predicting, and changing human behavior. The theory identifies human behavior as interaction between personal factors, behavior and the environment (Figure 2). The theory is based on that (i) people learn by observing and imitate others, (ii) the environment and a person's behavior are interlinked, and (iii) personality is an interaction between the environment, behavior, and a person's psychological processes.



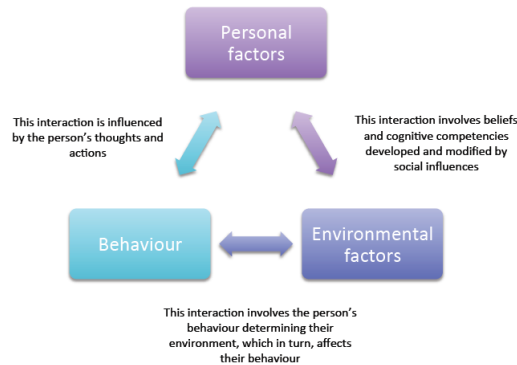


Fig 2. Bandura's Social Cognitive Theory (1986).

Furthermore, the concept of “self-efficacy” is closely related to the Social Cognitive Theory (Bandura, 2004). Self-efficacy refers to the image the individual has of her/himself and the potential he or she claims to have to perform or cope with a specific action or situation. The concept of self-efficacy argues that those with high self-efficacy expectancy (the belief that one can achieve what one sets out to achieve) are healthier, more efficient and, generally, more successful than those with low self-efficacy expectancy. The self-efficacy theory has been applied to dentistry and a review of studies by Kakudate et al. (2010) indicated that the self-efficacy theory could be a useful tool to predict oral health behavior.

### *Oral hygiene interventions directed to adolescents*

In dentistry, prevention programs are often based on traditional educational interventions assuming that increased knowledge (automatically) leads to beneficial behavioral changes (Watt & Mahrino, 2005; Ingelhart & Tedesco, 1995). In a review study by Brukiene & Aleksejuniene (2009), with the aim to review the effectiveness of different oral health promotion strategies directed to adolescents, it was shown that a majority of the studies included used the traditional education approach for improving oral health behavior. Some of the studies used self-assessments of oral hygiene status, and only a few studies used psychological models or theories as a basis for their interventions. Moreover, a majority of the studies reported only short-term results and it is therefore unclear which strategy is the best to promote and achieve long-term

effects on oral health-related behavior among adolescents. Tolvanen et al. (2009) conducted a study among 11-12-year-old children in Finland, with the aim to compare changes in children's oral health-related behavior, knowledge and attitudes, using a multilevel oral health promotion program implemented for 3.4 years, with or without additional individualized interventions, versus conventional reference groups. The results revealed greater improvement in oral health-related behavior among children exposed to a program of oral health promotion using a multilevel approach, than the children in the reference groups; however, similar effects on attitudes and knowledge were not observed.

Oral health promotion programs directed towards children and adolescents have been well established in the Swedish Public Dental Service for several decades. Despite this, there seems to be a lack in knowledge regarding periodontal health conditions among Swedish adolescents (Hugoson, 2005), and similar results have been shown in other young populations (Al-Omiri et al., 2006). Moreover, such a knowledge gap regarding periodontal health conditions is not only present in adolescent populations. In a study by Airla - Månsson et al. (2007) it was shown among a group of 30-40-year-old Swedes that only 1.2 % of the subjects reported that they were aware of gum problems, although 17.1 % of the subjects had been clinically examined and diagnosed with periodontitis.

It has been suggested that future oral health prevention/intervention models should move towards a wider psychosocial approach, in order to achieve long-term results in terms of improved oral hygiene conditions (Watt & Mahrino, 2005; Ingelhard & Tedesco, 1995).

Table 2. Overview of publications on oral/periodontal health related knowledge, perceptions, attitudes and behavior among adolescents/young adults.

Authors	Subjects	Aim	Methods	Findings	Authors conclusions
Östberg et al., 1999	17 280 students aged 13-18 years in the county of Skaraborg, Sweden.	The aim was to examine gender differences in knowledge, attitude, behavior and perceived oral health.	A cross-sectional dental questionnaire survey was conducted in classrooms of students.	Thirty-one percent of the girls and 21 % of the boys flossed regularly. Oral health was regarded as important by a majority of the students (95%). Girls considered sound teeth to be more important than boys.	It was concluded that most adolescents had a positive dental attitude and perceived their own oral health to be good. Poorer knowledge and behaviors concerning oral health were demonstrated. Girls scored more favorably on behavioral measures, showed more interest in oral health, and perceived their own oral health to be good to a higher degree than boys.
Faesi et al., 2004	A random sample of 2586 Saudi students aged 12-18 years residing in Jeddah.	The aim was to access the knowledge, attitude and behaviour in relation to periodontal health status among Saudi intermediate and high school students.	A dental/periodontal health questionnaire was used.	87 % knew that tooth brushing helps prevent periodontal disease, 33.1% knew that using dental floss helps in preventing periodontal disease. Only about 23% of school students rejected the statement that losing teeth is a natural sequence of getting old. Females used brushing and flossing more than males.	The findings suggested that the group of 15 years and older, male students in governmental school would be the start appropriate target group. This group will receive the first organized intervention leading towards improving periodontal health status through increasing their knowledge, attitude and behaviour, then followed by other groups.
Al-Omini et al., 2006	School children (n=557) of an average age of 13.5 years attending public schools in North Jordan.	The aim of the study was to investigate the dental health attitudes, knowledge and behavior of school children.	A questionnaire, aiming to evaluate behavior, knowledge, and perception oral health and dental treatment.	Oral hygiene habits were irregular, and parents' role in the oral hygiene habits of their children was limited. The participants showed higher awareness of caries than periodontal conditions. Irregular dental visits were common. Children had positive attitudes toward their dentists; still, they indicated that they feared dental treatment. The participants recognized the importance of oral health to the well-being of the rest of the body. Parents' knowledge and attitudes about the importance of oral health care and their fears about dental treatment influenced their children's dental care.	In conclusion: the results of this study indicate that children's and parents' attitudes toward oral health and dental care need to be improved. Comprehensive oral health educational programs for both children and their parents are required to achieve this goal.
Hedman et al., 2006	793 Swedish students, 12- and 15-years-old.	The aim of this study was to investigate the knowledge of and attitudes to oral health among 12- and 15-year-old students in Sweden.	A questionnaire consisted of fifteen structured questions regarding knowledge and attitudes to oral health.	The level of knowledge by adolescents was relatively high. A majority of the subjects felt that their teeth were important. Most of the adolescents had learned about oral health from the dental team. With the exception of the question about the meaning of the word "periodontitis", all the questions produced a distribution of correct answers in favour of the girls. Older students showed more knowledge than younger. The adolescents with an immigrant background showed less knowledge compared with natives of Sweden, in several areas.	It was concluded that facts are not enough to induce young people to change their health behaviour. Facts are an important part of the message but must be complemented by reflection and consideration of how the receiver understands it. In health promotion it is also needed to use qualitative analytical methods to obtain a deeper understanding of the phenomena.

Authors	Subjects	Aim	Methods	Findings	Authors conclusions
Broadbent et al., 2006	A longitudinal investigation of health and behavior in a complete birth cohort at ages 15, 18, and 26 years, in New Zealand.	The aim was to investigate the stability of dental health beliefs from adolescence to adulthood; to examine sociodemographic correlates of beliefs; and to determine whether favorable/unfavorable beliefs are associated with different oral health outcomes.	A questionnaire regarding the beliefs about the efficacy of water fluoridation, keeping the mouth clean, avoiding sweet foods, visiting the dentist, using dental floss, and using fluoridated toothpaste.	Individuals who held stable favorable dental beliefs from adolescence through adulthood had fewer teeth missing due to caries, less periodontal disease, better oral hygiene, better self-rated oral health, and more restorations.	It was concluded that dental beliefs can change between adolescence and young adulthood, and these changes are related to oral health. In particular, unfavorable dental health beliefs are related to poorer oral health.
Patuzzi et al., 2007	1302 adolescents aged 14-15 years in 39 schools, in two cities in Brazil.	The aim was to investigate the main social, psychosocial and clinical factors associated with poor self-rated oral health in adolescents.	A cross-sectional survey was carried out. Data were collected by clinical examinations and by self-administered questionnaires.	Poor self-rated oral health was significantly associated with males, low social class, poor self-rated general health, mouth appearance and with presence of untreated dental decay.	It was suggested that the single question on self-rated oral health appears to be a simple and easy way to collect dental health information in adolescents. Assessment and understanding of self-rated oral health should take into account social, psychosocial and oral factors.
Campos et al., 2009	913 Italian adolescents (14-16 years), 492 females and 421 males.	To evaluate the possible interaction between the type of secondary school attended (technical/grammar), oral clinical data and self-perceived oral health (SPOH)-behaviour.	Oral health behaviour data was collected using a questionnaire. Gingival conditions was assessed with the community periodontal index (CPI) following World Health Organization recommendations.	A third of participants showed a CPI = 0, whereas 34.9% had bleeding on probing and 37.9% had calculus. In males, CPI > or = 1 was associated with the type of school (grammar vs technical secondary programs) and experience of self-perceived tooth discomfort. In females, CPI > or = 1 were associated with the type of school.	It was concluded that the type of school is a sensitive indicator of oral health status among adolescents.
Tolvanen et al., 2010	The study population consisted of all 5th and 6th graders who started the 2001-2002 school year in Port (n = 1691); 1362 of them were monitored throughout the 3.4-year study.	The aim was to describe the individual stability and stage transitions for behaviors among children exposed to a oral health program (OHP) and to ascertain whether these phenomena differed in the group that was also exposed to the experimental regimen of a randomized controlled trial (RCT).	1362 individuals were monitored throughout the study; 1138 were exposed to OHP and 224 to OHP and the experimental regimen of the RCT. Data on toothbrushing and use of sytilitol products, candies, and soft/sports drinks were gathered with questionnaires. Behavior variables were dichotomized into good and poor. The stability of behaviors and stage transitions was evaluated.	Over half of the children had stable behaviors throughout the study. For those children whose behaviors changed, the behavior was more likely to improve than to worsen. For most behaviors, good behavior at baseline was associated with the ability to maintain the achieved good behavior and to recover from lapses to poor behaviors.	In childhood, behaviors, especially good ones, are rather stable. If healthy behaviors are learned young, lapses into poor behaviors, for instance during the teens, are likely to be temporary rather than permanent.
Mak & Day, 2011	4927 students in Hong Kong, (44.7% boys) aged 14-15 from 36 secondary schools.	The study aimed to investigate the prevalence and socioeconomic differences in dental health behaviours among Hong Kong adolescents.	Cross-sectional design, students reported their socioeconomic information and dental health behaviours using the Health Related Behaviour General Questionnaire (HRBGQ).	77.8% reported on regular brushing, 22.3% used dental floss weekly and 37.9% had annual dental visit. Male gender, Chinese ethnicity, two or more siblings and not living with both parents were significantly associated with lower odds of regular brushing, use of dental floss and annual dental visit. Students living in non-private housing were significantly less likely to have annual dental visit than those in private housing.	It was shown that in general, socioeconomic disparity in dental health behaviors was observed. Extending the existing government-run dental health programmes to secondary school students in Hong Kong is warranted.

*Health-Economic perspectives on demands and investments in (oral) health*

Scarcity of resources always puts limits to what can be achieved in an organization such as the Swedish Public Dental Service. This fact makes it necessary to utilize existing resources as wisely as possible in order to avoid waste and inefficiency. The health-economics discipline provides tools by which health effects can be related to costs in a systematic way at an individual as well as at a population level; and, furthermore, for prediction of individuals' health-related behavior. However, applications of health-economic theory and analysis to oral/periodontal health and dental care are still rather few (Gjerme & Gyttén 2009) (Table 3).

In the health economics discussion it is important to distinguish between positive theory/analysis and normative theory/analysis. In normative economic analysis the objective is to evaluate the cost effectiveness of inserted resources within, for instance, the Public Dental Service. Hence, a normative evaluation aims to compare the costs and effects of two or more options. The results of such evaluations are treated as recommendations, actions or strategies that the organization should/ought to implement to achieve as much effect (health) as possible for the cost invested (money and/or time). Using health-economics evaluations, the public dental service could receive support for allocation decisions—how to relate costs to clinical effects—which, in turn, may lead to improved resource utilization. There are, however, only a limited number of normative health-economic studies in relation to dentistry (Braegger, 2005).

In positive economic analysis the objective is either to explain observed phenomena in the past or to predict future decisions and behavior of individuals or organizations. The Grossman Human Capital model (1972) is a positive economic theory. Grossman's model aims to explain or to predict health-related behavior. In short, the Grossman model discusses two kinds of human health capital; health (innate capital) and education (investment in health capital). Every individual is born with a certain amount of "health capital" that depreciates with age. Furthermore, every individual is both a producer and a consumer of his/her own health. Investments in education are related to increased productivity, higher income and improved capability to deal with health conditions. The individual can also invest in his/her own health, which influences the time an individual can spend on work or leisure activities. According to the model, there are two reasons for an individual to demand health: (i) the direct pleasure of "being healthy/feeling good," and (ii) health as an investment that determines the number of healthy

days available for work or leisure. However, a limited amount of time and money is available to the individual and health-enhancing actions compete with other activities that the individual wants to invest his/her time and money in. The balance between the individual's different needs and wishes will determine his/her health requirements.

Only a few studies in the field of dental research have applied the Grossman model. In a study by Nguyen & Häkkinen (2005), based on data from the Finnish Health Care Survey of 1996, including about 4500 individuals aged between 20 and 92 years, the Grossman model was used as the theoretical framework. The results showed that being recalled by the dentist was an efficient way to stimulate individuals to seek dental care. Furthermore, based on data from the Northern Finland 1966 Birth Cohort, with respondents aged 31 ( $n = 5020$ ), Nguyen et al. (2008) concluded that oral health promotion should focus on strategies to improve dental education programs and on reducing the impact of common risk factors. In a study by Gerdtham & Johannesson (1999) the results are consistent with the theoretical predictions and show that the demand for health increases with income and education and decreases with age, male gender, overweight, living in big cities and being single. It was concluded that the results provide some support for the demand for health model.

In both dental and medical care, one of the main goals of the organization is to achieve as much health as possible from the inserted resources. In order to design effective prevention programs and evaluate the cost effectiveness of such programs (normative theory), knowledge about predictors that affect influence the (young) individual's health behavior (positive theory) is necessary.

Table 3. Overview of publications on (oral) health-economic analyses.

Authors	Subjects	Aim	Methods	Findings	Authors conclusions
Gerdttham & Johansson, 1999	Individuals between the ages 18 and 76 years, 5174 individuals for the full sample and 3184 individuals in the employed sample.	The aim of the study was to estimate a "Grossman" model of demand for health based on Swedish micro data.	Health capital was measured by a categorical measure of overall health status, and an ordered probit model was used to econometrically estimate the demand for health equation.	The results are consistent with the theoretical predictions and show that the demand for health increases with income and education and decreases with age, male gender, overweight, living in big cities and being single.	It was concluded that the results provide some support for the demand for health model. The results also demonstrate the usefulness of measuring health capital with the type of categorical health measure used in this study.
Grytten & Holst, 2002	Two sets of survey data, representative of the Norwegian population, aged 20 years and above. For 1985 and 1995, a sample of 6691 and 7457 individuals, respectively.	The aim of the study was to examine the relationship between income and demand/utilization for dental services among young adults in Norway.	Data collection by personal interviews using a pre-coded questionnaire, covering health status, utilization of health service and questions on demand for dental services (dental visit during the last year) and dental status. Income was measured at the family level.	Increase in demand with an increase in income was less for young adults than for older adults. There was a marked fall in the income elasticities among young adults from 1985 to 1995. The fall in the income elasticity corresponds to a marked decrease in the prevalence of dental diseases among young adults during that period.	It was suggested that the results imply that future policies for dental manpower should take into account the lower income elasticity for young adults compared to for older adults, and that future needs for dental personnel should be planned accordingly.
Nguyen & Häkkinen, 2005	6439 individuals aged between 20 and 97 years, using data from the Finnish Health Care Survey of 1996.	The aim of the study was to explore the determinants of utilization of dentists' services and the role of supply factors in the decision-making processes of utilization.	In a two-part model, (theoretical framework based on the Grossman model) care-seeking is modeled by a model taking into account dentist's recall, and a model with the number of positive visits to the dentist.	Recalls turns out to be a central determinant of care seeking and was significantly related to income and unemployment.	It was concluded that dentist's recall was efficient at stimulating individuals to seek care. This highly positive significance of dentist's recall and dental visits, implies that attention should be focused on supply-side factors and other incentives to encourage people to contact dentists more often.
Braegger, 2005	First economic assessments such as cost-benefit, cost effectiveness and cost-utility analyses were derived from the literature on health economy, than inclusion criteria required economic analyses based on scientific principles including, a hypothesis, valid comparative groups, cost/benefit, cost/ effectiveness and cost/ utility assessment.	The aim of this paper was to determine whether there is evidence that periodontitis prevention is economically justified	A literature search was conducted using PubMed up to December 2004. 14 papers were located, 3 systematic reviews, 3 randomized controlled studies, 4 controlled studies, 1 longitudinal cohort study, 3 papers based on statistical modeling.	Economic assessments and real costs are not generally available in the literature. Extensive prevention programmed aimed at prevention of periodontal disease in a general population group showed no economic benefit. Adjunctive genetic and or microbiological testing, programs likewise showed no economic benefit. Statistical modeling suggested non-surgical periodontal procedures as more economical than surgical interventions. The use of local delivery devices as an adjunct to Sc/RR showed no economic advantage.	It was concluded that economic parameters as well as patient-centered outcomes should be included in clinical trials. These data are essential for appropriate allocation of resources for preventive measures on an individual patient and population base.

Authors	Subjects	Aim	Methods	Findings	Authors conclusions
Nguyen et al., 2008	5020 respondents aged 31, in a longitudinal study of the Northern Finland 1966 Birth Cohort.	The aim was to explore the determinants of dental ill health as measured by the occurrence of caries.	Data from a follow-up questionnaire. A recursive bivariate probit model that was derived from health production and demand theory was employed to model caries, while taking account of dental care use. The factors controlled for relate to family background and health behavior during their youth, current socioeconomic variables and dental health stock.	Among females, factors increasing caries was (high) body mass index and intake of alcohol, sugar and soft drinks, (low) birth weight and (poor) adolescent school achievement. Among males, factors increasing caries was metropolitan residence and poor education and unhealthy diet. Smoking increases caries, whereas regular dental care attendance and brushing teeth at least twice a day decrease caries among both genders.	The results showed that to promote oral health, attention should focus on policies to improve dental health education and to reduce the impacts of common risk factors.
Gjerme & Grytten, 2009	Literature using the terms periodontal therapy and cost-effectiveness, cost, time consumption, time factor and time, and periodontal treatment modalities and cost-effectiveness, cost, time consumption, time factor and time.	The aim was to approach the problem of cost-effectiveness of treatment modalities.	Literature search in Medline (PubMed) and the Cochrane Library. Plus a hand search in relevant journals after 2005, with special attention given to reference lists in review articles on related subjects. To approach the problem of cost-effectiveness of treatment modalities, it was decided to use, as outcome variable, either tooth loss or retention, or as surrogate variables, bone level measured on radio- graphs in randomized clinical trials. An observation time of at least 1 year was required.	No randomized clinical trials were found that satisfied the requirements, thus, a systematic review was not possible. Studies that tried to address the cost-effectiveness aspects of periodontal treatment modalities were identified and further comments were based on a narrative review of those studies, and on previous reviews of related subjects. The results indicates that the main cost gains in periodontal therapy would be achieved by avoiding unnecessary surgery and by applying intervals of 1 year or more in the life-long maintenance phase.	It was concluded that as inflammation is variably associated with destructive disease and difficult for patients to assess, future studies on the cost-effectiveness of periodontal treatment modalities would benefit from focusing on end point variables, such as tooth loss or tooth retention, that are tangible for the patients.



## Rationale and intentions of the present thesis

The goal of dental care is to establish good oral health in the population. In order to reach this goal, preventive action should focus on the establishment of positive attitudes and beneficial oral health-related behavior early in life, with the intention of lifelong compliance with such behavior. Dental care professionals should work with effective prevention programs that young people can and want to identify themselves with. Such programs are of great importance, both for the health of the individual *per se* and from a health economics/societal perspective. Studies that investigate the relationship between the oral health condition of individuals and psychosocial/behavioral factors can contribute important knowledge for the development of cost-effective oral health promotion programs directed to young individuals.



## Aims

### *Overall aim*

The overall aim of the present series of studies was to investigate the periodontal health status among Swedish 19-year-old adolescents and to gain a deeper understanding of psychosocial and behavioral factors that interact with young people's periodontal health conditions.

### *Specific aims:*

- To analyze the periodontal health status of 19-year-old individuals in Västra Götaland, Sweden (*study I*).
- To investigate and analyze oral health habits and lifestyle factors in relation to the priority of regular dental care among 19-year-olds (*study II*).
- To evaluate oral health-related perceptions, attitudes and behavior in relation to oral hygiene conditions among Swedish 19-year-olds (*study III*).
- To analyze the demand for and investments in oral health among Swedish 19-year-olds, from a health economics theoretical perspective (*study IV*).



## Material & Methods

### *Ethical considerations*

The ethics committee at the University of Gothenburg approved the studies included (Reg. no.: 146-05). All participants were informed about the purpose and design of the trial and the possibility of leaving the study at any point in time, without giving a reason for dropping out and without this affecting their future dental care. The participants gave their written consent before they were included in the study.

### *Study design & Study population*

The study was conducted during the period August 2005 to September 2006 and included an anamnesis interview, questionnaires for self-assessment of psychosocial and oral health behavioral aspects and a clinical and radiographic examination (Figure 3). The study sample consisted of a random selection (database “Västfolket”; official population register on residents in Västra Götaland and Halland) of 10 % (n=1208) of all individuals born in 1987 and living in three different areas in the county of Västra Götaland, Sweden: Fyrbodal n=356, Skaraborg n=352, and Göteborg n=500). The individuals were invited by mail to participate in the study.

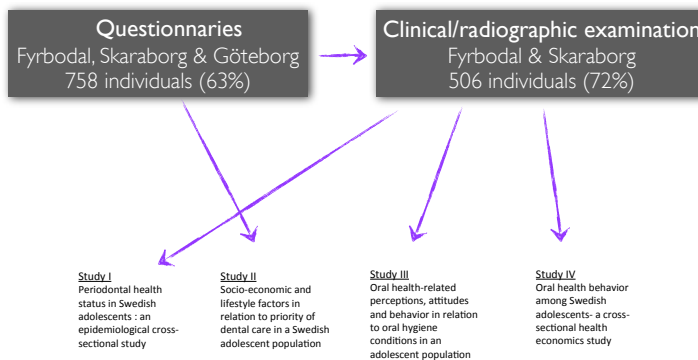


Fig 3. Study design.

### *Attenders/non-attenders*

Out of the 1208 randomly selected subjects, 758 (63 %) participated in the questionnaire part of the survey (Figure 3): Fyrbodal 70%, Skaraborg 73% and Göteborg 51%. The gender distribution was 351 males and 407 females. Reasons for not participating (n=450) were (i) no time/not interested (34 %) (ii), had moved from the area (6 %), (iii) deceased (one individual), (iv) no contact/unknown (60 %). The proportions of males were greater among the non-respondents than the respondents (58 % versus 46 %,  $p=0.025$ ). Internal drop - outs in the questionnaire was low (0.2-3.4 % of missing answers in separate items) and there were no differences between genders in this aspect.

A total of 707 randomly selected subjects from Fyrbodal and Skaraborg were also invited to the clinical and radiographic part of the survey and 506 individuals (72 %; Fyrbodal 70% and Skaraborg 73%) participated (Figure 3), 234 males and 272 females. Reasons for not participating (n=201) were (i) no time/not interested (66 %), (ii) moved from the area (3 %), (iii) did not show up at the examination (15 %), and (iv) no contact/unknown reason (16 %). The proportion of males was greater among the non-respondents than among the respondents (62 % vs. 46 %;  $p<0.001$ ).

### *Anamnesis Interview - Questionnaires*

Socio-demographic and background data were collected in the anamnesis interview. The questionnaire package included different (psychometric) instruments for self-assessments:

- Self-Perceived Oral Health (SPOH), which contained 27 items regarding perceptions, attitudes and behavior towards oral health. The items were constructed with three or four fixed response alternatives (Hamp & Nilsson, 1982; Östberg, 2002).
- General Self-Efficacy (GSE), which contained 10 items aiming to assess an individual's general sense of perceived self-efficacy to settle different situations and difficulties. Item scores range from 1 (totally disagree) to 4 (totally agree), with a final composite score from 10 to 40, where higher scores indicate a greater sense of perceived self-efficacy (Schwartz, 1993; Koskinen-Hagman et al., 1999).

The questionnaire package also included two psychometric instruments on the oral health locus of control and dental fear, presented elsewhere (Östberg & Abrahamsson, 2013).

### *Clinical examination*

The clinical examination was performed at the participants' regular public dental clinics. Four dental hygienists, specially trained and calibrated for the study, performed the examinations. Two project assistants recorded all the clinical recordings.

The following clinical variables were recorded (3rd molars excluded):

- Number of teeth
- Plaque score - presence/absence of visible plaque on four surfaces of the six Ramfjord index teeth (Ramfjord, 1967).
- Gingivitis – presence/absence of bleeding following probing of the sulcus area and recorded at six sites of all teeth (Løe, 1967). The highest value with respect to probing measurements at the mesio-buccal/mesio-lingual and disto-buccal/disto-lingual tooth sites, respectively, was selected to represent the proximal site.
- Probing pocket depth (PPD) – measured at six sites at all teeth with a calibrated periodontal probe (UNC 15 probe) to the closest higher mm. The highest value with respect to probing measurements at the mesio-buccal/mesio-lingual and disto-buccal/disto-lingual tooth sites, respectively, was selected to represent the proximal site.
- Gingival recession – defined as the location of the gingival margin apical to the cement-enamel junction (CEJ) and scored in mm at the facial aspects of all teeth.

### *Radiographic examination*

Four standardized bitewing radiographs were taken of the premolar and molar region, unless corresponding radiographs not older than one year and of adequate quality were available. In the radiographs the alveolar bone level (ABL) was measured; i.e., the distance in mm from the CEJ to the alveolar bone crest, defined as the point where the periodontal ligament space was considered to have a normal width (Bjorn et al., 1969). The measurements were made by the author (JSE)

and by using a magnifying lens (x7) to the nearest lower 0.5mm at all mesial and distal tooth surfaces reproduced in the radiographs. Dental calculus was scored as present/absent for each posterior jaw quadrant. A positive score was noted if at least two tooth surfaces in a jaw quadrant had radiographically detectable calculus. The intra-examiner reproducibility of the alveolar bone level measurements was evaluated by repeated assessments of 62 randomly selected subjects with a 1-3-week interval. The standard deviation for the repeated measure was 0.34 with 96.7 % of the measurements reproduced within a difference of  $\pm 0.5$ mm.

### *Socioeconomic grouping*

The adolescents were socioeconomically (SE) classified according to an index used by the Public Dental Service in Västra Götaland for resource allocation. The SE index was calculated based on the proportion of individuals aged 18-64 years in a given municipality (i) being born outside the Scandinavian countries, (ii) receiving social allowance, (iii) being unemployed, and (iv) having a low educational level (elementary school only), in relation to the corresponding figures for the whole population in each region (Fyrbodalen, Skaraborg & Göteborg). Thus, the adolescents were SE grouped according to the SE index of the Public Dental Clinic where they were listed as patients. Three SE groups were defined: SE 1 (SE index <8 %), SE 2 (SE index >8 % but <19.5 %) and SE 3 (SE index >19.5 %), where SE 1 represents the most affluent group of individuals.



### *Health-Economics model*

In study (IV), a health-economics theoretical framework was used, the Grossman human capital model. The model was based on independent/explanatory variables, chosen among available study data, to represent both the theoretical framework and to be associated with the chosen dependent/indicator variables. The gingivitis score (%) and a questionnaire item regarding self-perceived oral health were selected as objective and subjective indicators, respectively, for oral health in the “demand for health” model. For the “investment in health” model, several oral and general health indicators were examined: toothbrushing habits, missed dental appointments, tobacco consumption, physical exercise and self-perceived oral health attention (Figure 4).

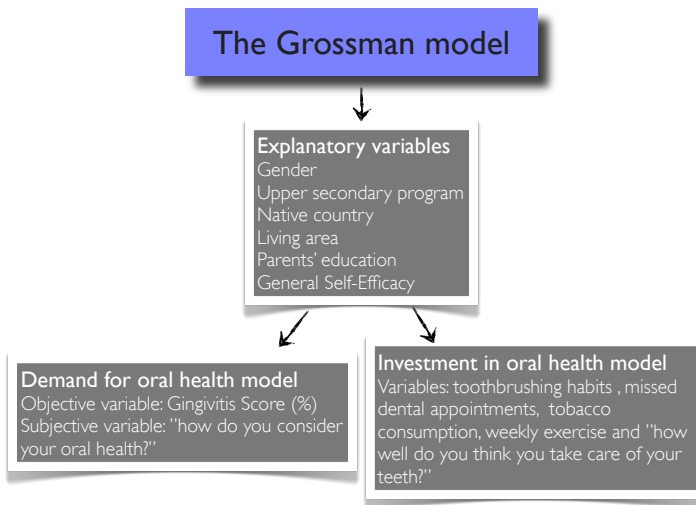


Fig 4. Explanatory factors and indicator variables used for the equations in the Grossman Human capital model

## *Data analysis – Statistics*

The statistical methods used for the analyses are presented in Table 4. Descriptive statistics were used to calculate mean values, standard deviations and standard errors. Proportions of sites within various categories of scoring units were calculated for data description, using the patient as the statistical unit. Student’s t-test was used for the analysis of continuous variables. Differences in proportions/groups were analyzed with the Chi-square and Fisher’s Exact Test. Associations between independent and binary/dependent variables were explored using logistic regression analysis. A *p*-value of less than 0.05 was considered as statistically significant. The statistical package for the social sciences, the SPSS version 18.0 software package (SPSS Inc., Chicago, Illinois, USA) was used for the data analysis. In addition, health economics analyses were performed using Stata 12.1 (StataCorp LP, Texas, USA).

Table 4. Methods for statistical analyses in Studies I-IV.

<b>Study</b>	<b>Statistical methods</b>
I Clinical and questionnaire-based data	Descriptive statistics, Student’s t-test, Chi-square analysis, and logistic multiple regression analyses.
II Questionnaire-based data	Descriptive statistics, Chi-square analysis, logistic bivariate and multivariate regression analyses.
III Clinical and questionnaire-based data	Descriptive statistics, Correlation analyses (Spearman’s rho), Student’s t-test, Chi-square analyses, Fisher’s Exact Test, logistic bivariate and multivariate regression analyses.
IV Clinical and questionnaire-based data Health economics model	Descriptive statistics, logistic multivariate regression analyses.

## Results

### Periodontal health status

Of the total number of 506 adolescents examined clinically (Skaraborg n= 256 and Fyrbodal n= 250), 53 % were females. 76 % of the participants reported toothbrushing at least twice daily, but only 4 % reported on daily interdental hygiene. The population had a mean plaque score of 47 % and the corresponding figure for gingivitis was 56 % (Table 5). The mean number of sites with a PPD of  $\geq 4$  mm was 8 for the entire population, with higher prevalence among adolescents in Fyrbodal than in Skaraborg (Table 6). The subjects had 5.5 teeth with facial gingival recession, on average. The mean number of proximal sites with a distance between the CEJ and the marginal bone crest of  $>2$ mm was 0.4. Radiographically detectable calculus in at least one jaw quadrant was found in 3 % of the subjects. Differences in oral hygiene conditions were found between genders, in favor of females, and between the two regions, in favor of Skaraborg, but not in relation to socioeconomic grouping. In the multiple logistic regression models formulated for plaque, gingivitis and PPD, respectively, it was revealed that gender (male) and county area (Fyrbodal) were significant factors associated with high plaque and gingivitis scores, as well as PPD $\geq 4$ mm.

Table 5. Mean percentage (SE) of sites with plaque and gingivitis in the county areas of Fyrbodal & Skaraborg.

Variable	Fyrbodal	Skaraborg	<i>p</i> -value
Plaque score %			
All surfaces	55.8 (1.3)	37.6 (1.5)	<0.001
Proximal	64.1 (1.5)	38.1 (1.6)	<0.001
Gingivitis score (%)			
All surfaces	64.3 (0.9)	46.9 (1.2)	<0.001
Proximal	90.1 (0.8)	63.4 (1.2)	<0.001

(SE=standard error)

Table 6. Mean number of sites (S.E) PPD $\geq 4$ mm in the county areas of Fyrbodal and Skaraborg.

Variable	Fyrbodal Mean (S.E)	Skaraborg Mean (S.E)	<i>p</i> -value
PPD $\geq 4$ mm			
All surfaces	10.2 (0.5)	6.1 (0.4)	<0.001
Proximal	9.9 (0.5)	5.9 (0.4)	<0.001

## Socio-economic and lifestyle factors in relation to priority of dental care

In study II, which included adolescents from all three parts of the county (Figure 3), the oral health-related questionnaire data were analyzed. The analysis revealed that females had significantly more favorable oral hygiene habits than males. A first and second ranking of regular dental care was given by 20 % of the males and 22 % of the females, while housing, clothes and leisure time were the top priorities with regard to spending time and money among both genders (Table 7). As shown in Table 7, regular dental care was ranked as a top priority by only 7 % of the adolescents. A majority (63 %) of the adolescents responded, “yes” to the question: “are you planning future regular dental visits (after leaving the free-of-charge dental care service). However, 41 % of the males and 30 % of the females were not planning such visits (Table 7). The multivariate logistic regression model showed that male gender, smoking and tooth brushing <2 times/day were factors identified for the probability of not “planning future regular dental visits”. There were no statistically significant differences in oral hygiene habits and dental care priorities between residential areas and socioeconomic groups.

Table 7. The participants’ priorities today and with regard to future regular dental care visits, by gender

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

## Oral health-related perceptions, attitudes and behavior in relation to oral hygiene conditions

In study III, subgroups of individuals with the lowest plaque and gingivitis score ( $\leq 30$ ) and highest plaque ( $\geq 70$ ) and gingivitis ( $\geq 80$ ) scores, versus all others, were analyzed with respect to questionnaire data. The analysis showed that oral health-related perceptions, attitudes and behavior were reflected in the individual's oral hygiene status; i.e., higher scores of plaque and gingivitis were found among individuals with less positive oral health-related perceptions, attitudes and behavior. Further, more favorable oral hygiene conditions and more positive perceptions, attitudes and behavior, in relation to oral health, were found among females than males. Two multiple logistic regression models with high plaque/gingivitis scores as dependent variables were formulated (Table 8). The model formulated for plaque revealed that male gender, toothbrushing once daily or less, low rated possibility to influence own oral health, low rated satisfaction with the esthetics of the teeth and flossing seldom/never, were factors significantly associated with belonging to the high plaque score subgroup. The model formulated for gingivitis revealed that male gender, toothbrushing once daily or less, often bleeding while brushing and low rated satisfaction with the esthetics of the teeth were factors significantly associated with belonging to the high gingivitis score group.

Table 8. Logistic regression models predicting plaque ( $\geq 70$  %=1) and gingivitis ( $\geq 80$  %=1)

Variable	$\beta$	S.E	df	OR	CI 95 %	<i>p</i> -value
<i>Model 1 Plaque</i>						
Gender (male)	1.0	0.2	1	2.79	1.72- 4.53	0.000
Tooth-brushing $\leq 1$ day	1.0	0.2	1	2.77	1.70- 4.53	0.000
Low rated possibility to impact on own oral health	0.6	0.2	1	1.83	1.13- 2.96	0.013
Low rated satisfaction with the esthetics of the teeth	0.6	0.3	1	1.89	1.09- 3.28	0.023
Flossing seldom/never	0.8	0.4	1	2.24	1.02- 4.96	0.045
<i>Model 2 Gingivitis</i>						
Gender (male)	0.7	0.3	1	1.93	1.02- 3.64	0.043
Tooth-brushing $\leq 1$ day	1.2	0.3	1	3.18	1.68- 6.00	0.000
Often bleeding while brushing	1.1	0.3	1	3.01	1.58- 5.71	0.001
Low rated satisfaction with the esthetics of the teeth	1.0	0.3	1	2.68	1.37- 5.22	0.004

Significance level for the models;  $<0.05$ ; OR = odds ratio; CI 95 % = confidence interval

*Model 1*; Nagelkerke  $R^2 = 0.19$ ; Hosmer and Lemeshow goodness-of-fit  $\chi^2 = 3.58$ ,  $df = 7$ ,  $P = 0.83$ ; PAC – sensitivity (mean predictive values among classes) overall = 78.7%.

*Model 2*; Nagelkerke  $R^2 = 0.22$ ; Hosmer and Lemeshow goodness-of-fit  $\chi^2 = 8.8$ ,  $df = 7$ ,  $P = 0.27$ ; PAC – sensitivity overall = 89.8%.

## Demands for and investment in oral health

The health-economics analyses (study IV) revealed that several factors related to (oral) health conditions and behavior, and to individual and socio-demographic aspects, were of importance for the demand for and investment in oral health among Swedish adolescents. Two models for demand for oral health and five models for oral health investment were formulated. Explanatory factors for all models were gender, native country, living area, upper secondary program, parents' education and GSE score. In the demand for oral health model with the gingivitis score as the objective indicator (Table 9), theoretical studies and living area were statistically significant, while in the demand for oral health model with an item on self-perceived oral health as the subjective indicator, none of the explanatory variables were statistically significant. In the oral health investment model, with 'toothbrushing twice or more daily' as the indicator, female gender and theoretical studies showed statistical significance. In the investment models with the indicators 'no or few missed dental appointments', 'no tobacco consumption' and 'weekly exercise', respectively, theoretical studies were statistically significant and positively associated. In the investment model with an item on self-perceived oral health as indicator, a higher score of GSE was significantly associated with the feeling of taking good care of one's teeth (Table 10).

Table 9. Demand for oral health. Multiple logistic regression model using an objective indicator for oral health (Model 1), showing all explanatory variables (gender, upper secondary program, parents' education, GSE, native country and living area).

Variables	Odds Ratio	p-value	Std.Err.	CI 95 %
<b>Model 1: Gingivitis score</b>				
Gender (female)	1.47	0.108	0.35	0.92 - 2.36
Upper secondary program (theoretical)	1.72	0.025	0.42	1.07 - 2.76
Parents' highest education (higher education/university)	1.17	0.528	0.29	0.72 - 1.90
GSE (sum score $\geq 30$ )	1.18	0.495	0.28	0.74 - 1.87
Native country (Scandinavia)	1.88	0.210	0.95	0.70 - 5.07
Living area (Skaraborg)	10.83	0.000	3.21	6.06 - 19.35

Table 10. Investment in oral health. Multiple logistic regression models, using five dependent indicators for oral health investment (Model 1-5), showing only the significant explanatory variables for the respective models.

Variables	Odds Ratio	p-value	Std.Err.	CI 95 %
<b>Model 1: Toothbrushing twice or more daily</b>				
Gender (female)	1.59	0.040	0.04	1.02 - 2.47
Upper secondary program (theoretical)	1.69	0.026	0.04	1.07 - 2.69
<b>Model 2: Missed dental appointments (<math>\leq 1</math>)</b>				
Upper secondary program (theoretical)	2.68	0.012	1.05	1.24 - 5.78
<b>Model 3: (No) tobacco consumption</b>				
Gender (female)	1.53	0.050	0.33	1.00 - 2.33
Upper secondary program (theoretical)	2.82	0.000	0.04	1.78 - 4.45
<b>Model 4: Weekly exercise</b>				
Upper secondary program (theoretical)	2.86	0.000	0.62	1.87 - 4.36
<b>Model 5: "How well do you think you take care of your teeth?"</b>				
GSE (sum score $\geq 30$ )	2.20	0.001	0.50	1.40 - 3.44

## Main findings

- Adolescents in Västra Götaland had poor oral hygiene conditions with high plaque and gingivitis scores. Females had more favorable oral hygiene habits and conditions than males (*Study I*).
- In relation to other lifestyle factors, future regular dental care were given a low priority by a majority of the adolescents. Toothbrushing <2times/day, smoking and male gender were factors identified for not planning future regular dental visits (*Study II*).
- Oral health-related perceptions, attitudes and behaviors were reflected by the clinical periodontal health status in the adolescent population. Gender differences were found with regard to oral health-related perceptions, attitudes and behaviors, in favor of females (*Study III*).
- The health-economics framework used for the analysis revealed that several individual, socio-demographic and lifestyle factors are of importance for young individuals' demand for and investments in (oral) health (*Study IV*).





## Discussion

The overall aim of the present series of studies was to evaluate the periodontal health status among Swedish adolescents and to gain a deeper understanding of psychosocial and behavioral factors that interact with young people's periodontal health conditions. For this purpose an epidemiological study approach, including clinical examinations and questionnaire surveys was selected. Of the randomly selected population samples of 19-year-old individuals, 72 % participated in the clinical part, whereas the participation rate was 63 % in the questionnaire part of the survey. These figures are somewhat higher than in other recent studies involving individuals of a comparable age (Abrahamsson et al. 2006, Hugoson et al. 2005). Socioeconomic factors have been shown to influence the participation rate in epidemiological surveys with commonly lower rates of participation in community areas with low socioeconomic status (Norberg et al. 2012). This is evident in some suburban areas of one of the largest cities in Sweden (Abrahamsson et al. 2006). A main reason given for not participating in the current project was "no time/not interested". In previous studies it has been discussed that attitudes and motivation for oral health care may have changed among young individuals during the last decades. Such changes might lead to less motivation to participate in clinical studies (Östberg 2002, Abrahamsson et al. 2006).

With regard to the evaluation of the periodontal conditions, well-established variables such as gingival inflammation and probing pocket depths were used. Four dental hygienists, specially trained and calibrated for the study, performed the clinical examinations. Since gingivitis is the prevalent disease condition of the periodontal tissues in adolescents, this condition was focused on in the analyses of various factors related to periodontal health status. The self-assessment questionnaires used for collection of data with regard to psychosocial and behavioral aspects of oral/periodontal health were all thoroughly tested instruments, and previously used in young populations (Hamp & Nilsson, 1982; Östberg, 2002 Schwartz, 1993; Koskinen-Hagman et al., 1999).

A potential weakness was the socioeconomic (SE) grouping of the participants, namely that the individuals were assigned to an SE index of the geographic area where the clinics at which they were listed as patients were located. A more selective, individually based grouping would have been preferable, but data allowing such grouping were not available for the current population sample. One further consideration is the absence of some "typical" Grossman model variables in

the data set, due to the fact that the analysis, using the human capital model, was not the primary objective of the original survey. However, the variables that could be included (Study IV) may still be considered as adequate to the model. Since health economics analyses are essential for the allocation of resources for prevention activities, both at individual and population level, and for the prediction of the health-related behavior of individuals, such aspects should have been considered already in the planning of the study.

## Ethical considerations

Written and verbal information was given to the participants prior to the examination in the present survey. An extra appointment for the examination was scheduled for the participants in Skaraborg and Fyrbodal. This may, on the one hand, be seen as inconvenient; on the other hand, the participants received an additional, thorough periodontal examination. If indicated, oral hygiene instructions were given and the individuals who had any form of dental treatment needs were scheduled for an appointment. The participants in Göteborg answered the questionnaire part of the survey in conjunction with their annual dental check-up, which then took about 25 minutes longer than the regular visit. All participants were de-identified and given a code number, and all data were treated confidentially.

## *Periodontal health conditions*

In the present population sample, it was shown that 62% of the adolescents had a gingivitis score of  $\geq 50$  % and 46 % had a plaque score of  $\geq 50$  % (Study I). Moreover, male adolescents had poorer oral hygiene conditions than females. Furthermore, other studies on young Swedish populations have reported a high prevalence of gingivitis. A cross-sectional study from Jönköping involving 20-year olds (Hugoson et al., 1998a) revealed that 30% of the individuals had a gingivitis score of more than 50 %. A mean gingivitis score of 44 % was reported for 19-year-olds living in Göteborg, (Abrahamsson et al. 2006), as compared to 56% in the current studies. In relation to these observations it is interesting to note that a great majority of the adolescents in the current survey stated that they brushed their teeth daily or even twice daily.

The reasons for the adolescents' poor oral hygiene/gingival conditions might be related to inappropriate oral hygiene techniques, i.e., the adolescents simply do not know how to achieve an

adequate standard of oral hygiene, and/or to poor attitudes and lack of motivation regarding oral health issues; they may know how to brush, but they don't have the time or the interest to invest in sufficient oral hygiene efforts. Nevertheless, the high prevalence of gingivitis and poor oral hygiene standards are disappointing, considering that the Swedish Public Dental Service offers free of charge regular dental care to all children and adolescents up to 20-years of age, and that most of the adolescents most likely have been subjected to comprehensive prevention programs in schools and dental clinics.

Young populations in other countries show a similar pattern of high prevalence of gingivitis; Albandar & Tinoco (2002) concluded that the dental plaque-induced gingivitis, in mild and moderate forms, is an almost universal finding in the young population. The experimental gingivitis study by Løe et al. (1965) clearly demonstrated that bacterial plaque accumulation on the teeth induces inflammatory reactions in the adjacent soft tissues, i.e. gingivitis, and that the introduction of adequate oral hygiene measures can resolve this problem and contribute to re-establishing healthy gingival conditions. Further, there is evidence that plaque-induced gingivitis by time may progress into a destructive disease - periodontitis (Lindhe et al.; 1975, Løe et al. 1978). However, the factors that influence/cause this progression are not well understood. As long as we do not know which individuals that may develop periodontitis, gingivitis should be prevented and treated. The key factor for a successful outcome with regard to these aspects is the individual's standard of daily self-performed oral hygiene efforts (Ramseier et al., 2012). To motivate young persons to make adequate oral hygiene efforts on a daily basis is thus a major challenge for dental professionals.

It is well-known that several factors, besides/together with dental plaque are of importance to oral/periodontal health, e.g. host defense, environmental and socioeconomic factors (Albandar & Rams, 2002). Socioeconomic factors in relation to oral/periodontal health conditions are discussed in many studies (Locker, 2000, Hjern et al., 2001; Lopez et al., 2006). In the present series of studies no differences in gingival conditions were found in relation to the defined socioeconomic (SE) grouping at dental clinic level. However, when socio-demographic variables were analyzed at the subject level, the father's education was shown to be related to the planning of future regular dental visits (Study II) and the variables of "living area" and "educational program" were shown to be related to (oral) health demand/investment behavior (Study IV). Hence, socioeconomic factors interacting with oral/periodontal health should be considered in the development of oral health promotion programs for the young population.

## *Oral health-related knowledge, attitudes and behavior*

The goal of dental care is to achieve a lifelong, good oral health in the population (Swedish Dental Care Act, 1985). If individuals already at a young age can learn and adapt to positive oral health related attitudes, beliefs and behaviors, the odds for such beliefs and behavior to follow the individuals throughout their adolescence and into adult life are high (Broadbent et al., 2006, 2011; Tolvanen et al., 2010).

Traditionally, preventive dentistry applies health educational interventions in order to improve oral hygiene behavior. Such interventions have often been based on the assumption that improved knowledge leads to beneficial oral health behavioral efforts (Watt & Mahrino, 2005). However, the results of a systematic review by Watt & Mahrino (2005) suggest that traditional educational interventions leads to a short term decrease in plaque and gingivitis, but the evidence of long-lasting effects is limited. The cost-effectiveness of traditional educational intervention programs may therefore be questioned and it has been argued that oral health promotion programs should move toward a wider psychosocial approach (Ingelhart & Tedesco 1995; Watt & Mahrino, 2005).

The results (Study III) revealed that a majority (89%) of the adolescents considered their knowledge about periodontal diseases to be poor. Based on a series of cross-sectional surveys, Hugoson et al. (2005) reported that the knowledge regarding periodontal diseases among adolescents/young adults has not changed much during the last decades, despite extensive oral health promotion programs. In addition, an analysis based on questionnaire data from a group of 12 and 15-year-old Swedish pupils revealed that the knowledge regarding periodontal diseases was poorer than the knowledge about caries disease (Hedman et al. 2006). The latter observations may be related to that Swedish dental professionals mainly focusing on the caries disease during their oral health education/activities for school-children (Hedman et al. 2009). Also Gupta et al. (2012) found that the knowledge about gum diseases was poor, compared with the knowledge about the causes of caries, in a group of Indian 15-year olds. These authors argued for the need to improve oral health knowledge among school children in general, with particular emphasis on the improvement of oral hygiene.

A majority of the individuals with high scores of plaque and gingivitis in our study considered themselves to have fairly good oral health (Study III). One explanation of this could be related to a lack of knowledge regarding healthy/unhealthy periodontal conditions; i.e., the adolescents do not recognize the signs of unhealthy gums but do not experience any problems from the mouth. Gingivitis, as well as early stages of periodontitis, may be present without marked subjective symptoms. Hence, it is important that the young individual has adequate knowledge about how to prevent and detect early signs of periodontal disease. However, knowledge may be a prerequisite, although not necessarily sufficient for a beneficial health behavioral change (Hugoson et al. 2007).

The results of poor oral hygiene conditions and the lack of knowledge about periodontal diseases, as shown in the present survey, indicate that dental personnel have been unsuccessful in delivering health messages to the adolescents. Even so, according to the results from Study II, the adolescents reported that the best oral health information source was the dental care personnel. This is in line with results from studies by Hugoson et al. (2005) and Hedman et al. (2006) where dental personnel was stated as a main source of oral health information among the study participants. The Swedish dental care system with dental visits on a regular/yearly basis provide unique conditions to reach young individuals with health messages. The effectiveness and cost-benefits of such health promotion activities are, however, fundamental.

Intentions to perform different kind of behaviors can be predicted by the individual's attitudes towards the behavior, subjective norms, and perceived behavioral control (Ajzen 1991, 2002). In Study III, the results revealed that the adolescents perceptions and attitudes towards oral health were positively related to oral hygiene behaviors and periodontal conditions. Hence, more individuals with poor oral hygiene/gingival conditions reported on less frequent tooth brushing and had an overall more negative attitude towards their oral health, compared with the adolescents with low plaque and gingivitis scores. This is partly in agreement with a study by Östberg et al. (2001) of a group of 13-18-year-old Swedes which showed that self-perceived oral health and attitudes towards dental care were strongly associated.

Dental care "today" and regular dental care in the future were given low priority compared with other lifestyle factors by a majority of the adolescents (Study II). Since adolescence is a changing and transformative period in life, when the individual becomes more independent and "self regulated", oral health issues may not be the main priority. The focus may be on other more

immediate things such as clothes, travels, leisure activities etc., rather than on dental care issues, especially if the young person does not experience any oral health problems. On the contrary the “searching” adolescence years, when the individual is testing and rejecting previous norms and values, could be a period to take advantage of (Hwang & Nilsson, 2011); the transformative period of adolescence may be just the right time to influence the attitudes and behavior of young individuals towards oral health. Such aspects need to be considered by dental health professionals when delivering health messages to adolescents.

The priority given by an individual to dental care may be related to several factors. Studies by Skaret et al. (1998, 2000) focused on dental attendance pattern among 12-20-year-olds in Norway. By collecting data from the adolescents’ dental records, it was shown that about 14% had missed or cancelled more than 20% of their dental appointments during the age period from 12 to 18 years (Skaret et al. 1998). At 20 years of age, the most important variable related to a high frequency of missed/cancelled appointments during the last five-year period was “*forgotten to attend appointments*”. This variable was associated with male gender, high dental anxiety and extensive caries experience (Skaret et al. 2000). In the present survey, 9 % of the individuals had missed at least two dental appointments during the last two-year period and missed dental appointment were more common among the young males than the females (Study II). In addition, education program was associated with missed dental appointments; for instance, theoretical studies were positively associated with fewer missed appointments (Study IV). The reasons behind frequent cancellations and/or missed dental appointments at an early age should be further recognized in order to prevent oral diseases and potential future dropouts from dental care (Skaret et al. 1998, 2000).

Previous studies have indicated that males more often than females display ”risk behavior” with regard to oral health; i.e, less concern and less favorable oral hygiene habits (Furata et al. 2011; Östberg et al. 2001). In all of the current studies, gender differences, in favor of females, were shown with regard to periodontal health conditions and oral health related perceptions, attitudes and behaviors. Moreover, male gender was a significant factor for not considering future regular dental care as important (Study II), while female gender was a significant factor for oral health investment behavior (Study IV). The reasons behind such gender differences can only be speculated on; but may be related to social norms and different behavioral expectations between males and females (Lalander & Johansson 2002). Moreover, the motivation for desirable oral

health related behavior might differ between young females and males, as well as between individuals.

The results from a questionnaire study by MacGregor et al (1997), involving approximately 7800 adolescents, identified two main reasons that motivate young individuals to perform oral hygiene; the "health-related" reason, aiming to avoid dental problems and the "cosmetic reason", when tooth brushing was performed for the sake of good appearance. It was concluded that individuals brush their teeth for different motivations and this should be considered when planning oral health promotion and prevention strategies directed to young people. In the present survey (Study III) it was shown that a majority of the adolescents were "fairly satisfied" with the esthetics of their teeth, with no difference between genders. However, more of the individuals with good periodontal conditions were "very satisfied" with the esthetics of their teeth, compared to the adolescents with poor periodontal conditions.

Positive self-esteem and self-efficacy beliefs are factors associated with oral health behavior; e.g. Macgregor & Balding (1991) revealed in a group of 14-year-olds schoolchildren that self-esteem and tooth brushing frequency were positively correlated. A systematic review focusing on application of the self-efficacy theory in dental clinical practice indicated that self-efficacy may be a useful tool for predicting oral health behavior (Kakudate et al. 2010). These results are in line with the results presented in study IV, where it was shown that a higher score of general self-efficacy were of importance for positive investment in oral health.

The concept of 'self-efficacy' is also a component of the sociocognitive health behavioral model, described by Bandura (2004). This theoretical model has been applied in many studies and evidence suggests that health behaviors are governed by the individual's beliefs and expectations, incentives, confidence and goals (Bandura, 2004). Moreover, sociocognitive models place the individual within a social context and normative influences of others. Preventive programs based on such a sociocognitive approach might increase the effectiveness of interventions aiming to promote oral health.

## *Health-Economics*

The results in Study IV contribute to our understanding regarding factors of importance to oral health demands and investments behavior among adolescents, despite limitations in the data set. A number of individual, sociodemographic and lifestyle factors, such as gender, living area, general self-efficacy, and educational program were factors that explained the demand for and investments in oral health by the studied young population. Furthermore, it was indicated that oral- and general-health investment behavior are related and might be explained by the same kind of factors. Hence, the educational program of the individual was shown to be an important variable for oral as well as general health investment behavior. In a study by Gísladóttir et al. (2013), the results revealed that participation in sports activities influences adolescents' mental and general conditions and their future expectations on work and happiness in a positive way. Such results support the idea that future oral and physical health messages should be further introduced as a holistic perspective on "health". Knowledge regarding indicators of importance for (oral) health demand and/or investment behavior among adolescents is important in the daily interaction between dental personnel and patients at the clinic, as well as for the planning of future oral health promotion programs and prevention strategies.

Further, in the demand-for-health model with the objective oral health indicator (GS), the variables "studying at a theoretical upper secondary program" and "living in Skaraborg" showed a significant and positive association with the oral health indicator (Study IV). The positive association between education and oral health was expected from the human-capital theory. However, the factors behind the association between living in the Skaraborg area and the demand-for-oral health can only be speculated on, as there are no evident differences between the two study areas, either with to regarding socioeconomic indicators, the number of inhabitants, population density, or the availability of public dental-service clinics (based on available statistical data, 2005). One speculation may be differences related to the oral-health promotion programs; the allocated financial resources and/or oral-health promotion efforts may differ between the two areas, as well as between the dental clinics.

Regarding how to spend time and money today, the adolescents gave low priority to dental care compared to other lifestyle factors (Study II). Furthermore, in terms of planning for future dental care, a majority of the individuals reported that they did plan for regular visits, however, a remarkably large group, 37%, did not plan for such visits (Study II). The participants in the



current studies are young individuals and their willingness to spend money/give priority to oral health may change with age and their life situations. For instance a future employment and potentially greater access to “money in the pocket”, may have a positive effect on dental care priority/utilization. Grytten & Holst (2002) found that the increase in demand for dental services, associated with income, is smaller for young adults (20-29 years) than for older adults (>30 years). Still, if an individual gives priority to dental care issues and has positive oral health related beliefs at a young age, this behavior is more likely to persist into adulthood (Broadbent et al. 2006, 2011).

In dentistry, both individual and population based oral health promotion strategies are applied. Which strategy that is preferable should be considered in relation both to oral-health outcomes and to the costs of achieving those outcomes. The individual promotion approach has been shown to improve oral hygiene behavior/conditions, but the long-lasting results are being questioned (Braegger, 2005). From a time consuming, i.e., direct cost aspect, the group-based oral-health promotion strategies seem to be cost-effective (Braegger, 2005). Economic parameters as well as patient-centered outcomes should be included in clinical trials. Such data are essential for the appropriate allocation of resources for preventive measures both at an individual patient and population level (Braegger, 2005) and moreover, longer follow-up periods should be used in future studies, to assess whether short-term oral hygiene beneficial changes are maintained (Watt & Mahrino, 2005).



## Future considerations

The results from the present thesis have elucidated various psychosocial and behavioral factors of significance for young individuals' periodontal health status, knowledge that is of value for the planning of future prevention and oral health promotion programs. However, the thesis also elucidates the need for further studies directed towards the understanding of psychosocial and behavioral factors interacting with periodontal conditions in young individuals; and with particular focus on:

- Educational interventions aiming to promote oral hygiene and periodontal health in adolescent populations based on socio-cognitive theoretical approaches and evaluated in terms of health- and cost-effectiveness.
- Gender differences with regard to oral health behavioral aspects among adolescents.
- Associations between indicators of importance for both oral and general health investment behavior.

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