



ANTTI J. SAARI

Factors in Adolescence Representing
the Risk of Subsequent Smoking



ACADEMIC DISSERTATION

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ANTTI J. SAARI

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University of Tampere, Faculty of Medicine and Life Sciences
Finland

Supervised by

Professor Elise Kosunen
University of Tampere
Finland

Professor emeritus Kari J. Mattila
University of Tampere
Finland

Reviewed by

Docent Sisko Honkala
University of Helsinki
Finland

Docent Kristiina Patja
University of Eastern Finland
Finland

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Abstract

Smoking in Finland has decreased since the peak after the 2nd World War, but it continues to have significant negative effects on public health. Family members and peers have an influence on the adolescent's risk to become a smoker. Personality traits are also known to be slightly linked with smoking risk. Smokers commonly have oral health problems (e.g. dental caries or periodontitis), but it is not fully known how they are connected to smoking. It is widely recommended to implement brief interventions into daily practice with patients with different attitudes towards smoking and different smoking habits.

This study aims to find out if smoking in adulthood could be predicted in adolescence by the smoking of one's close friends and family members, dental caries experience or self-esteem. In addition to these the long-term effects of brief tobacco interventions were assessed. The dissertation is a composition of four sub-studies that all use an age cohort born in 1979 (n=2,586) and living in four Finnish towns. The cohort participated in an earlier study executed at annual oral health check-ups when they were 13–16 years old (in 1992–1994). During this earlier study their oral health, smoking behavior and social risk factors for smoking were annually monitored. A randomized part of the group (n=1,348) received brief interventions. The self-esteem of the cohort was assessed using Lawrence Self-Esteem Questionnaire. In 2008, when the subjects were 29 years old, a follow-up questionnaire was sent to the group. In the questionnaire, the subjects were asked about their smoking behavior and the exposure to factors affecting their smoking risk. Responses were received from 1,020 subjects (39.4% of the original age cohort).

The smoking behavior of the current close friend was the most important social risk factor of smoking for both sexes (OR 5.0). In females, high adulthood smoking risk was linked with the smoking of their school age close friend, but this was not the case with males. The smoking behavior of parents and siblings was not found to have any association with smoking in adulthood. Those adolescents, who were non-smokers, but had tooth decay during adolescence, were more likely to smoke in adulthood. Non-smoking adolescents with weaker self-esteem were more likely to smoke during their early adulthood. No long-term effects of the brief interventions were shown in this study.

The results reinforce the earlier paradigm that smoking often occurs parallel with other hazardous attributes. These include inadequate oral care, following the example set by smoking friends and weak self-esteem. Using these factors, it is possible to point out some individuals that are at a higher risk of becoming smokers and to direct them to support and surveillance.

Tiivistelmä

Vaikka tupakoivien suomalaisten määrä on merkittävästi vähentynyt 2. maailmansodan jälkeisistä huippuluvuista, tupakoinnilla on edelleen merkittäviä negatiivisia kansanterveydellisiä vaikutuksia. Perheenjäsenillä ja ystävillä on vaikutusta nuorten tupakoinnin aloittamisen todennäköisyyteen. Myös eräiden persoonallisuuspiirteiden tiedetään olevan yhteydessä tupakoinnin todennäköisyyteen. Tupakoitsijoilla on yleisesti suun terveysongelmia (kuten hammaskariesta ja hampaiden kiinnityskudosten sairautta), mutta ei ole täysin selvää, kuinka suurelta osin ne ovat yhteydessä tupakointiin. Lyhytinterventioiden käyttöä on laajalti suositeltu osaksi päivittäistä kliinistä työtä eri tavoin tupakointiin suhtautuvien potilaiden kanssa.

Tämän väitöstudiumin tarkoituksena oli selvittää, pystytäänkö aikuisiän tupakointia ennustamaan nuoren lähiverkoston tupakoinnin, hammaskarieksen tai itsetunnon perusteella. Lisäksi selvitettiin nuoruusiässä annettujen tupakkalyhytinterventioiden pitkäaikaisvaikutuksia. Väitös koostuu neljästä osatutkimuksesta, joissa tutkitaan vuonna 1979 syntyneitä ikäkohorttia (n=2,586) neljästä suomalaisesta kaupungista. Kohortti osallistui 13–16 vuoden iässä vuosittaisten (1992–1994) suun terveystarkastusten yhteydessä toteutettuun tutkimukseen. Tämän aiemman tutkimuksen yhteydessä heidän suun terveytensä, tupakointitottumuksensa ja tupakoinnin sosiaaliset riskitekijänsä tarkistettiin vuosittain. Satunnaistettuun osaan kohorttia (n=1,348) kohdistettiin vuosittain tupakoinnin ehkäisemiseen tähtäävä lyhytinterventio. Kohortin itsetunto mitattiin Lawrencen itsetuntokyselyllä. Vuonna 2008, ikäkohortin ollessa 29-vuotias heille lähetettiin seurantakysely. Kyselyssä selvitettiin vastaajien tupakointitottumuksia ja heidän kokemuksiaan tupakkariskiä vaikuttavista taustatekijöistään. Vastaus saatiin 1,020 henkilöltä (39,4 % alkuperäisestä ikäkohortista). Nykyhetken läheisin ystävä oli tupakoinnin sosiaalisista riskitekijöistä merkittävin molemmilla sukupuolilla (vedonlyöntisuhde 5.0). Naisilla kouluiän läheisen ystävän tupakointi lisäsi riskiä aikuisiän tupakointiin, mutta samaa ei havaittu miehillä. Tässä aineistossa perheenjäsenillä ei ollut vaikutusta tupakointiriskiä. Niiden tupakoimattomien nuorten, joilla nuorena esiintyi hampaiden reikiintymistä, joukossa oli enemmän aikuisena tupakoivia. Tupakoimattomien nuorten heikko itsetunto oli yhteydessä

suurempaan tupakalle altistumisriskiin varhaisessa aikuisuudessa. Nuoruusiän lyhytinterventioilla ei havaittu pitkäaikaisvaikuttavuutta tupakointitottumuksiin.

Tulokset vahvistavat aiempaa näkemystä siitä, että tupakointi esiintyy usein samanaikaisesti monien terveyden kannalta haitallisten tekijöiden kanssa. Näihin kuuluvat suun itsehoidon laiminlyönti, tupakoivien ystävien antaman esimerkin mukainen toiminta ja heikko itsetunto. Edellä kuvattujen tekijöiden avulla voidaan tunnistaa tupakointiriskissä olevia yksilöitä ja ohjata heitä tarkemman seurannan ja tuen piiriin.

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1 List of original communications

This thesis is based on the following four original articles, which are referred in the text by their Roman numbers I to IV. In addition to the contents of the published articles, this thesis contains previously unpublished data.

I: Saari AJ, Kentala J and Mattila KJ (2014): The smoking habit of a close friend or family member – how deep is the impact? A cross-sectional study. *BMJ Open* 4:e003218 doi:10.1136/bmjopen-2013-003218.

II: Saari AJ, Kentala J and Mattila KJ (2014): Flawed oral health of a non-smoking adolescent suggests smoking in adulthood. *The European Journal of Public Health* doi: 10.1093/eurpub/cku201.

III: Saari AJ, Kentala J and Mattila KJ (2015): Weaker Self-Esteem in Adolescence Predicts Smoking. *BioMed Research International*, Article ID 687541, 5 pages. doi:10.1155/[2015/687541](https://doi.org/10.1155/2015/687541).

IV: Saari AJ, Kentala J, Mattila KJ (2012): Long-term effectiveness of adolescent brief tobacco intervention: a follow-up study. *BMC Research Notes* 5:101. doi: 10.1186/1756-0500-5-101.

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2 Abbreviations

BI	Brief Intervention
CI	Confidence Interval
D	Decayed tooth
DMF	Decayed, Missing and Filled teeth
LAWSEQ	Lawrence Self-Esteem Questionnaire
LTFU	Lost To Follow-Up
N	Number
NRT	Nicotine Replacement Therapy
OHC	Oral Health Check-up
OR	Odds Ratio
QS	Questionnaire Study
TCA	Tobacco Control Act
WHO	World Health Organization

3 Introduction

Tobacco smoking causes significant economic and health problems as well as premature deaths (Neubauer et al. 2006, Doll et al. 2004, Peto 1994). According to the Action on Smoking and Health (2013), more than a quarter of all cancer deaths can be attributed to smoking and about half of all lifetime smokers die prematurely. If a person does not start smoking in adolescence, he/she is very unlikely to start smoking at all (Coombs, Li and Kozlowski 1992). World Health Organization defines adolescents as people between 10 and 19 years old (WHO 2015). Compared to childhood or adulthood, the increased risk-taking behavior in adolescence is associated with different developmental trajectories of subcortical and cortical regions of the brain (Casey, Getz and Galvan 2008). Most adult smokers in Finland started to smoke between the ages of 12 and 15 years (Okoli et al. 2009, Rainio et al. 2009, Sticklely and Carlson 2009, Vartiainen et al. 1998). The smoking rate among young adult females remains a significant issue and global evidence shows a rising trend in the smoking rates among females (Giovino et al. 2012, Ali et al. 2009).

Adolescents are aware of the harmful effects of smoking, but this awareness does not prevent their smoking experiments (Rogachewa et al. 2008). Adolescents tend to underestimate the negative health effects of tobacco on themselves and their likelihood to become addicted to smoking (Pallonen et al. 1998). To prevent the onset of adolescent smoking, a variety of anti-smoking strategies is needed (Backinger et al. 2003, Lantz et al. 2000, Wakefield and Chaloupka 2000). Among smokers there are great differences in their abilities to succeed in smoking cessation (Hall et al. 2015). The impact of these differences would diminish if effective methods to prevent the onset of smoking could be distributed among the society. Good results have been achieved by anti-smoking interventions in oral health care (Nasser 2011). Oral health care in Finland provides an excellent setting for interventions to prevent smoking since practically all school age children participate in the annual oral health check-ups (Statistical information on welfare and health in Finland 2016). The smoking that never starts, never needs to be ended.

4 Literature review

4.1 Smoking in Finland

Like in many countries after the Second World War, the Finnish population has gone through a huge change in smoking: it has gone from being one of the countries with the highest rate of smoking to one of the countries with the lowest. Currently approximately 19% of adult males and 13% of adult females in Finland smoke regularly (Helldán and Helakorpi 2015). During the time period from 1970s to 2010s, the social norms regarding smoking have markedly changed – from smoking being allowed nearly everywhere to restricted smoking environments (Helldán and Helakorpi 2015). After the 1970s the smoking prevalence has declined significantly among the highly educated, but those with lower education seem to smoke almost as frequently as before (Patja and Vartiainen 2003).

The change in social norms regarding smoking was promoted by changes in legislation. The first Finnish Tobacco Control Act came into force in 1977 (Finnish TCA 1976). The first restrictions prohibited smoking in public transport, daycares and schools and restricted selling tobacco to those under the age of 16. A more restrictive act was approved in 1995, when the minimum age to purchase tobacco products rose to 18 and selling of snus was prohibited (Finnish TCA 1995). The next step was the 2007 Tobacco Act, which restricted smoking in restaurants and bars to separate smoking booths (Finnish TCA 2007). The anti-smoking political atmosphere was reinforced in the 2010 Tobacco Act that made it illegal for minors to obtain tobacco products, and the purpose of the tobacco act was defined as ending smoking in all forms (Finnish TCA 2010). In 2012 it became illegal to have tobacco products on display at points of sale (Finnish TCA 2012). Additionally, tobacco brands could no longer be shown in commercials or public events. (Finnish TCA 2016)

The Finnish Ministry of Social Affairs and Health has published an action plan on tobacco in 2014. This action plan was prepared considering the international studies and recommendations, the insights of Finnish tobacco experts and EU's new Tobacco Products Directive that came into force during the same year (2014). The vision of the action plan is that in 2040 no more than 2% of Finns use tobacco products. To achieve this goal, the action plan lists several actions. These actions aim to create an

environment where minors do not use tobacco products and all citizens' exposure to tobacco smoke is restricted. The ministry also aims to provide support for smoking cessation and prevent the launching of new tobacco products. These actions are planned to be monitored, studied, developed, evaluated, and used in political decision-making. (Sosiaali- ja terveystieteiden ministeriö 2014)

The action plan had an almost immediate influence on Finnish legislation. Two years later, in 2016, yet another new tobacco act further restricted tobacco products and smoking. In the 2016 act it became illegal to smoke in a vehicle carrying a passenger under the age of 15. The same act made it easier to apply for a smoking ban on semi-private areas such as high-rise balconies or terraced house gardens. (Finnish TCA 2016)

How were these changes in society reflected in the smoking behavior of adolescents? The data on the population aged 14–18 years is largely based on the Adolescent Health and Lifestyle Survey carried out every other year since 1977. One in four 16-year-olds smoked daily in 1995 (Rimpelä, Rainio, Pere et al. 2007). Ever since, the overall trend in adolescent smoking has been declining, but there still are 12–13% daily smokers among the 16-year-olds (Rainio et al. 2009). Adolescents in Finland tend to start experimenting with tobacco at the age of 12–15, even though it has been illegal to sell tobacco products to minors since 1995. For unknown reasons, smoking trend began to decline among boys in the late 1990s (during a financial depression in Finland) and this trend also took place among girls several years later. The amount of tobacco products used by the adolescents smoking daily has been up to 14 cigarettes per day, but during the last ten years it has been cut down to 5 cigarettes per day (Kinnunen et al. 2015).

4.2 Smoking and oral health

In addition to its widely known harmful effects on different parts of the human body (Doll et al. 2004), smoking also has negative effects on oral health (Heikkinen et al. 2008, Winn 2001). Tobacco smoke contains pre-carcinogenic substances, such as nitrosamines, aromatic amines and benzopyrenes, which cause mutated regions in DNA after oxidation in the mucous membrane of the mouth (Rivera 2015). Exposure to tobacco smoke may also produce free radical oxygen and nitrogen and through this mechanism promote neoplastic mutations (Rivera 2015). Current or previous use of tobacco in any form increases the risk of dental caries (i.e. tooth decay) (Rooban et al. 2011), oral cancer (Gandini et al. 2008), periodontitis (Han, Lim and Kim 2013; Do et

al. 2008; Tomar and Asma 2000), and root caries (Matthews et al. 2012). As with other tobacco-related health problems, the negative impact on oral health is also a result of passive exposure to tobacco smoke (Lee et al. 2009). This environmental tobacco exposure has been shown to be a risk factor for gingivitis and enamel opacities in preschool children (B Hasmun et al. 2017).

Oral health problems have been found to be a marker of behavioral risk factors (Sabbah et al. 2013) and oral health problems occur more frequently among those with poorer socio-economic position (Guarnizo-Herreño et al. 2014). Daily smoking, brushing teeth less frequently than twice a day as well as low attainment in school have been shown to be linked in a postal survey among a group of 14-18-year-old Finns (Honkala et al. 2011). While those in poorer socio-economic position are more likely to have tobacco exposure than others (Bilodeau and Guggenheimer 2017; Alves, Kunst and Perelman 2015), the relationship between oral health and tobacco smoking seems important when attempting to reduce the health inequalities between socio-economic levels. There are no published studies considering the possibility that a poor oral health might predict the onset of smoking. Almost every Finnish child at school age participates in the annual oral health check-ups (Statistical information on welfare and health in Finland 2016). This provides a good arena for preventive health care actions.

4.3 Onset of smoking

Adolescents usually start smoking after repeated experimentations with tobacco products (Lerman and Berrettini 2003). A variety of factors seem to have an effect in the onset of smoking. The importance of discovering these factors is that it may bring up a feasible arena for an intervention to prevent the onset. These factors can be divided to societal, extrinsic and intrinsic factors.

4.3.1 Societal factors

Legislation can be used to direct an individual's behavior towards a healthier lifestyle – including avoiding smoking. Finnish TCA prohibits selling tobacco to minors. However, most of the minors who smoke daily purchase their tobacco products from their friends and strict tobacco control laws may increase this type of behavior (Etter

2006). However, in an experiment where the minimum age to buy tobacco was raised locally to 21, a clear reduction in adolescent smoking was observed (Kessel Schneider 2015). In a Russian population it has been found that poor implementation of anti-smoking legislation leads to practically no effect on smoking rates (Rogacheva et al. 2008). Smoking restrictions in the environments children spend their time in and banning the advertising of tobacco products have been accepted as the most important legislative ways to reduce smoking initiation among adolescents (Brownson, Haire-Joshu and Luke 2006, Schepis and Rao 2005). There is also strong evidence to support the effectiveness of the minimum purchase age restrictions (Sowden, Arblaster and Stead 2003).

The WHO framework convention on tobacco control and its guidelines has recommended nations to ban descriptors, such as “light” or “mild” in tobacco retail packaging (WHO 2004). These descriptors may lead consumers to think some tobacco products are safer, and thus result in an increase in tobacco sales. After the implementation of this ban no desired effect on cessation or smoking initiation rates in U.S. population was observed, although the act was passed with high hopes (Alpert, Carpenter and Connolly 2017). Tobacco industry’s internal research results in the prominence of different color combinations in tobacco retail packaging have been used against the industry to design effective health warning labels to be used in the very same packages (Lempert and Glantz 2016).

Attitudes on smoking have become stricter among adolescents during the first years of the new millennium, and nowadays most adolescents see smoking as something that is done by “losers” (Kinnunen et al. 2015). Health education, a primary school subject launched in 2000 might have been a promotor of these changes. Young people and daily smokers have the most liberal attitudes towards smoking, but overall social climate on smoking is negative in Finland (Ruokolainen et al. 2018). It should be kept in mind that attitudes do not always mean actions to match the attitude (Tyas and Pederson 1998). For the adolescents to remain non-smokers, it is essential that the negative attitude towards adolescent smoking is similar among all the adults working with the children, including the smoking adults (Emory et al. 2010, Schepis and Rao 2005).

Finnish tobacco product pricing is among the lowest in Europe (Giskes et al. 2007). Increasing the price of tobacco products effectively prevents the onset of smoking and promotes cessation among adolescents and adults (Moyer 2013). This effect is not related to the socioeconomic status of the adolescent (Pfortner et al. 2016). The evidence on the effectiveness of tobacco price increase to reduce the onset of adolescent smoking has been considered insufficient (Guindon 2014).

Those individuals with lower socio-economic status are more likely to have tobacco exposure than others (Bilodeau and Guggenheimer 2017; Alves, Kunst and Perelman 2015). The socio-economic status has been found to have an effect also on adolescents. Lower education level of parents has been shown to be associated with increase in adolescent smoking (Kestilä et al. 2006). It has also been found that those with lower socio-economic status have weaker self-efficacy to refuse smoking (Mathur et al. 2008). Thus, lower socio-economic status results in loss of autonomy over health-related choices.

4.3.2 Extrinsic factors

The development of nicotine dependence and a smoking habit is linked to the social influence from family and friends (Okoli et al. 2009, deVries et al. 2006, Lerman and Berrettini 2003, Tyas and Pederson 1998). The smoking of the parents influences the future smoking behavior of children already during their early childhood (B Hasmun et al. 2017). Children who are exposed to smoking at home are more likely to experiment with smoking (Barman et al. 2004, Farkas et al. 2000, Rimpelä 1980). A smoking parent makes an adolescent more positively disposed to smoking (Wilkinson, Shete and Prokhorov 2008). On the other hand, the smoking of the parents does not always result in smoking of the children: some children do not model their parents' smoking behavior as they grow up in order to help them feel autonomous and thus like an adult (Otten et al. 2007).

Those adolescents who live in a single parent household are more likely to smoke tobacco, regardless of the smoking behavior of the parent (Brown and Rinelli 2010). Smoking siblings also increase the risk of regular smoking (Sasco et al. 2003). Similar smoking patterns among family members can be partly explained through shared genes (Vink et al. 2003). Problems in the parent-adolescent relationship are linked with adolescent smoking (Moor et al. 2015). Lack of smoking rules at home increase smoking among adolescents (Pennanen, Vartiainen and Haukkala 2012, Andersen et al. 2004,) whereas parental support to make healthy choices protects the adolescent from smoking initiation (Wiefferink et al. 2006).

The smoking behavior of peers has a great influence on the adolescent's own smoking habits (Kobus 2003), since starting to smoke in adolescence is highly related to imitation of peer behavior and the strive to appear mature. The influence of smoking peers seems to be greater than that of smoking parents when considering the likelihood of an adolescent starting to smoke (Bricker et al. 2006, Kempainen et al.

2006, Flay et al. 1994), or continuing the habit from adolescence to adulthood (West, Sweeting and Ecob 1999). There is also evidence that the increased risk to continue smoking caused by a smoking peer is comparable to that caused by a smoking parent (de Vries et al. 2003). Both male and female smokers tend to select other smokers as friends, but only females seem to be encouraged to smoke by their peer group (Mercken et al. 2010). If the social atmosphere in the peer group favors healthy choices, it reduces the risk of the adolescent to start smoking (Wiefferink et al. 2006). In industrialized countries, smoking is most common among those in poorer socio-economic position (Alves, Kunst and Perelman 2015). Smoking habits in Finland are closely related to education: smoking is twice as common in those groups with lowest education compared to those with highest education (Jousilahti and Borodulin 2012). Although smoking has been diminishing in all socio-economic groups in Finland, the gap between those with high education and those with low education is widening (Lahelma et al. 2016). In one Finnish study the socio-economic position of parents was considered to have no direct effect on adolescent smoking (Paavola, Vartiainen and Haukkala 2004). That points towards the possibility that a lower socio-economic position could be a marker of other risk factors that accumulate within this group. A tobacco-positive social environment has been found to be a predisposing factor for smoking (Rogacheva et al. 2008). A recent large cohort study found that a lower socio-economic position and smoking together result in a 4–5 years shorter life expectancy; no other known risk factor had as vast combined effect with socio-economic position as smoking (Stringhini et al. 2017).

4.3.3 Intrinsic factors

Many factors that are related to personality traits are associated with smoking. Challenges with concentration had an independent effect on the probability of becoming a smoker according to a Finnish twin study (Barman et al. 2004). Adolescents with insufficient skills in managing negative and hostile emotions (Weiss et al. 2011) or with poor self-efficacy can be more prone to start smoking. Smoking initiation has been shown to be linked with stress and loneliness at school (Park 2009).

The link between smoking and depressive emotions seems to be due to problems with negative affect regulation – smoking is assumed to alleviate negative emotions (Schleicher et al. 2009). Among adolescents, a decrease in self-esteem is linked with the development of depression (Väänänen et al. 2014), social phobia (Zou and Abbott 2012), and weight problems (Ternouth, Collier and Maughan 2009). Mental illness in

young people predicts greater likelihood to start smoking (Lawrence et al. 2010, Morrell et al. 2010) and poor self-esteem frequently occurs among those with mental illnesses (Link et al. 2001). During adolescence, the experimentations with smoking and other substance use have been connected with lower self-esteem that drives adolescents towards substance use to gain peer acceptance (McGee and Williams 2000). If the adolescent gains acceptance through substance use it may also enhance their self-esteem (O’Callaghan and Doyle 2001). Lower self-esteem has been shown to be connected (Boden et al. 2008, Wiefferink et al. 2006) and unconnected (Baumeister et al. 2003) with the use of alcohol and tobacco. Smoking in adolescence has been shown to relate to higher self-esteem during adolescence but to effect negatively the development of self-esteem after adolescence (Kiviruusu et al. 2015). It has been suggested that initiation of smoking and problems with self-esteem share a mechanism (Tsuang et al. 2012). An Iranian study by Khosravi et al. (2016) on both smoking and non-smoking adolescents suggests that poor self-esteem causally increases cigarette smoking.

Low attainment in school is linked with increased likelihood to smoke (Honkala et al. 2011, Doku et al. 2010, Bryant et al. 2000). Children also tend to befriend those with similar academic performance (Kindermann 2007). Higher education is associated with a lower likelihood to smoke tobacco (Kestilä et al. 2006) as well as the adolescents’ better understanding that smoking might seriously endanger their health (Wiefferink et al. 2006). The earlier the smoking experiments had begun, the higher is the risk of poor grades at school (Ellickson, Tucker and Klein 2001). Thus, this relationship may go both directions.

Genes seem to also influence the choice of friends and thus have an effect in adolescent smoking (White et al. 2003). The genetic variability in receptivity to nicotine dependence is described in chapter 4.4.1.

4.4 Continuing smoking

The negative health impact of smoking accumulates over time. Thus, it is important to understand why patterns in smoking behavior are different among different individuals. Some individuals simply experiment with tobacco and smoking never becomes a regular habit. On the other hand, the initial smoking experiments make some people strongly and instantly addicted. Factors that affect continuing of smoking can be divided into physiological, psychological and social factors.

4.4.1 Physiological factors

The development of the nicotine addiction is the most important factor in determining the heaviness and persistence of the smoking (Hughes, Helzer and Lindberg 2006). Smoking a cigarette provides a dose of nicotine that crosses the blood-brain-barrier and produces a pleasant effect within seconds (West and Hardy 2006). When the nicotine amount in the nicotine addicted smoker's blood drops below a certain level, withdrawal symptoms (irritability, restlessness, difficulty in concentrating) draw the smoker towards the next cigarette (West and Hardy 2006). Some individuals may experience the full symptoms of nicotine dependence without daily use (DiFranza et al. 2000). Thus, even occasional puffs increase the risk of addiction. A nicotine addiction can quickly be measured using the Fagerström's test (Heatherton et al. 1991). It has been suggested that 20–68% of adolescents who smoke report withdrawal symptoms (Colby et al. 2000). Adolescents may develop a nicotine addiction even faster than adults (Rubinstein et al. 2007).

The probability of developing nicotine addiction after experimenting with nicotine products is associated with polymorphisms in a cluster of nicotinic acetylcholine receptors on chromosome 15q24, and mutations that reduce the enzymatic activity of CYP2A6 (Yu and McClellan 2016). In other words, the receptivity to nicotine dependence is in our genes. This can be seen in practice by observing those adolescents who start using electronic cigarettes (that contain only nicotine) regularly, as they are also more likely to use combustible tobacco products (Wills et al. 2017, Leventhal et al. 2015). Recent findings conclude that e-cigarette use in adolescence is associated with cigarette use within a few years, but combustible cigarette use does not predict future e-cigarette use (Bold et al. 2018). The overall impact of the genetic risk factors involves the impact of many genes along with the environmental risk factors, showing that genes have different effects in different environments (Bierut 2009). This means that although some individuals are more prone to develop a nicotine addiction, their smoking habits can nevertheless be affected by environmental factors.

Those smokers who are polytobacco users, in other words, those using many different forms of tobacco products such as cigarettes, cigars, pipe, hookah and snus are more likely to have a strong nicotine addiction (Harrell et al. 2016). It is yet unknown how common this type of tobacco use is in Finland, but in American population one in ten adults are polytobacco users (Lee et al 2014). Some individuals may first start using smokeless tobacco products such as snus and then switch to smoking tobacco (Tam et al. 2015). The risk of a quick relapse after attempting to quit is greater among polytobacco users than unitobacco users (Messer et al. 2015). The

treatment of tobacco addiction has largely been the treatment of nicotine addiction as it has for a long time been considered as the fundamental reason for individuals to continue using tobacco products (U.S. Department of Health and Human Services 1988). However, some smokers seem to be unaffected by Nicotine Replacement Therapy and relapses after a pharmacologically aided cessation are common (Hughes et al. 1999). The other components of the tobacco smoke, such as monoamine oxidase inhibitors and acetaldehyde, seem to play a role as well. In animal studies these constituents seem to enhance or reduce the effect of nicotine in an individual (Hall et al. 2014). Some of these compounds may later provide a new method of smoking cessation.

4.4.2 Psychological factors

Psychological addiction to smoking can be described as such a powerful urge to smoke that it overwhelms the individual's will to resist (West and Hardy 2006). The addiction should be understood as a weakening of self-control rather than an increase in the urge to engage in the addictive behavior; or a syndrome where reward-seeking behavior has become uncontrollable (West and Hardy 2006). "Prime theory of motivation" by Robert West (West and Hardy 2006) is a synthesis of earlier theories on addiction. When applied to tobacco smoking, it means that the individual's Plans, Responses (to external stimuli), Impulses, Motives and Evaluations on smoking are influenced by each other and the internal environment of the individual. Other theories and models exist as well. The positive reinforcement model means that the immediate effect of a drug (tobacco) functions as a primary positive reinforcer that motivates the individual to continue smoking. This process may happen even during early tobacco use (Glautier 2004) as it does not rely on the nicotine withdrawal symptoms. On the other hand, the negative reinforcement model means that tobacco addiction is the result of a smoker's attempt to avoid aversive states. These aversive states that motivate continued tobacco use are seen as a consequence of repeated exposure to nicotine. Thus the smoker learns that smoking eases or prevents aversive conditions (Eissenberg 2004). Cognitive and social learning models look at the smoking behavior through the smoker's expectancies, self-efficacy, coping and craving (Brandon et al. 2004). The bio-behavioral model of smoking behavior (Lerman, Niaura 2002) is a framework for examining the determinants of health-related behaviors that contribute to disease susceptibility (Hiatt, Rimer 1999). Smoking initiation and persistence have been shown to be heritable (Li et al. 2003, Sullivan,

Kendler 1999). Thus, genetic differences partly explain the individual responses to nicotine (Walton et al. 2001).

Those adolescents with poor school grades are less likely to succeed in smoking cessation (Chassin et al. 1996). Continuing smoking as well as smoking cessation increases the risk of depression (Korhonen et al. 2007) which indicates the link to mental health in smoking to be profound. Low levels of self-efficacy increase the likelihood of risk behavior (Bandura 1989). Self-efficacy is not a stable attribute and it can be enhanced (Moffitt et al. 2011) with positive effects to later health related choices. Generally, those adolescents, who do not see smoking as something that is harmful to them and do not perceive strong negative signals from their (social) environment, are more likely to be smokers (Wiefferink et al. 2006).

4.4.3 Social factors

Smoking can be addictive in other than pharmacological ways. Many of the implications noted in chapter 4.3.2 also have an effect on the likelihood to continue smoking. Social factors that make it difficult for the adolescent to quit smoking are peer smoking, smoking-positive culture at the school or workplace, stress, boredom and the use of alcohol (Amos et al. 2006). Recent findings suggest that smoking is increasing among young adults under the age of 22, possibly through the increase in living in metropolitan areas and the influence of smoking friends (Bernat, Klein and Forster 2012). Thus, changes in society may significantly change the spectrum of smokers and smoking. In Finnish population, the adolescents' smoking greatly relies on their own education after primary school: those in vocational schools are more likely to smoke than those in senior secondary and high schools (Kestilä et al. 2006).

Some smokers only use tobacco products on specific occasions and they represent no signs of nicotine addiction. This type of smoking has been described as social smoking (Levinson et al. 2007). Social smokers do not identify themselves as smokers and may thus be unnoticed by most smoking habit surveys (Berg et al. 2009). The tobacco exposure is significantly lower among the social smokers and they may be unwilling to quit their irregular smoking (Levinson et al. 2007). Although it is unlikely that this type of smoking has as negative an impact on health as regular smoking, it serves as tobacco-positive role-modelling. A recent study shows that even low-intensity smoking has a negative effect on all-cause mortality over time (Inoue-Choi et al. 2017). Thus, low-intensity smoking should not be seen as a non-significant health issue.

4.5 Interventions to smoking prevention and cessation

While the onset of smoking usually occurs during adolescence (Okoli et al. 2009), the methods that attempt to prevent the onset of smoking are directed at children, adolescents and families. Meanwhile, tobacco cessation methods are directed to smokers – adolescents and adults. The methods used in health care have been criticized for lacking trustworthy evidence of effectiveness in reducing smoking initiation in the adolescent population (Patnode et al. 2013). However, some of the anti-smoking interventions tested on adolescents effectively discourage smoking initiation and promote abstinence among adolescent smokers (Pbert et al. 2008). Comprehensive, nation-wide strategies that involve several other actors in addition to the health care professionals have been recommended (U.S. Department of Health and Human Services 2012). There is evidence that interactive social influences or social skills programs are effective among adolescents (Flay 2009). However, to fulfill this statement they must involve at least 15 sessions that produce short-term effects as the effect wears off over time (Flay 2009).

Many of the studied interventions take place in a clinical setting although anti-smoking interactions among individuals often happen without the health care professionals having any role in them. The Prochaska's "stages of change" is an effective model to assess a person's willingness to change his/her smoking behavior (Prochaska and DiClemente 1983). The model is quick and easy to use in everyday clinical practice and gives the clinician immediate information about the subject's readiness to quit. The theory relies on five stages over time: pre-contemplation, contemplation, decision, action, and maintenance. The stages of change help the clinician to find the right time for an effective intervention. Tobacco Use and Dependence Guideline Panel (2008) has published a comprehensive recommendation on the interventions for smoking cessation. Patnode et al. (2013) have made a thorough assessment of the available research data on the relevant primary care interventions for smoking prevention and cessation in minors.

4.5.1 Brief intervention

Brief interventions (BI) have been used where health care professionals have care-related needs but limited time to promote change in subject's risk behavior. The behavior that could justify such approach could include a lack of physical exercise, an unhealthy diet, excessive use of alcohol or tobacco smoking. The emphasis is on self-

efficacy and patient's own role (Babor 1990). Most BI practices are based on the FRAMES model (Hester and Miller 1995) that was originally developed for the treatment of alcohol abuse:

F=Feedback: Give feedback on the risks and negative consequences of substance use. Seek the client's reaction and listen.

R=Responsibility: Emphasize that the individual is responsible for making his or her own decision about his or her substance use.

A=Advice: Give straightforward advice on modifying substance use.

M=Menu of options: Give menus of options to choose from, keeping the client involved in decision-making.

E=Empathy: Be empathic, respectful, don't judge.

S=Self-efficacy: Express optimism that the individual can modify his or her substance use if they choose. Self-efficacy is one's ability to produce a desired result or effect.

Brief tobacco interventions have been shown to have an effect in promoting smoking cessation among adolescents (Heikkinen et al. 2009). Brief intervention is the foundation of many evidence-based tobacco dependence treatment guidelines (Tobacco Use and Dependence Guideline Panel, 2008; Tobacco dependence and cessation, 2011; Johnson and Bain 2000). Unfortunately, BIs are not always addressed properly or used as a regular practice (McMillin and O'Connor 2010). BI has been shown to be feasible in preventing the onset of smoking as well as promoting smoking cessation among adolescents (Patnode et al. 2013). United States Preventive Services Task Force recommends using BI for the prevention of smoking initiation of school-age children and adolescents (Moyer 2013). Brief tobacco cessation interventions implemented in primary care settings have been shown to be effective (Wray et al. 2017). Although it is recommended to use the stages of change model to determine which smokers need help for cessation (Bilgiç and Günay 2018), some research findings speak for care-relevant interventions throughout the clinical practice (Aveyard et al. 2012). Low-risk patients do not significantly benefit from time-taking lifestyle interventions (Crouch, Wilson and Newbury 2011).

4.5.2 Other interventions

In daily practice, it is strongly recommended to routinely inquire about the patients smoking behavior during medical consultations (Gordon et al. 2006). A Cochrane review by Stead et al. (2013) concludes that simple advice has small effect on cessation rates. There is evidence that the later in life the first experiment with smoking occurs, the less likely it is for smoking to become a habit (Cengelli 2012). It is possible that postponing the smoking experimentations could prevent the actual onset of smoking. Therefore, even those interventions that lose their effectiveness in a few years may be useful in smoking prevention. As environmental tobacco exposure during early childhood already changes nicotine content in the subject's saliva, it is encouraged to specially stress the importance of anti-smoking interventions targeting the parents of small children (B Hasmun et al. 2017). For example, proactive telephone counselling promotes smoking cessation among the parents of small children (Abdullah et al. 2005).

The interventions to prevent the onset of smoking usually are similar to the cessation interventions, and include items such as the participant's attitudes, beliefs, and knowledge about smoking; the consequences of smoking; the influence of the social environment on one's smoking; and skills to decline cigarettes, while some interventions target the parents' attitudes and beliefs on smoking and parent-child communication (Moyer 2013). The use of printed material as well as computer and mobile phone applications has an effect when combined with other anti-smoking actions. Mass media campaigns carrying an anti-smoking message have an effect on adolescents' smoking (Moyer 2013, Brinn et al. 2010). Care-relevant behavioral interventions to prevent tobacco use in school-aged children and adolescents have a moderate net benefit (Moyer 2013).

For some reason, most Finnish adolescents do not recall seeing any anti-smoking advertisements (Kinnunen et al. 2015). A careful selection of the (social) media through which these are offered, is vital. There is currently very little research data on the internet-based anti-smoking interventions for adolescents. In adults, the evidence of the efficiency of this type of approach is insufficient (Taylor et al. 2017) or the effect is considered small (Chen et al. 2012). Incentives seem to be ineffective in smoking prevention among children and adolescents (Hefler, Liberato and Thomas 2017).

Adolescent cessation programs including parent participation have reported positive results (Thomas, Baker and Lorenzetti 2007, Tingen et al. 2006) and it is recommended to encourage and assist parents to quit smoking to prevent the onset of

adolescent smoking (Patnode et al. 2013, Priest et al. 2008). In a Cochrane review on family-based programs for preventing smoking initiation in children and adolescents by Thomas et al. (2015), it was concluded that effective interventions encouraged parents to set rules and show their caring and interest in the adolescent.

Oral health care in Finland provides an excellent setting for anti-smoking interventions: practically all school aged children take part in the annual oral health check-ups (Statistical information on welfare and health in Finland 2016). As dental hygienists and dentists see their population regularly even the initial effects of tobacco can be noted from the dentition. Compared to physicians, dentists have been shown to be less likely to ask about their patients' smoking and provide assistance in cessation (An et al. 2008) and the anti-smoking advice from dentists is clearly inferior in efficacy to that of physicians (Gorin and Heck 2004). Anti-smoking interventions in oral health care have been successful (Nasser 2011, Carr and Ebbert 2007, Albert, Severson and Andrews 2006). In oral health care setting, recommending a non-smoking adolescent to refrain from smoking (Garg et al. 2006) has also been shown to diminish subsequent smoking. WHO has published an oral health program (Petersen 2003). Among its many objectives resides the development of indicators to assess tobacco use as a part of natural health programs and effective use of schools in tobacco prevention among minors.

4.6 Summary of literature review

The Finnish smoking epidemic remains a problem although the habit has been declining over the years. Family members and peers have a great influence on the adolescents' smoking behavior, but the knowledge on who has the strongest influence is controversial. Although we know smoking causes damage to oral health, we do not know if those with oral health problems, but no previous tobacco exposure might be more prone to experiment with smoking. We know smokers tend to have a poorer self-esteem, but we are unaware if those non-smoking adolescents with poorer self-esteem are more likely to start smoking later in life.

Oral routine screening provides a good forum to reach young people of all ages. These check-ups enable us to monitor those adolescents who later become smokers if it is not prevented. The problem is that we do not know which adolescents benefit from interventions to prevent smoking. It is unlikely that exposing all adolescents to annual anti-smoking interventions would be cost-effective. Through research it is

possible to find predicting factors that point out those adolescents who are in need for interventions to help them remain smoke free throughout their life.

5 Aims of the study

This study aims to find out factors that predict the onset and continuity of smoking in adolescence and later in life. It also aims to study the long-term effectiveness of brief tobacco intervention(s) in adolescence. The study questions are:

- What are the effects of social relationships on the risk of becoming an adult smoker when observing the smoking of parents, siblings and close friends? (study I)
- What kind of association is there between poorer oral health among non-smoking adolescents and their likeliness to become smokers later in life? (study II)
- Is there a relationship between weaker self-esteem in adolescence and smoking in adulthood? (study III)
- Can initiation of smoking be postponed through brief tobacco intervention(s) in oral health care performed at the age of 12–16? (study IV)
- Can adult smoking be prevented through brief tobacco intervention(s) in oral health care performed at the age of 12–16? (study IV)

6 Materials and methods

6.1 Study design and populations

This thesis is based on four sub-studies. The study population in each sub-study is based on a Finnish age cohort used previously in an earlier study by Kentala et al. (1999). In the initial study, the study population was the entire age group born in 1979 and living in one of four Finnish towns (Kokkola, Pietarsaari, Seinäjoki or Vaasa) in 1992–1994. The age cohort study (n=2,586) was conducted during senior comprehensive school age (13–16 years) in the middle schools. The four towns have relatively similar school conditions. The mother tongue of 24.1% (n=614) of the age cohort was Swedish, the rest spoke Finnish as their mother tongue. This age cohort was used as a subject pool that was observed through different settings in the four sub-studies presented in this thesis. The study populations used in the sub-studies and how their sources of data differ are described in Figure 1 and in the following chapters.

Figure 1: Source of data in the four sub-studies I–IV. OHC=oral health checkup, BI=brief intervention, QS=questionnaire study, LAWSEQ=Lawrence Self-Esteem Questionnaire.

	OHC annually in 1992–1994	BI during OHC in 1992–1994	QS annually in 1992–1994	LAWSEQ in 1995	Follow-up QS in 2008
Study I			x		x
Study II	x		x		x
Study III			x	x	x
Study IV		x (if born on an odd day)	x		x

6.2 Contents of the study visits in 1992–1994

The study visits were incorporated in a part of Finnish standard health care: the annual oral health check-ups of schoolchildren. The oral health care personnel

included extra questions required by the study in the standard oral health care appointment. 100% (n=2,586) of the age cohort agreed to take part in the study at their oral health check-up in 1992, 84.2% (n=2,178) participated in 1993 and 60.8% (n=1,571) in 1994. The smoking rate in the age cohort was 5.7% (n=148) in the beginning of the study and it rose steadily during the study up to 19.4% (n=304) in 1994. (Kentala et al. 1999). The number of participants at each study visit and follow-up are represented in Table 1. The contents and nature of these visits and measurements are described in the following chapters.

Table 1. Participants at the oral health check-ups with questionnaire studies (OHC+QS), the self-esteem questionnaire (LAWSEQ) and the follow-up questionnaire. The late two columns present the same participants divided in two as in study IV.

	All age cohort subjects (n=2,586)		Intervention group (n=1,348)		Control group (n=1,238)	
	n	% of group	n	% of group	n	% of group
OHC+QS						
in 1992	2,586	100	1,348	100	1,238	100
in 1993	2,152	84.0	1,130	83.8	1,022	82.6
in 1994	1,578	61.6	849	63.0	729	58.9
LAWSEQ in 1995	1,073	41.9	560	41.5	513	41.4
Follow-up QS in 2008	1,020	39.4	529	39.2	491	39.7

6.2.1 Oral health check-ups (OHC)

During the annual oral health check-ups in 1992–1994 the usual measures of oral health indicators were monitored. These included D (Decayed teeth) and DMF (Decayed, Missing, and Filled teeth) indicators, which we used to determine subject’s oral health in adolescence. The values of these indicators were derived directly from the dental records.

Those subjects whose DMF was 0 were classified as caries free, while others were classified to have dental caries. D indicators were used similarly; those subjects whose D was 0 were interpreted to have no decayed teeth, while others were interpreted to have at least one decayed tooth. These indicators were used in study II.

The hypothesis for study II was that there are more smokers in adulthood among those with positive dental caries experience in adolescence, their smoking began earlier, and they smoke heavier than those who were caries free in adolescence.

6.2.2 Questionnaire study (QS)

Each time a subject took part on an OHC he/she was also asked to respond to a questionnaire. Thus, the number of participants responding to a certain QS is similar to the number of participants in the OHC in question. In the questionnaires, the participants were asked about their current smoking behavior and previous smoking experimentations. Some background information (gender, smoking behavior of parents, intention to try smoking) was also gathered. The questionnaires were printed in both Finnish and Swedish and the subjects received the questionnaire in their mother tongue. The smoking behavior questions in the QS were the Fagerström's test for nicotine dependence questions (Heatherton et al. 1991) that has been widely used to research smoking behavior.

The responses were seen as cross-sectional information on smoking related habits. As adolescents have been shown to vary their smoking behavior throughout adolescence (O'Malley, Bachman and Johnston 1983), we used several different methods to assess it. Only the self-reported nonsmokers were used as the study population in study II and III. To identify these subjects the responses in the annual questionnaires in 1992–1994 to the question “Do you smoke?” were used. In the first part of the study II the nonsmoking subjects were picked using only one response to the question “Do you smoke?” at ages 13, 14 or 15 without paying any attention on their possible earlier or later responses. In the second part of the study II all available information on the subject's smoking behavior were used in the identification of the non-smoking adolescents. In this second analysis the annual responses to “Do you smoke?” were observed. To define a subject as a nonsmoker the exact criteria were: he/she had responded “Yes” 0 times, “No” 1–3 times and had missing data for the annual questions 0–2 times. All subjects that did not fulfill these criteria were considered to be adolescent smokers and they were not used as a study population in the second part of study II.

The first of the two inclusion criteria for study III was the same as the inclusion criteria for the second part of study II (any self-reported smoking lead to exclusion from the analysis). See chapter 6.2.4 for information on the second inclusion criteria for study III.

6.2.3 Brief intervention (BI)

The age cohort was divided into two groups based on their date of birth. Those participants who were born on odd days (n=1,348) received brief tobacco

interventions during each oral health check-up they participated in, the rest (n=1,238) were assigned to the control group. The control group received standard oral health check-ups without brief interventions.

The BI was based on the hypothesis that adolescents are not worried about the serious long-term health impacts smoking could have on them (Pallonen et al. 1998). Therefore, the BI stressed the cosmetic impact of smoking as follows: The participants in the intervention group were shown a series of photographs of oral diseases and dental stains caused by smoking. Then a mirror was given to the participants and they were asked to see if they had similar phenomenon in their own mouth. Non-smoking adolescents received similar intervention, but they also received positive feedback for being non-smokers. The duration of a single BI was 2–3 minutes (Kentala et al. 2005). The interventions were repeated each year with the participants in the intervention group. No statistically significant differences in smoking rates at the age of 15 were found between those participants who received the BIs and those who did not. (Kentala et al. 1999)

In the study IV the earlier brief interventions were seen as a community intervention that promoted cessation and prevented initiation. This type of approach has been found effective resulting in positive changes in smoking behavior in the community (Secker-Walker et al. 2002). Anti-smoking interventions could promote the development of a non-smoking self-image. Although not initially found effective, BI could have had an impact on the adolescent's smoking behavior later in life, after the possible experiments with smoking in adolescence. The hypothesis for study IV was that there should be fewer adult smokers in the intervention group and those who nevertheless started smoking would do it later than those in the control group.

6.2.4 Self-esteem questionnaire (LAWSEQ)

At the age of 16 those who remained in the study (n=813) were requested to respond to Lawrence Self-Esteem Questionnaire (LAWSEQ) (Lawrence 1982). A variety of methods to measure self-esteem have been developed. Rosenberg Self-esteem Scale (Rosenberg 1965) has been used as the golden standard to measure self-esteem. During the time of the initial cohort study, a relatively new method of measuring self-esteem was Lawrence Self-Esteem Questionnaire (LAWSEQ) (Lawrence 1982), which has been shown to be a valid measure of an individual's self-esteem (Hart 1985, Lawrence 2006). A back-translation (from Finnish into English) of the version of LAWSEQ that was used is presented as Appendix A (Appendix A). Two versions of

LAWSEQ had been used in 1995, one in Finnish and one in Swedish. The subjects responded to the version in their mother tongue.

The responses to LAWSEQ were used to assess the respondent's self-esteem in study III. A sum variable of LAWSEQ responses (LAWSEQ score later in text) was used. It is the total number of points from the LAWSEQ questions. A "Yes" answer to a question resulted in 2 points, "I don't know" 1 point and "No" 0 points except for the question "Do you think that your parents usually like to hear about your own ideas?" where "Yes" resulted in 0 points, "I don't know" yielded 1 point and "No" yielded 2 points. Theoretically LAWSEQ score is a value between 0 (zero) and 20, where 0 represents the strongest and 20 the weakest self-esteem.

As described in 6.2.2, all adolescent smokers were excluded from the analysis in study III, although for comparison the LAWSEQ scores of smokers in adolescence were compared to the LAWSEQ scores of the study population in a separate analysis. The study population in study III consisted of 813 subjects. 51.7% of this population (n=402) got LAWSEQ scores from 0 to 2 with median LAWSEQ score being 3. As this provided us with a clear cut-point for splitting the population in two, the subjects were then divided into two groups: those with lower (0 to 2) LAWSEQ score and thus stronger self-esteem and those with higher (3 to 20) LAWSEQ score and thus weaker self-esteem.

Then the responses to individual self-esteem questions were classified as weaker (1–2 points) and stronger (0 points). The reclassified responses were then analyzed to see if they reflected differences in smoking behavior. The hypothesis for study III was that those with poorer self-esteem in adolescence are more likely to start smoking earlier than other adult smokers. We were also interested to see if the smoking characteristics of those with poorer self-esteem differ from those with higher self-esteem.

6.3 Follow-up questionnaire in 2008

A follow-up questionnaire (Appendix B) was sent to the original age cohort in 2008 when the subjects were approximately 29 years old. 272 subjects had incorrect or missing social security numbers in the 1992–1995 OHC, QS and LAWSEQ forms, 121 had unknown addresses and 18 had deceased. The Finnish Population Register Centre provided the addresses of 2,175 subjects based on their social security numbers obtained from the 1992–1994 questionnaires. The follow-up questionnaire was sent either in Finnish or Swedish depending on the respondent's mother tongue. A cover

letter describing the purpose and methodology of the study was included with the questionnaire as well as a consent form. Recipients were requested to read, sign, and return the consent form with the completed questionnaire. Only those follow-up questionnaires that were returned with a signed consent form were used as data in all four sub-studies. In the case of a nonresponse, a reminder questionnaire was sent three months after the initial questionnaire. Table 1 shows the number of participants during the oral check-ups and the follow-up questionnaire in 2008.

The questions about smoking were based on a questionnaire used and validated in twin studies (Kaprio and Koskenvuo 2002). Those respondents answering “yes” to the question “Do you smoke?” (No/Yes) were classified as adulthood smokers in studies I, III and IV. In studies II and partly III we changed the crucial question to whether the subject was or had been smoking regularly, as only including one cut-point for determining adolescent smoking behavior could be unreliable. This dichotomization was executed using the responses to two different questions. Those respondents answering “yes” to both questions “During your life have you smoked more than 5 packs of cigarettes or cigars or at least the equivalent amount of loose or pipe tobacco?” (Yes/No) and “Do you smoke or have you smoked tobacco products regularly, in other words daily or almost daily?” (Yes/No), were classified as smokers in study II and as having been smoking regularly in study III.

The ex-smokers’ duration of smoking was calculated by subtracting the age at the initiation from the age at the cessation. The smokers’ duration of smoking was calculated by subtracting the age at the initiation from 29 (the average age of the cohort when the questionnaire was mailed). The amount of tobacco products consumed was dichotomized to heavy (more than 10 cigarettes per day) or light (1–10 cigarettes per day) smoking.

The respondents were also asked to look back at their smoking exposure in school age. As this part of the questionnaire was based on the perceived influence theory, the respondent’s own perception of his/her influences was of interest. Those responding “yes” to the question “When you were of school age, did your father smoke?” were deemed to have had a smoking father in school age. The same pattern was repeated with similar questions about the smoking habits of the respondent’s mother, brother, sister, and a close friend during respondent’s school age. Those without a brother (or a sister) were treated as missing data for the question on smoking behavior of their brother (or sister). Those respondents answering “yes” to the question “Does your close friend smoke?” were deemed to have had a smoking close friend in adulthood.

We also measured some potential confounders for smoking. These were marital status, level of education and self-perceived health. The options for marital status were

Single, Married, Cohabiting, Remarried, Divorced, Widowed. Single, divorced, and widowed respondents were classified as single, while married, remarried and cohabiting respondents were classified as married or cohabiting in the analysis. Education was classified as higher education if the respondent had a polytechnic or university degree. All other education was classified as lower education. Respondents were also asked about their self-perceived health and the options were Very good, Good, Average, Poor, Very poor, I don't know. After analyzing the frequencies in each option, the responses were reclassified as Very good/Not very good, whereas all answers other than Very good were classified as Not very good. Very good self-perceived health was considered a strong positive health perception sign and thus different from all the other options.

The hypothesis for study I was that there should be more smokers among those with smoking siblings, parents and/or close friends during adolescence and in adulthood.

6.4 Statistical analysis

The analysis was performed using SPSS versions 16.0–24.0 for Windows/OS. Frequencies and cross-tabulations were calculated. Associations between frequencies were tested using Fisher's exact test and χ^2 -test. Logistic regression analysis was performed to obtain Odds Ratios (OR) and 95% Confidence Intervals (CI) for comparisons between groups. Unpaired t-test was used to analyze respondents' age at the initiation of smoking between the groups and LAWSEQ score differences among the smokers and the non-smokers. Multivariate analyses were also conducted to adjust for confounders.

6.5 Ethics

The Ethics Committee of the Pirkanmaa Hospital District, Finland approved the study protocol. Written informed consent was obtained from the participants for scientific purposes and publication. All procedures contributing to this work comply with the Helsinki Declaration of 1975, as revised in 2008 (WMA 2008). This study was registered at clinicaltrials.gov (NCT01348646).

6.6 Analysis of a non-response

The follow-up produced 1,020 responses from the age cohort after one reminder. As 2,175 subjects did not respond or could not be contacted (see 6.3 for explanation), the response rate was 46.9% according to the population used in studies I and IV. Among the non-respondents there were significantly more males and those with dental caries and/or tooth decay at the age of 13 (Table 2). There were no differences between respondents and non-respondents in relation to smoking at the age of 13, willingness to try smoking (among those who were non-smokers at the age of 13) or smoking behavior of parents (Table 2). Of those adolescents who had responded in any of the 1992–1994 QS that they had a smoking parent, 62.7% (n=751) did not respond to the 2008 follow-up while 57.8% (n=785) of those without a smoking parent (p=0.011) did not respond. This phenomenon was not observed when only one measurement on exposure to smoking of parent(s) was acknowledged (Table 2).

Table 2. Comparison of respondents and non-respondents in relation to the potential confounders in the four sub-studies. LTFU = lost to follow-up.

	Studies I and IV		Study II		Study III	
	respondents	LTFU	respondents	LTFU	respondents	LTFU
	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)
female	59.3 (605)**	41.9 (646)**	60.5 (513)**	42.7 (510)**	62.8 (243)**	47.9 (218)**
male	40.7 (415)**	58.1 (895)**	39.5 (335)**	57.3 (684)**	37.2 (144)**	52.1 (237)**
no parent smoking when 13 years	59.1 (600)	55.4 (847)	62.4 (528)	61.1 (722)	64.6 (250)	61.4 (278)
parent smoking when 13 years	40.9 (416)	44.6 (683)	37.6 (318)	38.9 (460)	35.4 (137)	38.6 (175)
no smoking in 1992	95.3 (972)	93.7 (1,441)	100 (972)	100 (1,193)	100 (387)	100 (455)
smoking in 1992	4.7 (48)	6.3 (97)	0 (0)	0 (0)	0 (0)	0 (0)
not willing to try smoking in 1992	94.3 (661)	93.9 (916)	94.8 (606)	94.5 (804)	93.8 (270)	93.8 (317)
willing to try smoking in 1992	5.7 (40)	6.1 (59)	5.2 (33)	5.5 (47)	6.3 (18)	6.2 (21)
caries free (DMF=0) at 1992	40.5 (413)**	34.2 (527)**	42.5 (360)*	36.3 (434)*	37.0 (143)*	28.1 (128)*
dental caries (DMF>0) at 1992	59.5 (607)**	65.8 (1,016)**	57.5 (488)*	63.7 (761)*	63.0 (244)*	71.9 (327)*

no decayed teeth (D=0) at 1992	71.4 (728)**	64.9 (1,001)**	72.4 (614)*	66.9 (799)*	69.8 (270)*	61.8 (281)*
tooth decay (D>0) at 1992	28.6 (292)**	35.1 (542)**	27.6 (234)*	33.1 (396)*	30.2 (117)*	38.2 (174)*

*=p<0.05, **=p<0.001

In study II, a response to the follow-up questionnaire was received from 40.3% (n=848) of those subjects who reported to be non-smokers at age 13, 44.5% (n=833) of those subjects who reported to be non-smokers at age 14 and 45.3% (n=567) of those subjects who reported to be non-smokers at age 15. The gender difference was very stable throughout the four different settings used in study II: Females were 17.2–19.5 percentage points more likely to respond in the 2008 follow-up than males. The difference was statistically significant on each setting. Table 2 presents the numbers in relation to the analysis with those who were non-smokers during 1992–1994. Dental caries and tooth decay at the age of 13 was significantly more common among those who did not respond to the 2008 follow-up questionnaire (Table 2).

In study III the response rate to the follow-up questionnaire was 46.2% (n=387). Again, there were significantly more females among respondents (Table 2). The response rate was not different comparing those with smoking parents at adolescence to others. Missing data for a measurement on QS on smoking was treated as non-response for that measure and it did not affect the classification according to the other measures on smoking behavior. For example, an adolescent might have reported non-smoking at ages 12 and 14, had not participated aged 13 and be classified as non-smoker in adolescence.

In the follow-up questionnaire most respondents were married or cohabiting, had higher education and perceived their health to be very good. These characteristics were similar among the intervention group and the control group in study IV. The smoking rates in 1992–1994 questionnaires were also similar in the intervention group and the control group according to the study IV. There was no difference in the response rate between the intervention group and the control group.

7 Results

7.1 Predictors of smoking in adulthood (I–III)

The information on three different predicting factors for adulthood smoking was analyzed: social relationships in adolescence and adulthood, dental caries experience in adolescence and self-esteem in adolescence. These are discussed in the subsequent chapters.

7.1.1 Social relationships (I)

There was a strong association with the smoking behavior of a close friend in adulthood and smoking in adulthood in study I. The univariate OR for smoking in adulthood was 10.0 (95% CI 6.2–15.9) for those who had a smoking close friend in adulthood (Table 3). When analyzing this association by gender, some differences were observed. Among those males who had a smoking close friend in adulthood it was 7.1 (95% CI 3.6–14.0) times more likely that they were smokers. The respective association was slightly weaker among females (OR 4.7, 95% CI 2.5–8.6).

The analysis of the impact of smoking of a close friend in adolescence was adjusted in two different ways. The first analysis consisted of only those potential confounders that were present at the same time as the close friend in adolescence. These included gender and the smoking of mother, father, sister or brother. The second adjustment was even wider also including those confounding factors that appeared years after the potential impact of the close friend in adolescence (Table 3). In the adjusted analysis, females with a smoking close friend at school age had more than five times greater likelihood of being smokers in adulthood. This connection was not observed among males. Adjustment brought up differences that were not observed in the unadjusted analysis. In the first adjustment with gender and family members' smoking, the OR for smoking in adulthood was 5.0 (95% CI 3.3–7.4) for those with a smoking close friend in adolescence. When adjusting only by family members' smoking and analyzing by gender, similarly to the unadjusted model females were at higher smoking risk if their close friend in adolescence was a smoker (OR 7.8, 95% CI 4.3–14.0). Unlike in the

unadjusted model, males represented similar increase in smoking risk by the smoking behavior of their close friend in adolescence (OR for smoking in adulthood 3.3, 95% CI 1.9–5.8).

When looking at the confounders in study I, 56.6% (n=94) of adulthood smokers had lower education while 29.6% (n=244) of non-smokers had lower education ($p<0.001$). Another statistically significant difference between smokers and non-smokers was found in their self-perceived health in adulthood: 72.0% (n=121) of adult smokers and 90.0% (n=745) of adult non-smokers reported their self-perceived health very good ($p<0.001$). There were also significantly more females among adult non-smokers (61.5%, n=510) compared to adult smokers (51.2%, n=86, $p=0.016$). As the difference in the distribution of these factors was statistically significant among smokers and non-smokers, they were included in the multivariate logistic regression analyses.

The smoking of a mother, a brother, or a sister when the subject was of school age seemed to increase the likelihood of being a smoker in adulthood more than twofold among males, but when adjusted for confounders, all impact of family members on adulthood smoking disappeared (Table 3). The impact of friends (in adulthood and at school age) persisted in the adjusted model. Marital status and self-perceived health had an independent association with the smoking behavior in adulthood, but the strength of these associations was lower than the impact of a close friend. Those who were single or perceived their health anything else than very good, were twice as likely to be smokers in adulthood (Table 3).

Table 3. Logistic regression analysis of smoking in adulthood according to the smoking behavior of the family members and friends. All respondents included (n=1,020). Multivariate analysis is adjusted by gender, marital status, education and self-perceived health.

			OR for smoking in adulthood (95% CI)				
			bivariate	<i>p</i> -value	multivariate	<i>p</i> -value	n
Close friend	In adulthood	Non-smoker	1	<0.001	1	<0.001	711
		Smoker	10.0 (6.2–15.9)		5.0 (3.1–7.8)		271
Close friend	In school	Non-smoker	1	<0.001	1	<0.001	613
		Smoker	4.2 (2.7–6.5)		3.1 (1.9–5.0)		365
Mother		Non-smoker	1	0.002	1	0.055	750
		Smoker	2.1 (1.3–3.2)		1.7 (1.0–2.8)		238
Father		Non-smoker	1	0.009	1	0.70	614
		Smoker	1.8 (1.2–2.7)		1.1 (0.7–1.8)		362
Sister		Non-smoker	1	<0.001	1	0.80	790
		Smoker	3.8 (2.3–6.4)		1.7 (0.9–3.0)		126
Brother		Non-smoker	1	<0.001	1	0.90	746
		Smoker	3.0 (1.9–4.9)		1.6 (0.9–2.7)		167
Gender		Female	1	0.057	1	0.14	596
		Male	1.5 (1.0–2.3)		1.4 (0.9–2.2)		401
Marital status		Married or cohabiting	1	0.141	1	0.012	775
		Single	1.4 (0.9–2.2)		2.0 (1.2–3.3)		221
Education		Higher	1	<0.001	1	0.08	651
		Lower	2.6 (1.7–4.0)		1.5 (1.0–2.4)		338
Self-perceived health		Very good	1	<0.001	1	0.008	866
		Not very good	2.8 (1.7–4.8)		2.3 (1.2–4.1)		130

7.1.2 Oral health in adolescence (II)

The caries free non-smokers at the oral health check-ups during adolescence are presented in Table 4; first for the entire age cohort and then only those who responded to the 2008 follow-up questionnaire.

Table 4. Oral health of the age cohort and the 2008 follow-up respondents at the oral health check-ups (OHC).

OHC at age (years)	TOTAL AGE COHORT		
	n	Caries free (DMF=0) % (n)	No decayed teeth (D=0) % (n)
13	2 413	37.9 (913)	68.3 (1,648)
14	1 864	33.2 (619)	66.1 (1,233)
15	1 245	28.5 (355)	68.7 (855)

OHC at age (years)	RESPONDENTS TO FOLLOW-UP		
	n	Caries free (DMF=0) % (n)	No decayed teeth (D=0) % (n)
13	848	42.5 (360)	72.4 (614)
14	753	36.7 (276)	71.3 (537)
15	552	33.5 (185)	74.8 (412)

In the first analyses of the study II where non-smokers were defined by a single QS, dental caries experience (DMF>0) at adolescence was not linked with smoking rates in adulthood, regardless of which OHC was used as the measuring point of dental caries. Having at least one decayed tooth (D>0) at the check-up at the age of 14 predicted a 1.8 times greater odds ratio for smoking in adulthood compared to those with no decayed teeth ($p=0.004$), even when adjusted by gender and smoking behavior of parents. When analyzing this setting by gender, things changed. In males the adjusted OR for smoking was 2.0 (95% CI 1.0–3.9, $p=0.037$) but in females this difference was no longer statistically significant despite the greater number of females in this analysis (501 females versus 306 males). These differences persisted after adjusting for smoking behavior of parents. Tooth decay at the age of 15 was not associated with smoking in adulthood. There was no difference in the proportion of heavy smokers between those with positive dental caries experience or decayed teeth and those with caries free dentitions. Those adult smokers who had at least one

decayed tooth at the age of 15, started to smoke 1.1 years earlier than those without any decayed teeth aged 15. Initiation of smoking for these age groups was at the age of 16.3 and 17.5, respectively ($p=0.013$).

The second analysis consisted of non-smokers as defined by all the QSs; only those who reported no smoking at any of the check-ups at ages 13, 14 or 15. There were 848 respondents who were not smokers at any of the annual check-ups at the ages of 13–15. 45.5% ($n=386$) had positive dental caries experience ($DMF>0$) and 30.2% ($n=256$) of this population had tooth decay ($D>0$) in at least one check-up. Logically, all respondents having $D>0$, also had $DMF>0$.

The analysis was done after adjusting for smoking behavior of parents when the respondent was aged 13 and gender was also taken into account, first by adjusting by gender and then by presenting the results separately for both sexes (Table 5). Tooth decay ($D>0$) at the check-up at ages 14 or 15 predicted twofold odds for being a smoker in adulthood compared to those with no tooth decay. Similarly, increased odds for adulthood smoking were observed with dental caries at the OHC at the age of 14 (Table 5). Tooth decay ($D>0$) at the age 13 or dental caries at the age of 13 or 15 showed no association with higher smoking rates in adulthood. The heaviness of smoking was not associated with dental caries or tooth decay at the age of 13, 14 or 15. Those adult smokers with positive dental caries experience ($DMF>0$) aged 13 started to smoke 1.1 years earlier than those without dental caries at this age (smoking initiation age 17.0 vs. 18.0, $p=0.036$). Those subjects who had tooth decay ($D>0$) at the age of 15 started smoking 2.8 years earlier than those without any decayed teeth at the age of 15 (initiation aged 15.0 vs. 17.8, $p=0.013$).

When analyzed by gender, the previously observed association between smoking and dental caries at the age of 14 disappeared (Table 5). On the other hand, tooth decay at the age of 14 and dental caries at the age of 15 were still associated with higher smoking rates in adulthood in females. In the male population, no association between positive dental caries experience or tooth decay in adolescence and smoking in adulthood was observed.

Table 5. Logistic regression analysis of smoking in adulthood according to dental caries experience of all respondents defined as non-smokers in adolescence (n=831). OR for otherwise similar subjects with DMF=0 or D=0 is equal to 1. All values are adjusted by gender and smoking behavior of parents when the respondent was 13 years old.

ALL						
Age (years)	DMF>0			D>0		
	OR for smoking (95% CI)	n	p-value	OR for smoking (95% CI)	n	p-value
13	0.9 (0.6–1.4)	831	0.616	1.4 (0.9–2.2)	831	0.157
14	1.8 (1.1–3.1)	739	0.028	1.9 (1.2–3.1)	739	0.008
15	2.3 (1.2–4.6)	544	0.017	1.3 (0.7–2.4)	543	0.331

FEMALES						
Age (years)	DMF>0			D>0		
	OR for smoking (95% CI)	n	p-value	OR for smoking (95% CI)	n	p-value
13	0.7 (0.4–1.4)	507	0.724	1.5 (0.8–2.7)	507	0.209
14	1.6 (0.8–3.2)	457	0.211	1.9 (1.0–3.6)	457	0.043
15	3.4 (1.1–9.9)	345	0.028	1.7 (0.8–3.6)	345	0.193

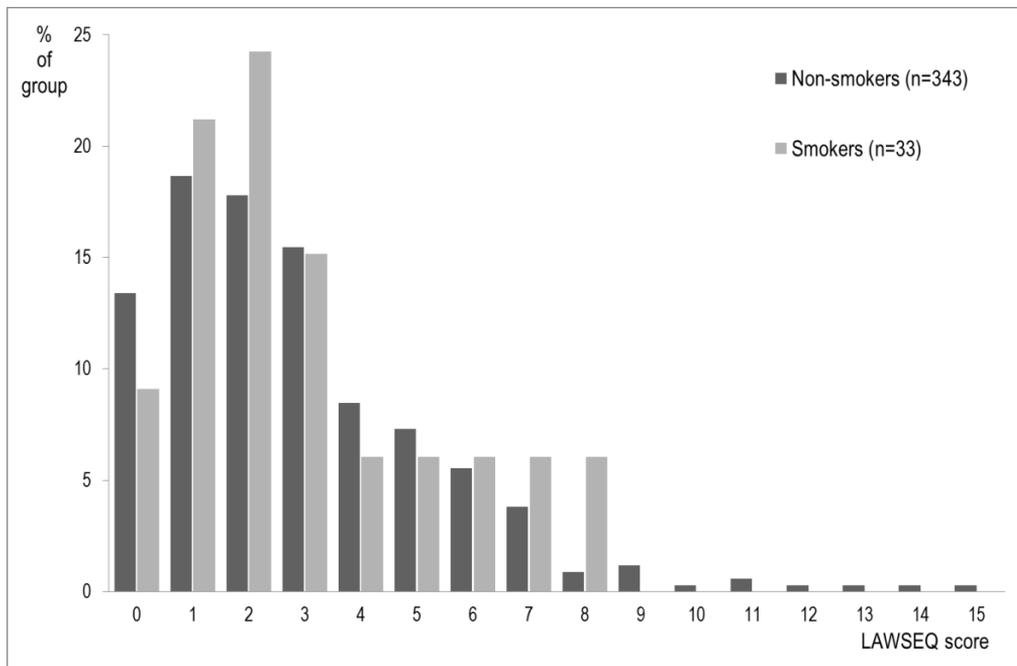
MALES						
Age (years)	DMF>0			D>0		
	OR for smoking (95% CI)	n	p-value	OR for smoking (95% CI)	n	p-value
13	1.1 (0.6–2.1)	324	0.744	1.3 (0.6–2.5)	324	0.475
14	2.1 (1.0–4.7)	282	0.067	1.9 (0.9–4.0)	282	0.097
15	1.7 (0.7–4.2)	199	0.276	1.0 (0.4–2.5)	198	0.979

7.1.3 Self-esteem in adolescence (III)

About half (n=229) of all respondents in study III scored less than 3 (three) with median score being 2. As the LAWSEQ score median was 3 among the original age cohort, it was accepted as the cut-point for splitting LAWSEQ scores to those representing stronger (LAWSEQ score 0–2) or weaker self-esteem (LAWSEQ-score 3–20). There were no statistically significant differences in LAWSEQ scores between

the groups of adulthood smokers and non-smokers (Figure 2). In a separate analysis the LAWSEQ scores of the adolescent smokers (that were not included in any other following analysis in study III) were compared to the LAWSEQ scores of the adolescent non-smokers. In this analysis the mean LAWSEQ score was slightly higher among those who were smokers in adolescence (mean difference of LAWSEQ score 0.61 higher, 95% CI of difference 0.24–1.0, $p=0.001$).

Figure 2: Distribution of LAWSEQ score measured at the age of 16 in the groups of smokers and non-smokers at the age of 29. Higher scores indicate weaker self-esteem.



8.9% ($n=33$) of all respondents in study III were smokers in adulthood while 41.3% ($n=155$) reported having been smoking regularly. Among the respondents, 7.6% ($n=18$) females and 11.0% ($n=15$) males were smokers but this gender difference was not statistically significant. On the other hand, 36.7% ($n=87$) of females and 49.3% ($n=68$) of males had been smoking regularly ($p=0.022$).

Weaker self-esteem during adolescence was not significantly associated with the response “Yes” to “Do you smoke?” in adulthood. However, among all respondents, 24.5% ($n=58$) of the females and 36.7% ($n=51$) of the males had been smoking regularly ($p=0.014$). Those with weaker self-esteem during adolescence were more likely to having been smoking regularly and this difference persisted after adjusting for

confounders (OR 1.8, 95% CI 1.1–3.0, $p=0.03$). When analyzing each LAWSEQ question separately, responses to the separate LAWSEQ questions were not associated with smoking behavior in adulthood regardless of which definition of smoking was used.

7.2 Brief intervention in adolescence and smoking in adulthood (IV)

The majority (97.0%) of the respondents in the intervention group in study IV had received at least one BI in adolescence. Respectively 85.6%, 63.5% and 21.6% had received at least two, three or four BIs. 16.9% of all respondents were smokers in the 2008 follow-up. The median age at initiation of smoking was 15 years in both the intervention group and the control group. 15.3% and 18.5% respectively of the intervention group and control group were smokers. This difference of 3.2 percentage points in smoking was not statistically significant. The odds for being a smoker were similar when those in the intervention group were compared with those in the control group (Table 6). There was no difference in mean duration of smoking between the intervention group and the control group (median values 10 and 11 years respectively, $p=0.10$). Repeating the BI up to four times caused no change in smoking rates and odds. There was no difference between the intervention group and the control group in heaviness of smoking currently or before cessation.

When comparing the intervention group and the control group at the age of 13–15, there were no differences in the smoking rates or gender distribution. In the follow-up questionnaires education, marital status or self-perceived health were not different when those in the intervention group were compared to those in the control group.

Table 6. Odds ratios (OR) and 95% confidence intervals (CI) for being a smoker in adulthood for those in the BI group comparing to those in the control group with potential confounders. The adjusted model includes all tabulated variables.

	OR for smoking in adulthood (95% CI)	
	bivariate	multivariate
Brief intervention		
control group	1	1
intervention group	1.3 (0.9–1.8)	1.1 (0.7–1.5)
Gender		
Female	1	1
Male	1.5 (1.1–2.1)*	1.1 (0.8–1.6)
Marital status		
married or cohabiting	1	1
Single	1.3 (0.9–1.9)	1.6 (1.1–2.5)*
Education		
High	1	1
Low	3.1 (2.2–4.4)**	2.1 (1.4–3.1)**
Self-perceived health		
very good	1	1
not very good	3.5 (2.3–5.2)**	2.9 (1.8–4.7)**
Close friend in adolescence		
non-smoker	1	1
Smoker	5.8 (4.0–8.4)**	5.6 (3.7–8.2)**

*=p<0.05, **=p<0.001

Multivariate logistic regression analysis was executed using the confounders noted in chapter 7.1.1 since study IV used the same population and thus had similar risk of bias from confounding factors as study I. These factors were gender, marital status, education, and self-perceived health. For comparison across the settings in study I and study IV, the smoking of a close friend in adolescence was also included in the analysis. The association between smoking and the level of education was obvious: the prevalence of adulthood smoking was more than twofold in the lower education group (Table 6) Being single and having other than very good self-perceived health

were similarly associated with a higher smoking rate in adulthood. However, the strongest association by far was the close friend in adolescence: those who had a smoking close friend in adolescence were over 5 times more likely to smoke in adulthood (Table 6). The BI yielded no significant decrease in smoking in the group with higher education. However, in the lower education group, those who were in the intervention group were less likely to smoke than those in the control group (21.8% vs. 34.1% smokers in adulthood, $p=0.015$). A significant interaction effect was found between the BI and education ($p=0.02$). When dividing the cohort by education and looking at the smoking rates in the group with lower education retrospectively in the first follow-up in 1993, the proportion of smokers was not different between the intervention group and the control group. In those who got lower education later in life the share of smokers was in 1993 already greater than in those who later got higher education (7.2% vs 3.3%, $p=0.007$).

The results on the ineffectiveness of brief interventions in males and females were similar: the OR for being a smoker was not explained by the brief interventions in either gender group. There was no difference in the effectiveness of the BI when those with very good self-perceived health were compared to those with lower self-perceived health.

8 Discussion

This study presented findings on predictive factors of smoking initiation and continuing smoking to adulthood. These factors included social connections in adolescence and adulthood, oral health in adolescence and self-esteem in adolescence. It also gives insights on the long-term non-effectiveness of brief tobacco interventions performed in oral health care during adolescence.

8.1 Limitations of the study

This study has several limitations that need to be pointed out before further discussion. The smoking rates among the study populations were lower than those reported by population studies in Finland (Helldán and Helakorpi 2015). This was likely caused by selection bias: in 1992 nearly half of the study population was female but in the 2008 follow-up three in five respondents for studies I and IV were female, so males seem less likely to respond. As males are also more likely to smoke, this caused selection bias in the results. Most of the respondents were highly educated and in a relationship, thus they were likely to be non-smokers (Broms et al. 2004). As this knowledge is combined it is likely that there were a lot of adult smokers among the non-respondents.

When considering the reliability of the questionnaire studies (annually at 1992–1995 and the follow up in 2008), it is important to point out that the respondents mostly had high education, were in a relationship and perceived their health to be very good – thus according to existing knowledge they are unlikely to be smokers. This phenomenon was similar in all the sub-study settings. It is likely that smokers were not very keen to respond to postal questionnaires about smoking. This is supported by the high drop-out rate of frequent smokers after the first round of the initial study (Kentala et al. 1999). The questionnaire at 1992–1995 was not validated before use and thus the internal consistency could be insufficient. Its crucial questions on smoking behavior were whatsoever based on a widely used method (Fagerström’s test of nicotine dependence). Lately the validity of Fagerström’s questions has been found to be inferior to CDS-12 (Etter 2005), but this does not make it a bad method.

The response rate was low but satisfactory since there was no incentive or other external motivator to increase the inclination to respond. It is difficult to keep participants interested in continuing until the end of the trial and follow-up studies after such a long period of time are uncommon. The use of incentives could have produced an increase in response rate (Booker et al. 2011). Recent evidence suggests that non-respondents could also be more effectively reached using a telephone interview for those who did not respond to the mailed questionnaire (Helakorpi et al. 2015). Using a web-based survey would not have been likely to increase the response rate (Hohwü et al. 2013). Specific methods to increase the response rate were not used and this is likely to emphasize the selection bias. The non-respondents might have been living in different areas and thus in a different environment with regard to the social influences on smoking. As some addresses could not be found for the follow-up, it is not possible to know if this is true. Furthermore, it is possible that the group that did not respond had a different education spectrum to those who responded. This is supported by the finding that those who were smokers in the initial QS were likely to get lower education later in life. This may have produced bias in the study, as those with the most pro-smoking indicators were most likely to not respond.

The occupation, income, socio-economic status and education of the subjects' parents were not asked for, so these potential confounders have affected the results. However, it would have demanded a different study design to gain this information. The QS in adolescence would have been unsuitable for collecting this information since adolescents generally do not know how much money their parents make. Asking this in the follow-up questionnaire in adulthood would not have been trustworthy because of the length of time between the actual event and the follow-up. The smoking behavior of the respondent's close friends at school age was not measured and thus it is possible that the smoking behavior of the close friend was recalled incorrectly. This, on the other hand, is unlikely to cause any false conclusions since the study was based on the perceived influence theory, which does not necessarily mean the factual smoking behavior of the close friend was as perceived. The smoking behavior of parents, siblings and close friends was determined by only one question (Did she/he smoke?). This could be seen as a weakness in this study, because heaviness of their smoking, possible periods of abstinence and the perceptivity of their possible smoking remain unknown. This is, however, unlikely to have caused any false results because of the theoretic framework in the study as noted earlier. Adolescents have been shown to be reliable regarding their self-reported smoking (Kentala et al. 2004), so it is unlikely that the respondent's own smoking behavior was incorrectly determined. The respondents would have had no reason to lie about their smoking

behavior in the confidential follow-up questionnaire. Some of the questions in the follow-up questionnaire might have been misunderstood by the recipients since there was no specific option for those who did not have a brother or sister (or perceivable mother or father). It is possible that some of these subjects selected either the option “No” or “I don’t know”. This problem was dealt with via variable transformation: “Yes” was considered the option of interest and the rest of the responses were assigned in the same group. This might have produced some rendering bias since the relationship with a non-smoking sibling or parent might have had a positive effect on the adolescent’s own behavior, which is unlikely to be the same if there was no relationship at all.

When it comes to the results in the oral health check-ups, those adolescents with dental caries seem to be a different group than those without dental caries (Wigen and Wang 2010), and the finding on the high drop-out rate among those with oral health problems speaks for this as well. Only a small proportion of those who did not participate in the study after the initial OHC in 1992 responded to the 2008 questionnaire. It was also common for these participants to avoid the later study visits and to not respond to the 2008 follow-up questionnaire if a participant had oral health problems in the first check-up. Thus, it is possible that a group of subjects with oral health problems escaped the attention of this study and the association between poor oral health in adolescence and adult smoking is therefore underestimated. In a German study the oral health of the non-respondents was poorer than that of others (Splieth et al. 2005). Those with oral health problems are also known to be more likely to not attend regularly to oral health care (Richards and Ameen 2002). Thus, it is possible that this non-attendance was also reflected to the participation on the 2008 follow-up questionnaire. This selection bias is likely to undermine the results. The study was conducted in four separate town and many dentists took part in the collection of the DMF indicators. Thus, the results from all the OHC:s may not have been collected similarly. The non-response rate was high among those with a smoking parent in the first QS, but not in the later QS. This can be interpreted as a sign of selection – those with heavy positive influence on smoking are likely to avoid non-smoking actions. In a study in Netherlands, the non-participants did not represent worse DMF indicators than the participants (Vermaire et al. 2011), but Splieth et al. (2005) concluded that the negative “effect” of non-participation may show itself only in the permanent dentition. The present results speak for the paradigmatic literature: non-participation is a sign of problems (in oral health).

Now I come to the limitations of the brief intervention setting. The participants in the control group were not specifically informed about the actions provided to the

intervention group during dental check-ups, but there were children in both groups attending the same schools and classes. This is a limitation of the study when considering the informational part of the BI. However, the subjective impression with the photographs of dental discoloring and one's own mouth seen through a mirror could not be transferred to another participant. The groups were not blinded because it would not have been possible in the chosen setting: there were subjects from both intervention and control groups in the same schools. The possible periods of abstinence and their duration were not determined in the follow-up for the ex-smokers or smokers, so their actual smoking time may be less than the calculations suggest. This might lead us to incorrect conclusions on the heaviness of the tobacco exposure for the smokers and ex-smokers.

8.2 Social relations and adulthood smoking

The main result on social relations was that the close friend's behavior heavily associates with the subject's own smoking behavior in adulthood. While smoking in adulthood is associated with the smoking of a close friend in adulthood, the close friend in adolescence is also an important predictor of smoking in adulthood. This result is not new (Johnson et al. 2002) and the strong influence of peer smoking has been observed earlier in studies with adolescent populations in Finland (Broms et al. 2012), USA (Bricker et al. 2006), Russia (Kemppainen et al. 2006), New Zealand (Scragg and Laugesen 2007) and Canada (Okoli et al. 2009). Why do friends matter so much? A probable explanation is orientation – we befriend with someone who reminds us of ourselves and agrees with our views. People who smoke usually see smoking as a part of their self-image and thus tend to have friends who also are smokers (de Vries et al. 2006). Friends who smoke increase the likelihood of their friends continuing smoking (Klein, Forster, and Erickson 2013) thus making it more likely for the individual to accumulate a hazardous dose of tobacco exposure. The results on the great importance of close friends' importance as a predictor of smoking risk should be noted as an advantage for planning anti-smoking actions addressing social influences. The herd mentality in smoking experimentations in adolescence is also well demonstrated through the annually increasing numbers in smoking rates during the initial cohort study (Kentala et al. 1999). This is explained by the adolescents' tendency to see tobacco as something that might be harmful for others but not for themselves (Pallonen et al. 1998). In any case, isolation and lack of social

support would be devastating for their health (Bunker et al. 2003) so peers are important for both good and bad choices.

In this study males seemed to be less influenced by their close friends smoking in adolescence than females. Assuming that close friends mostly represent the same gender, the present finding that females are more influenced by their peers smoking is in line with previous knowledge (Mercken et al. 2010). This is impossible to prove as an eligible statement as the gender of the close friend was not asked in this study. The gender differences could be explained by differences in social networking between males and females (Baines and Blatchford 2009).

The importance of family members as endorsers and idols for smoking and other health-related lifestyle choices was clearly weaker than expected in this study. As some parents were deemed by their own children to be smokers in 1992 but some “became” smokers during the following years, it is interesting to consider what happened in the adolescents’ perceptions on their parents during those years. It is unlikely that parents with adolescent children start smoking if they have not smoked previously, so the change most likely happened in the perception – for some reason the adolescent changed from seeing their parent as a non-smoker to seeing her/him as a smoker. Considering the perceived influence theory, it is logical that only this later described smoking would have effect on the adolescent’s own behavior. As the smoking of parents may cause changes in the adolescent’s predisposition on smoking (Wilkinson, Shete and Prokhorov 2008), it is possible that these changes take time and the later the perception of smoking parent comes up, the less impact it has on the adolescent. Still, this one exception cannot refute the paradigm that smoking of parents is closely associated with the adolescent’s own smoking behavior (B Hasmun et al. 2017, Barman et al. 2004). According to earlier findings by de Vries et al. (2006), parents’ smoking behavior affects adolescents’ choice of friends and thus the impact of parents on an individual’s smoking comes both directly from parents and indirectly through friend selection. The results of this study do not support this paradigm. Cohen et al. (2010) conclude that the higher socioeconomic background of parents is associated with reducing the adolescent’s risk behavior through adolescent model-making mimicry. It might be that in other studies with follow-ups ending in adolescence the effects of these social relationships are different than in studies with a longer follow-up.

Another surprising finding was that the siblings had no effect on the subjects’ smoking behavior. This is different from what Sasco et al. have concluded in 2003. The strength of this study is that the influence of all the immediate family members

(mother, father, sister, brother) and close friends were measured both in school age and in adulthood in the same cohort.

8.3 Oral health problems and adulthood smoking

Those non-smoking adolescents, who have tooth decay, are more likely to start smoking than those without tooth decay. The age when the dental caries indicators were measured had some importance in this study population – the age of 14 years seemed to be the best time to determine the risk based on the occurrence of tooth decay. The importance of different oral health indicators and check-up ages varied slightly, but eventually it seems that those with dental health problems may start smoking earlier and are more likely to continue smoking in adulthood. The variation in the predictive weight of oral health indicators between ages 13–15 could be caused by the behavioral changes in puberty. This is supported by the known finding that adolescents vary their smoking behavior during adolescence (O'Malley, Bachman and Johnston 1983). Since there is no biological rationale to back the idea of oral health problems leading to tobacco smoking, it could be hypothesized that the mechanism is behavioral or psychosocial. It is possible that poorer oral health and addiction to tobacco smoking are both partially caused by the same phenomenon: differences in health-related knowledge, self-efficacy and choices. The mediator behind this effect might be the parents: in a study with Belgian preschool children and their parents the development of dental caries was associated with smoking behavior of parents (Leroy et al. 2008).

The development of dental caries in children under school age has been shown to be linked with economic status of parents (Hooley et al. 2012) as well as changes in family status during early childhood (Wigen and Wand 2011) It is possible that those individuals whose parents lacked skills and information on healthy lifestyle, learn some unhealthy habits from their parents even before school age. This sequence of events can be seen happening in the early senior school age in the form of dental caries and as time passes the consequent choices make the individuals more prone to experiment with smoking. If the individual has the misfortune to be prone to developing nicotine dependence, their choices may lead to a smoking addiction.

In study II (and III) the smokers were determined first by one question (Do you smoke?) but later by inquiries about smoking more than 5 packs of cigarettes and having been smoking regularly. Why did we do this? Social factors have been shown to be an important factor in smoking initiation while factors that make the habit

persistent are much more individual (Griesler, Kandel and Davies 2002). The chosen method made it possible to identify those who at the time of the follow-up questionnaire did not identify themselves as smokers but nevertheless had significant tobacco exposure in their personal history. After all, the negative health impact of smoking is related to the accumulated dose (Day and Brown 1980), not the individuals' determined smoker status.

From a critical point of view, interpretation of DMF index as a marker of dental caries is not straightforward, since there are other conditions that can explain higher DMF indicators (for example trauma or congenital defects). The importance of DMF or D indicators for smoking in adulthood was clear in the female population, but not in the male population. Over the past century the differences between the smoking habits of males and females have diminished (Peters, Huxley and Woodward 2014). This study did not bring up this diminishing in the gender differences in smoking.

8.4 Self-esteem issues and adulthood smoking

Lower self-esteem measured in adolescence seems to relate to smoking in adulthood. The LAWSEQ scores were slightly lower among the adolescent smokers (that were not the study population in the study III) but this was not significant. In a U.S. study with college students the males with lower self-esteem were more likely to be smokers than males without self-esteem issues or females (Hale et al. 2015). This study emphasizes the earlier finding that self-esteem might be a mediator of the differences in smoking. However, the actual result (lower self-esteem in a non-smoking adolescent predicts adulthood smoking) is new. The link between self-esteem and smoking should be understood in the context of peer relationships (Glendinning 2002). In other words, it is what smoking means to the adolescent that makes her/him decide to go for the experiment, usually in a social situation with peers. This brings us back to the findings of study I on the importance of social relationships on lifestyle choices.

The reliability of LAWSEQ scores has been found satisfactory in recent analyses (Rae et al. 2011) and therefore it is possible to say that those with higher scores are more likely to have poorer actual self-esteem. On the other hand, it must be mentioned that measuring self-esteem is controversial. Global measures of self-esteem have been found to be insufficient, since feelings of self-esteem are very context specific (Glendinning and Inglis 1999). As self-esteem is an attribute of a non-numeral nature, it should be interpreted with care when studied within means of quantitative research. Also, LAWSEQ has not been validated in Finnish populations and cultural

differences may also influence the adequacy of the translation used in this study. Thus, it is not possible to make strong statements based on the observed LAWSEQ scores. The back-translation of the LAWSEQ version used in the study III was slightly different than the original English version (see Appendix A) and this might have had some effect on the responses.

8.5 Long-term effectiveness of brief tobacco intervention

The differences in smoking in adulthood were not explained by the brief tobacco interventions at oral health care during adolescence. The same finding (brief interventions lack long-term effectiveness) has been observed in another study with a Nordic population (Dalum et al. 2012). The same conclusion was made in a Cochrane review with 41 trials and more than 13,000 subjects (Fanshawe et al. 2017). Thus, the result could be generalized to Nordic countries. The cohort was not actually randomized but divided into two groups by date of birth (odd/even day of the month). This method does not have the validity of random numbers, but it is unlikely that this is a cause of bias in the study.

It has been shown that school dentists are motivated to prevent adolescent smoking, but only one in five regularly intervenes with a young patient's smoking (Yee et al. 2008). As the practice of brief interventions did not always go as planned and there was evidence that the BI was sometimes performed inadequately, with additional training of personnel the reduction could have been more remarkable (Kentala et al. 2005). It is also possible that the BI could have been more effective if it had some new content every time. An annual cessation rate as high as 10–15% can be achieved among adults through effective anti-smoking programs implemented into daily work with patients (Warnakulasuriya 2002). It is likely that adolescents are different from adults, since they are still building up their self-image. According to present knowledge, only those interventions that initially produce an effect, are encouraged to be repeated periodically to enhance the effect (Flay 2009). As the BI in question did not show initial effectiveness, the lack of enhancement with repeated interventions was not a surprise.

8.6 Implication for further studies

It would be interesting to conduct a study that would combine the perceptions of adolescents on the smoking behavior of their close ones with questionnaires completed by their parents and peers to see how these actually match. It would also be interesting to study if the span of the perception influences the impact on smoking. As the finding of the association between dental caries experience in non-smoking adolescence and smoking in adulthood is new, it is recommended to attempt to reproduce such a finding in another population. The same recommendation goes to the findings of the association between self-esteem and smoking behavior. Possibly the use of another measure on the self-esteem and different population might produce interesting results. RSES (Rosenberg Self-esteem Scale) (Rosenberg 1965), the golden standard of self-esteem measurements is nowadays translated and validated to Finnish, Swedish and Finns and therefore it could be used in future studies. Regarding the brief intervention, with the present findings and existing literature, it can be said that further studies on the long-term effectiveness of single brief interventions are not needed. The scope should now be projected more towards the promising behavioral group-based cessation interventions (Fanshawe et al. 2017) and behavioral incentive interventions (Corepal et al. 2018).

9 Conclusions

The following conclusions can be drawn from the results:

1. The smoking behavior of a close friend in adolescence or adulthood is significantly associated with the subject's own smoking behavior in adulthood. The association is greater than the impact of smoking family members.
2. Tooth decay in a non-smoking adolescent could predict smoking in adulthood.
3. Problems with self-esteem in adolescence could predict the initiation of smoking.
4. Annual brief tobacco interventions performed at routine oral health care in adolescence are not effective in the long term.

Based on the results the following is recommended:

1. Smoking prevention programs should place specific emphasis on the peer pressure and family influence on the smoking behavior.
2. Anti-smoking strategies should be directed to those adolescents with poor oral health and they should be pointed out as a group that may be prone to start smoking.
3. Intervention studies are needed to see how adolescents with self-esteem issues benefit from anti-smoking interventions.
4. The use of brief interventions in oral health care to prevent the onset of smoking during adolescence is discouraged.

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11 Appendices

Appendix A: Back-translation of LAWSEQ (from Finnish to English). Options for response were Yes/I don't know/No.

1. Are there many things you would like to change about yourself?
2. Do you think your school friends often talk ill of you?
3. Do others often think you are lying?
4. Do your parents usually want to hear your thoughts?
5. Do you usually feel yourself stupid when talking with your parents?
6. Do you often find it difficult to address your teacher?
7. If there is something that you need to tell your teacher, do you usually feel yourself stupid?
8. Do other pupils often run into conflicts with you?
9. Do you often feel yourself lonely at school?
10. Do you often need to find new friends because your old friends are with someone else?

Appendix B: The follow-up questionnaire (translated from Finnish to English).

The questions begin here. Mark a cross at the option that fits best with your situation.

1 Your marital status?

- | | | | |
|--------------------------|--------------|--------------------------|-------------------------------|
| <input type="checkbox"/> | 1 single | <input type="checkbox"/> | 4 remarried |
| <input type="checkbox"/> | 2 cohabiting | <input type="checkbox"/> | 5 divorced or living separate |
| <input type="checkbox"/> | 3 married | <input type="checkbox"/> | 6 widow |

2 Level of your occupational education (please choose only one option)?

- | | |
|--------------------------|--|
| <input type="checkbox"/> | 1 no occupational education |
| <input type="checkbox"/> | 2 occupational course (at least 4 months) |
| <input type="checkbox"/> | 3 apprenticeship |
| <input type="checkbox"/> | 4 occupational school degree |
| <input type="checkbox"/> | 5 college degree |
| <input type="checkbox"/> | 6 academic or higher college degree (university or university of applied sciences) |

3 What do you mainly do for living? Are you

- | | | | |
|--------------------------|---------------------|--------------------------|----------------------------------|
| <input type="checkbox"/> | 1 in full time job | <input type="checkbox"/> | 6 housewife or -dad |
| <input type="checkbox"/> | 2 working part time | <input type="checkbox"/> | 7 on retirement by age |
| <input type="checkbox"/> | 3 unemployed | <input type="checkbox"/> | 8 on retirement by other reasons |
| <input type="checkbox"/> | 4 in furlough | <input type="checkbox"/> | 9 something else |
| <input type="checkbox"/> | 5 a student | | |

5 Do you smoke?

- | | | | | | |
|--------------------------|------|--------------------------|-------|--------------------------|----------------|
| <input type="checkbox"/> | 1 no | <input type="checkbox"/> | 2 yes | <input type="checkbox"/> | 3 I don't know |
|--------------------------|------|--------------------------|-------|--------------------------|----------------|

6 Does your close friend smoke?

- | | | | | | |
|--------------------------|------|--------------------------|-------|--------------------------|----------------|
| <input type="checkbox"/> | 1 no | <input type="checkbox"/> | 2 yes | <input type="checkbox"/> | 3 I don't know |
|--------------------------|------|--------------------------|-------|--------------------------|----------------|

7 When you were of school age, did you mother smoke?

- | | | | | | |
|--------------------------|------|--------------------------|-------|--------------------------|----------------|
| <input type="checkbox"/> | 1 no | <input type="checkbox"/> | 2 yes | <input type="checkbox"/> | 3 I don't know |
|--------------------------|------|--------------------------|-------|--------------------------|----------------|

8 When you were of school age, did you father smoke?

- | | | | | | |
|--------------------------|------|--------------------------|-------|--------------------------|----------------|
| <input type="checkbox"/> | 1 no | <input type="checkbox"/> | 2 yes | <input type="checkbox"/> | 3 I don't know |
|--------------------------|------|--------------------------|-------|--------------------------|----------------|

9 When you were of school age, did you brother smoke?

1 no

2 yes

3 I don't know

10 When you were of school age, did you sister smoke?

1 no

2 yes

3 I don't know

11 When you were of school age, did you close friend smoke?

1 no

2 yes

3 I don't know

12 During your lifetime have you smoked more than 5 packs of cigarettes or cigars or smoked at least the equivalent amount of loose or pipe tobacco?

1 yes

2 no; please move to question 19

13 Do you smoke or have you smoked tobacco products regularly, in other words daily or nearly daily?

1 yes

2 no; please move to question 19

14 How old were you when you started smoking cigarettes, cigars or pipe regularly?

___ - years old

15 Do you still smoke cigarettes, cigars or pipe regularly?

1 no

2 yes; please move to question 18

16 How old were you when you quitted smoking?

___ - years old

17 How many cigarettes did you smoke daily on average before you quitted?

If you smoked pipe or cigars, choose you estimate on the equivalent amount of cigarettes.

1 1–10 cigarettes; please move to question 19

2 11–20 cigarettes; please move to question 19

3 more than 21 cigarettes; please move to question 19

18 How many cigarettes do you currently smoke daily? If you smoked pipe or cigars, choose you estimate on the equivalent amount of cigarettes.

- 1 1–10 cigarettes
- 2 11–20 cigarettes
- 3 more than 20 cigarettes

19 Has a physician ever diagnosed you having asthma?

- 1 no
- 2 yes

20 During the last year have you had more than 3 times a respiratory infection, like sinusitis, otitis or bronchitis?

- 1 no
- 2 yes

21 How do you perceive your overall health?

- 1 very good
- 2 good
- 3 average
- 4 poor
- 5 very poor
- 6 I don't know

The questions end here. Thank you for your responses! Please return this form and your signed consent form in the attached envelope that's post costs have been paid beforehand.