CHAPTER 1

General introduction
Smoking is the world’s leading avoidable cause of mortality and kills 6 million people each year. The high fatality of smoking is due to its strong carcinogenic effects, and its negative impact on the cardiovascular and respiratory systems\(^1\). About half of all of those who initiate smoking die of the consequences\(^2\) and smokers die on average about 10 years younger than lifelong non-smokers\(^3\). In the European Union, 23% of adults were current smokers in 2012\(^4\). Europe has one of the highest proportions of deaths attributable to tobacco compared to the rest of the world. 16% of all deaths in adults over 30 in Europe were due to tobacco. This is much higher than in the African or the Eastern Mediterranean Regions, with 3% and 7% tobacco-attributable deaths, respectively, and higher than the global average of 12\(^5\%).

### SOCIAL PATTERNING OF SMOKING THROUGHOUT HISTORY

The high burden of smoking on population health is not equally distributed throughout society\(^6\). Those of lower socioeconomic status (SES) seem consistently more likely to initiate smoking and less likely to quit smoking\(^7\). This causes large inequalities in smoking which find their origins in adolescence and increase over time into adulthood\(^8\). These smoking inequalities translate into large inequalities in smoking-related and all-cause mortality\(^9-11\).

While inequalities in smoking between higher and lower classes in developed countries are large today, tobacco smoking was not always concentrated amongst the lower class\(^12\). In fact, tobacco was a luxury product and hence was only affordable for the elite. The shift towards the working class took place mostly in the 20\(^{th}\) century\(^13\).

The tobacco plant was originally found in the American continents where it had been used as a medicinal plant and in rituals for centuries. With the discovery of “the new world” at the end of the 16\(^{th}\) century, new plants and their uses were discovered. Tea and coffee were among the less harmful, while opium and tobacco turned out to bring nothing but trouble to the homelands of the explorers. Although it is believed that tobacco had been used at a smaller scale in Columbus’ time\(^14\), tobacco started becoming popular in Europe from the time Jean Nicot brought tobacco to France in 1559\(^13\). From France it spread to Great Britain and other parts of Europe\(^13\). Tobacco was then smoked by the elite in the form of cigars or in pipes. Inequalities in smoking were large, but were opposite of what they are today: smokers were mostly from the higher class, while in the lower class there were few smokers.
Cigarettes started making their entrance as a cheap alternative to cigars in the 19th century, when scraps of tobacco from cigar production were rolled into paper. The commercial production of cigarettes exponentially increased at the beginning of the 20th century, with cigarettes being manufactured by machines. Cigarettes were getting very popular for multiple reasons: they were affordable, available to the general public, and highly addictive (due to flue-curing the tobacco smoke became inhalable). Moreover, the invention of modern matches made cigarettes easy to use. The combination of these factors made cigarettes an easily accessible and highly desirable product. This was reinforced by the tobacco industry’s tactic of providing cigarettes to national armies during the First World War, which caused almost all young men in obligatory military service to take up smoking. The tobacco industry lived its glory days around the 1950s, roaming freely in the realms of marketing and retail. Smoking became so affordable during the 20th century, and the economic circumstances were so good in Europe that smoking moved from an elite hobby to an addiction of the masses. Because smoking became very common in the higher as well as the lower class, socioeconomic inequalities in smoking were small or non-existent.

From the very beginning of the introduction of tobacco to Europe, there have always been those who were opposed to smoking, because of the smell, and the suspected adverse health effects. During the second half of the 20th century the realisation of the adverse effects of smoking grew stronger and discoveries on tobacco’s health effects started being accepted by the public. Even though it is difficult to time-stamp the moment when smoking was considered indisputably bad for health, studies by Richard Doll provided convincing epidemiological evidence in the 1950s that smoking could cause serious health damage. The 1964 publication by Doll and Hill established strong associations of smoking with multiple causes of mortality, among which lung cancer. Ever since there has been a steady long-term decline in smoking prevalence. However, during this period socioeconomic inequalities in smoking came into existence. Higher SES groups were more likely to stop smoking and less likely to take up smoking. The social norm toward smoking became more negative, but at a faster rate in high SES than in low SES groups. As a consequence smoking rates decreased at a faster rate in high SES than in low SES groups, and inequalities widened over time.

In the 21st century adults with a low educational level, income or occupational status are more likely to be smokers than their high SES counterparts. Also, parents with a low educational level, income or occupational status more often have children who smoke than high SES parents. Figure 1.1 presents an overview of smoking inequalities by different SES measures in adults and
adolescents in Europe. Adult inequalities in smoking are fairly well described and appear to be consistent across SES indicators\textsuperscript{24}. Studies support that educational level is a useful indicator for socioeconomic inequalities in smoking, but that other SES indicators should also be taken into account\textsuperscript{25-28}. In adolescents smoking inequalities are less consistent across different SES indicators. The adolescent’s educational track, i.e. the difficulty level of the curriculum that the adolescent is enrolled in, seems highly predictive of smoking\textsuperscript{8,29}. However, according to the family affluence, i.e. the material wealth of a family, differences are very small\textsuperscript{30}.

The results on adolescents in Figure 1.1 are retrieved from various European studies and are not directly comparable, as the age of study populations, year of the study and the selection of countries differ between studies. Adolescent SES is traditionally measured by characteristics of the parents or the family\textsuperscript{31}, but recently more studies focus on characteristics of the adolescent to measure SES\textsuperscript{29,32}. It is not clear if family and adolescent indicators of SES can both be used to measure smoking inequalities in various European settings. Moreover, the role of the residential area in smoking initiation is understudied\textsuperscript{33,34}. More research is needed to clarify how large inequalities are in different countries and which indicators are best used to measure smoking inequalities in adolescents in Europe.

\textbf{Figure 1.1:} Smoking rates in Europe in high and low SES adults\textsuperscript{24} and adolescents\textsuperscript{30,35,36}, according to different SES indicators. Adolescent smoking rates are presented according to the education and occupation of parents.
WHY ARE LOW SES INDIVIDUALS MORE LIKELY TO START SMOKING?

The initiation of smoking occurs in the majority of cases in adolescence\textsuperscript{37-39}, the years roughly between 10 and 20 years old, in which puberty occurs. Adolescence is a time during which humans develop their personality, social status, and individuality\textsuperscript{40}, but also the period in which the brain is more responsive to addictive substances and not yet fully capable of risk-perception and regulating dangerous behaviour\textsuperscript{41,42}. Adolescence is therefore a vulnerable period in which smoking and other unbefitting behaviour can easily be adopted. Previous studies found that individuals with a lower socioeconomic status are more likely to initiate smoking and smoking inequalities do not decrease over time\textsuperscript{30,36}. Understanding why individuals of low SES are more likely to initiate smoking is not only important for science, but may also have important implications for developing successful tobacco control policies and interventions aimed at reducing inequalities in smoking.

Social factors, such as peer smoking, parental smoking and attitudes and norms of others toward smoking are important in smoking uptake\textsuperscript{43,44}. Especially the influence of peers on adolescent smoking behaviour has been a much discussed topic for the past decades\textsuperscript{44-48}. Smoking behaviour of others is very predictive of smoking due to modelling after other people’s smoking behaviour or smoking norms as part of socialisation processes\textsuperscript{45,46} and due to selection of peers with similar norms, attitudes and behaviours\textsuperscript{45}. The role of parents is also acknowledged, as they could buffer the effects of peer influence by setting a non-smoking role model\textsuperscript{49} and by adopting parenting practices that may prevent smoking\textsuperscript{45,50}. Parents also play a role in becoming a smoker through the transfer of genetic factors, which make some adolescents more sensitive to addiction and more likely to become a regular smoker\textsuperscript{51,52}. Genetics and environmental factors are also important in shaping the personality of adolescents and their susceptibility of smoking\textsuperscript{51}. Individuals differ in their mental health\textsuperscript{53}, cognitive ability\textsuperscript{54}, self-control\textsuperscript{55}, and other personal characteristics which make adolescents more or less likely to initiate smoking.

It is plausible and often suggested that due to the socioeconomic inequalities in smoking among adolescents\textsuperscript{50}, young people of low SES are more likely to imitate their peers’ behaviour, who are likely to have a low SES themselves\textsuperscript{47,56-58}. However, this does not fully explain the higher smoking rates in low SES, as it does not explain why those peers had started smoking\textsuperscript{59}. Perceptions of smoking behaviour among peers may differ between low and high SES, resulting in differences in norm perception and consequently higher smoking rates\textsuperscript{60-62}. 
Influence of the parents may be considered separately from peers, as parents have been in adolescents’ lives throughout their lifespan. Higher smoking rates, a more accepting norm, and a lower level of social support in parents of low SES adolescents may explain part of the inequalities in adolescent smoking\textsuperscript{63,64}. Some specific anti-smoking parenting strategies have been found to prevent smoking among adolescents\textsuperscript{65-69}. However, evidence for the role of parenting practices in educational inequalities in smoking is scare and mixed\textsuperscript{70,71}.

Smoking inequalities may also be caused by individual characteristics that differ between SES groups. Examples are future orientation\textsuperscript{59,63,72-74}, stress\textsuperscript{59,64,73}, mental well-being\textsuperscript{59}, or rebelliousness\textsuperscript{59}. These characteristics can develop during adolescence. However, individual intrinsic factors such as cognitive ability and self-control, are likely to develop early in childhood\textsuperscript{75,76}, and can teach us more about whether smoking inequalities are a result of factors that developed before adolescence. The level of cognitive ability may be important\textsuperscript{73} to enhance the understanding of the harms of smoking and to act on this knowledge\textsuperscript{63,72-74}. Furthermore, the level of self-control may be important, as self-control can prevent adolescents from taking up smoking and achieving poor results in school\textsuperscript{64,72,73}.

A better understanding of why adolescents of lower socioeconomic strata initiate smoking is important to inform equity-oriented policies. Current evidence is highly fragmentary, and a stronger evidence base would add to the information needed for the development of effective prevention of smoking uptake in young people of low SES groups.

**THE PREVENTION OF SMOKING: TOBACCO CONTROL POLICIES IN EUROPE**

Since the irrefutable establishment of the dangers of smoking to health in the 1960s, governments have slowly started taking action against smoking\textsuperscript{77}. In the beginning, the strong tactics ran by the tobacco industry delayed the introduction of tobacco control policies\textsuperscript{78}. In Europe, pioneers in tobacco control were the UK and Finland, as these were among the first to introduce tobacco control policies in the 1970s\textsuperscript{77}. However, much of the action in Europe to counteract smoking and the tobacco industry started much later, in the late 1980s. Steeper increases in the price of cigarette through taxes are observed in most European countries from the 1980s onward, although some countries did not substantially increase prices until the 1990s\textsuperscript{77}. Tobacco control policies that were introduced in an early stage were advertising bans, which were mostly focused on banning television and radio advertising\textsuperscript{77}. In many European countries, bans on print media
and outdoor advertisement followed in a later stage. Health education and mass media campaigns were introduced, and, often much later, public places became smoke-free.

The World Health Organization (WHO) made a serious effort to control tobacco worldwide by introducing various Action Plans for a Smoke-Free Europe. The first Action Plan was established in 1987 and the second and third Action Plans would follow in 1993 and 1997, respectively. In response, various nations adopted higher tax increases on tobacco, restrictions on tobacco advertisements, an age limit for the sales of tobacco to minors, and small health warnings on tobacco products.

In 2003, the WHO made a unique step forward that had not before been seen in public health: a treaty on tobacco control. The Framework Convention of Tobacco Control (FCTC) is a legally binding agreement between countries to introduce cost-effective tobacco control policies. The FCTC came into force in 2005. As a result, many countries introduced stricter advertisement bans, smoke-free policies, higher age-limits for the sales of tobacco, public smoking cessation services, larger and health warnings and various laws to regulate the properties of tobacco and its packaging.

As a result to national tobacco control and the increasingly negative norm toward tobacco and smoking, schools joined the fight against youth smoking. Many schools have introduced various health programmes including smoking prevention, and have introduced smoke-free areas in and around the school to discourage adolescent smoking.

The development and success of tobacco control policies have been driven by public support and by the political will, but is also very dependent of individuals who are committed to advocacy for tobacco control policies. Scientific evidence is an important tool for tobacco control advocacy and more evidence on the effectiveness is therefore crucial in the progression of tobacco control policies in Europe.

Tobacco control policies are introduced in countries or regions, making all of its inhabitants exposed to these policies. However, equality in exposure does not always lead to equality in effects. A number of studies have demonstrated that tobacco control policies can have smaller or larger effects in low SES groups than high SES groups. In adults, taxation may have stronger effects in low SES individuals, while smoke-free policies may have weaker effects in low SES individuals. Studies on other tobacco control policies such as mass-media campaigns and advertisement bans show more mixed results, and are considered to have a neutral effect on smoking inequalities. In adolescents, there are far fewer studies than in adults, and
results are less clear. However, the same pattern as in adults seems apparent: in low SES adolescents stronger effects of taxation were found and weaker effects of smoke-free policies, while other policies mostly had equal effects among high and low SES adolescents\textsuperscript{84}.

Taxation of tobacco is to date the only tobacco control measure with supportive evidence of an equity positive effect. However, simply increasing the price of tobacco tenfold might have a large adverse impact: it would disproportionally affect low SES smokers who are unable to successfully quit, might magnify income inequalities and might cause or aggravate poverty due to high spending on tobacco\textsuperscript{85,86}. Moreover, there is a lack of evidence on the equity impact of many other tobacco control policies, especially in adolescents\textsuperscript{83,84}. Furthermore, it is unclear whether comprehensive policy packages have a different equity impact than single policies. It has been suggested that policy packages are more effective at reducing smoking rates\textsuperscript{87}, but it is unclear how inequalities in smoking are affected by comprehensive packages versus single policies.

It is important to gather more evidence on the equity impact of various new or less studied policies. Especially in adolescents, there is a lack of evidence on the equity impact of many tobacco control policies. Information on the equity effects can be important in predicting the equity impact of new tobacco control policies and can help in the development of tobacco control policies that are more effective in reducing smoking inequalities than current policies.

AIMS OF THIS THESIS

The overall aim of this thesis is to assess socioeconomic inequalities in smoking in Europe and the effects of tobacco control policies on smoking and smoking inequalities.

Two specific aims are addressed:

1. To quantify socioeconomic inequalities in smoking and assess the contribution of a few specific mechanisms through which socioeconomic status might affect smoking initiation
2. To evaluate the impact of tobacco control policies on smoking rates in national populations and their impact on socioeconomic inequalities in smoking
OUTLINE OF THIS THESIS

This thesis consists of two parts which were carried out in parallel.

Part I Describing and understanding socioeconomic inequalities in smoking

Part I consists of chapters 2 to 6 and aims at quantifying socioeconomic inequalities and assessing the contribution of a few specific mechanisms through which socioeconomic status may affect smoking initiation.

Chapter 2 studies the magnitude of socioeconomic inequalities in adolescent smoking using various family and adolescent SES indicators and compares these between six European countries. Chapter 3 investigates the association between socioeconomic characteristics of the residential area and smoking initiation, continuation and cessation in the Netherlands. In Chapter 4 the association between the socioeconomic status and smoking-specific parenting strategies is described. Chapter 5 describes the perceived school smoking prevalence and its school-level and individual-level determinants for high and low socioeconomic groups. Chapter 6 studies the role of cognitive ability and self-control in forming inequalities in adolescent smoking and drinking behaviour.

Part II Evaluating tobacco control policies and their equity impact

Part II consists of chapters 7 to 11 and aims at evaluating the impact of tobacco control policies on smoking rates in national populations and their impact on smoking and socioeconomic inequalities in smoking.

Chapters 7 and 8 study the impact of tobacco control policy packages on adolescent smoking. Chapter 7 studies the equity impact of a comprehensive tobacco control policy package implemented in 2003 in the Netherlands, and studies whether there were changes in national trends before and after the introduction of this tobacco control policy package. Chapter 8 investigates the association between national tobacco control policies, measured with the Tobacco Control Scale, and smoking behaviour among 15 and 16-year-olds in 13 European countries. Chapter 7 and 8 additionally report on socioeconomic inequalities in the observed impacts.

Chapters 9, 10 and 11 focus on the evaluation of specific tobacco control policies. In Chapter 9 we investigate the association between the strength of school smoking policies and individual smoking behaviours. Chapter 10 studies the impact of the partial tobacco point of sale display ban, introduced in England in April 2012, on smoking behaviour in the general
population. Chapter 11 evaluates the impact of a minimum age of tobacco sales in 19 European countries. We tested the change in smoking behaviour of 15 and 16-year-old adolescents in countries that introduced minimum age laws after 2007 compared to countries that had introduced these laws before 2004. Chapters 9, 10 and 11 additionally report on socioeconomic inequalities in the observed impacts.

Finally, Chapter 12 gives a systematic discussion of why tobacco control policies can have an impact on inequalities in adolescent smoking. For this, we start with an overview of mechanisms that underlie inequalities in smoking and we evaluate how policies may act upon such mechanisms. We conclude with formulating implications and recommendations for future tobacco control policies and smoking research.

DATA SOURCES AND STUDY DESIGNS

Table 1.1 describes the data sources and study designs that are used in each chapter. In total, seven data sources are utilised, of which two are acquired during the PhD project.

Part I Describing and understanding socioeconomic inequalities in smoking

Data sources

Three national data sources are used in Part I, which all refer to the Netherlands. Chapter 3 is based on the Dutch POLS data, a repeated cross-sectional annual national household survey on health, health behaviour and living circumstances of the general population. Chapter 4 is based on cross-sectional data that we acquired during the project in a school in Haarlem, the Netherlands. Chapter 6 is based on cross-sectional data on health behaviour and cognitive function among adolescents in 7 different cities in the Netherlands. The data were acquired by students from the University of Twente.

Chapters 2 and 5 are based on the cross-sectional international SILNE survey. The European SILNE project aimed to generate new empirical evidence on the effectiveness of strategies to reduce socioeconomic inequalities in smoking. The project was a collaboration of 12 European universities and included researchers from different disciplines. One of the work packages focused on smoking initiation by young people in six countries. Within this work package an international survey in six European cities was conducted. Fifty schools participated in the survey, yielding
11,000 student respondents.

**Study designs**

All chapters in part I have a cross-sectional design. Chapter 3 pools multiple years of data, while data in chapters 2 and 4 to 6 are measured at one point in time. Chapters 3, 4 and 6 only compare data at the individual-level. Chapters 2 and 5 additionally compare data at the school-level, using the variability in school smoking policies and smoking prevalence rates between schools and countries in a cross-national design.

**Part II Evaluating tobacco control policies and their equity impact**

**Data sources**

In Part II, two national repeated cross-sectional data sources are used, from the Netherlands and England, respectively. In Chapter 7, we use the Dutch Youth Smoking Monitor, which was an annually repeated cross-sectional national survey on the smoking behaviour of young people in the Netherlands. Chapter 10 utilises data from the Smoking Toolkit Study, which is a national monthly repeated cross-sectional survey on the smoking behaviour of representative samples of the general population of England.

Three Chapters are based on international data. Chapter 9 uses the previously described SILNE survey. Chapters 8 and 11 are based on international repeated cross-sectional data from the European Survey Project on Alcohol and other Drugs (ESPAD). ESPAD is a large international project that surveys a sample of approximately 2000 adolescents every four years in over 30 European countries. Chapter 8 and 11 use the data of, respectively, 13 and 19 countries.

**Study designs**

Evaluations of the equity impact of policies are important for informing tobacco control policies that aim at reducing smoking inequalities. This applies especially to new and less well studied tobacco control policies. In evaluation studies, the randomised controlled trial (RCT) may be the golden standard method, as it allows comparing changes over time between groups that have potentially identical characteristics. However, because many policies aim at changes at the national level, and thus apply to a large group of people, the evaluation of policies in RCTs is practically unfeasible, or even unethical. Moreover, results from RCTs in a small subsample are not always applicable to the general population. For these reasons, natural experiments may be considered as a potential alternative to RCTs in policy...
A natural experiment study observes the implementation of policies or interventions by measuring either differences between groups or countries (cross-national design), trends over time (time-series design), or trends over time in contrasting groups (quasi-experimental design). In cross-national studies, differences in policies between settings can be associated with differences in the outcome of interest at the same point in time. Cross-national designs have been applied in chapters 8 and 9. Time-series analyses compare trends before and after the implementation of policies and analyse whether trends or levels of smoking prevalence rates have changed after implementation. Time-series designs have been applied in chapters 7 and 10. Quasi-experimental studies combine these two techniques by comparing changes over time (before and after implementation), between different countries or between other settings. The countries or other settings are divided into intervention and control settings, such that the policy of interest has been implemented during the study period in the former group, but not in the latter. Such a quasi-experimental design was utilised in Chapter 11.
Table 1.1: Overview of data sources, designs and geographic coverage in each chapter.

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<th>Chapter</th>
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<td>Youth Smoking Monitor</td>
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<td>19 European countries</td>
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Note: Data of the SILNE survey and the local survey in Haarlem were acquired during the PhD project.
REFERENCES

33. Shohaimi S, Luben R, Wareham N, Day N, Bingham S, Welch A, Oakes S, Khaw KT. Residential area deprivation predicts smoking habit independently of individual educational level and occupational social class. A cross sectional study in the Norfolk cohort of


63. Pampel FC, Mollborn S, Lawrence EM. Life course transitions in early adulthood and SES disparities in tobacco use. *Social Science Research* 2014;43:45-59.


74. Maralani V. Understanding the links between education and smoking. *Social Science Research* 2014;48:20-34.


