EXPLORING THE EDUCATION EFFECT ON TOBACCO USE:
EVIDENCES FROM EAST AND SOUTHEAST ASIA

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by

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ABSTRACT

Tobacco use has been extensively documented as a predominant cause of many lethal chronic diseases. While the number of smokers is still increasing worldwide, the regional disparities of this epidemic between developed and developing countries keep enlarging in recent decades, which shifts the major burden of anti-smoking campaigns to low- and middle-income countries. Education has a lasting significant effect on reducing individuals’ tobacco use. Consisting of three separate but substantially interrelated research papers, this dissertation examines the relationship between education and individuals’ smoking behaviors in China and 17 other East and Southeast Asian countries, most of which are underdeveloped and plagued severely by the tobacco epidemic.

The first paper investigates the association between educational attainment and individual tobacco consumption patterns across different age-cohorts in China. By analyzing cross-sectional data from the 2010 Global Adult Tobacco Survey (GATS) in China, I employ cohort-analysis and multivariate logistic regression to examine how educational attainment is related to two crucial indicators of individuals’ tobacco use: their current smoking status, and tobacco-related behavioral change. Then, structural equation modeling (SEM) technique is used to examine two underlying crucial pathways of such education-smoking relationship: individuals’ knowledge about tobacco use, and their attitudes toward smoking behaviors.

The second paper analyzes the causality in the education-smoking relationship in China. By using data from China Health and Nutrition Survey (CHNS), I employ two-
stage least square (2SLS) technique to draw the causal inference between educational attainment and individuals’ smoking behaviors. The first Compulsory Education Law in China enacted in early 1986 is used as the instrumental variable in this study.

The third paper extends the research scope from China to 17 East and Southeast Asian countries, investigating how adolescents’ smoking status is associated with the smoking-related factors in different social ecological environments they are frequently exposed to, including families, friends, schools, communities and societies. Multiple logistic regression technique is applied to analyze data from Global Youth Tobacco Survey (GYTS) in those 17 countries separately.

In sum, the results show that the negative relationship between educational attainment and tobacco use is robust and persistent in current China. Meanwhile, the strength of the education effect on individuals’ tobacco-related behavioral change is weaker in middle-age cohort than in both young and old cohorts. Individuals’ tobacco knowledge plays a more significant role in mediating the education effect than their attitude toward smoking, and there is no causality found in the sample in the relationship between people’s years of schooling and smoking behaviors in China. Cross-national analysis on the 17 East and Southeast Asian countries shows that the strongest predictors of adolescents’ smoking behaviors, including peer influence, lack of tobacco knowledge and the quality of health class, are all associated with health education in school. Therefore, improving anti-tobacco education or prevention programs in school could be an effective strategy to control the tobacco prevalence among adolescents in East and Southeast Asia. Furthermore, it is highly necessary to carry out strict anti-smoking laws and regulations to reduce the tobacco epidemic in such regions. More accurate
information and knowledge about tobacco use should also be dispersed to the population, especially how harmful smoking tobacco could be to human health.
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I wish my Ph.D. study had been a simple and smooth journey but it was not. When I look back to the past seven years at Penn State, pursuing a Ph.D. was more like a difficult expedition entangled with countless self-doubt and self-reflection, and a tough quest for the meaning of life and the identity of myself through daily reading, writing and researching. Life in State College, one of the most peaceful and beautiful towns I have lived in, was as still as a lake surface without a breeze. But my inner conflict never stopped escalating. Fortunately, when this dissertation was finished, I realized that the most precious treasures I had harvested from this life stage were not knowledge, theories or research methods, but the reaffirmed passions for academics, the habit of continuous self-improvement, the determination to embrace every possibility in the future, and the courage to fulfill my duties as a scholar, a husband, and a father. That’s how my Ph.D. period became a unique and irreplaceable trajectory in my life.

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Chapter One

Introduction

It could be traced back to prehistoric times when tobacco was insinuated into the life of mankind in the same way as food and tea (Musk & de Klerk, 2003). During the thousands of years of its history, tobacco has been widely spread to every corner of the world along with the voyages during the Age of Exploration from 15th to 17th century, and promoted for various religious, spiritual, martial and medical reasons in different regions in the world. In some cultures, it was even used as sacred gifts (Hughes, 2003; Norton, 2008). Today, the estimated number of smokers worldwide has reached one billion (World Health Organization, 2011). And a much larger amount of population, even if they are non-smokers, have to live and get affected under the dome of tobacco smoke.

However, it was not until the last several decades when the harm of tobacco use to population health has been overwhelmingly revealed by numerous medical sociological research (Doll, Peto, Boreham, & Sutherland, 2004; U.S. Department of Health and Human Services, 2014). Up to now, tobacco use has been identified as the predominant cause of many lethal chronic diseases, such as multiple types of cancers (Colditz, 1996; Ezzati, Henley, Lopez, & Thun, 2005; Giovannucci & Martinez, 1996; Lumey, 1996; U.S. Department of Health and Human Services, 2010), cardiovascular diseases (Ambrose & Barua, 2004; Glantz & Parmley, 1995), respiratory diseases (Akinbami & Liu, 2011; Bates et al., 2007), diabetes (Eliasson, 2003; Rimm, Chan, Stampfer, Colditz,
& Willett, 1995), and immune function and autoimmune diseases (Holt, 1987; Sopori, 2002). Similar medical evidences are still gradually accumulating on extended health outcomes such as eye disease (Thornton et al., 2005), dental disease (Ayo-Yusuf, Reddy, van Wyk, & van den Borne, 2007), bone disease (Law & Hackshaw, 1997), bowel disease (Loftus, 2004) and even more.

The health risk of tobacco use is borne beyond smokers themselves. It has been well known that the hazard of smoking could be transmitted maternally and interpersonally. Smoking behaviors of pregnant women have a significantly higher possibility to cause multiple adverse pregnancy outcomes than non-smokers (Walsh, 1994), including infant death (DiFranza & Lew, 1995; Högberg & Cnattingius, 2007). Their smoking habits are more likely to be passed to their offspring (Kandel, Griesler, & Schaffran, 2009). Also, being exposed to second-hand smoking can lead to various chronic diseases in the same way as smoking does, and contributes to mass deaths every year (Eisner et al., 2005; Trichopoulos, Kalandidi, Sparros, & Macmahon, 1981; Woodward & Laugesen, 2001). As Öberg et al. (2011) estimate, in 2004, 40 percent of children, 33 percent of male non-smokers, and 35 percent of female non-smokers from 192 countries were exposed to second-hand smoke. A more recent report by World Health Organization (WHO) also illustrates that nearly six million people are killed each year by tobacco use, including more than 600,000 non-smokers who die from second-hand smoking (World Health Organization, 2011). Globally, 12 percent of all deaths among adults aged 30 years and above could be attributed to tobacco (World Health Organization, 2012). If the current trends of smoking persist, more than 8 million people
will be killed by tobacco per year worldwide by the year 2030 (World Health Organization, 2009).

Besides the significant health risks imposed on individuals, tobacco use also brings tremendous financial burden to the society, which consists of health care costs, medical expenditures and productivity losses attributable to smoking-related morbidity, disability and premature mortality (Warner, Hodgson, & Carroll, 1999). For example, in 2000, the estimated economic burden of smoking-related health care costs reached 16.6 billion EURO in Germany (Ruff, Volmer, Nowak, & Meyer, 2000) and 5 billion dollars in China (Sung, Wang, Jin, Hu, & Jiang, 2006). In the United Kingdom, the estimated economic cost of smoking was 3.3 billion EURO in 2006-2007 (Scarborough et al., 2011). In the United States, smoking cost over 193 billion dollars in 2004 (Centers for Disease Control Prevention, 2008). Undoubtedly, such heavy financial burden has become more and more unaffordable, especially for those low- and middle-income underdeveloped countries.

But unfortunately, it is those low- and middle-income countries who are suffering most from this global tobacco epidemic. From the comparative perspective, it is notable that the regional disparities of tobacco use have significantly enlarged in recent decades. As the percentage of smokers steadily declines in different developed countries (Schiaffino et al., 2007; U.S. Department of Health and Human Services, 2014), the prevalence of tobacco use remains high and even increasing in developing countries (Musk & de Klerk, 2003), which largely reshapes the overall pattern of global tobacco consumption. Currently, nearly eighty percent of tobacco users in the world live in low- and middle-income countries (World Health Organization, May 2014), which should be
treated as another main battlefield of the anti-smoking war and given more research and policy attentions.

In particular, China is the most significant contributor to the tobacco prevalence. At present, one third of the world’s one billion smokers live in this country, and half billion of Chinese population are frequently exposed to second-hand smoking (World Health Organization, 2011). Such tobacco use accounts for 1.1 million deaths in China every year (World Health Organization, 2011), and the death toll is expected to reach 2 million per year by 2025 (Zhang, Ou, & Bai, 2011).

Undoubtedly, the tobacco epidemic and its severe consequences raise an emergent call for more effective anti-smoking campaigns and intervention programs by governments and health-related organizations in each country, especially in developing countries. For that purpose, it is highly necessary to systematically uncover the controllable influential factors that are related to or account for people’s smoking behaviors, based on which more targeted strategies could be implemented to cut down the odds of smoking initiation. Previous studies have extensively documented the significant effect of education on reducing people’s smoking-related behaviors and attitudes (Cavelaars et al., 2000; de Walque, 2007; L. G. Escobedo & Peddicord, 1996; Sander, 1995). Broadly speaking, those studies could be sorted into two main categories, discussing the role of education from different perspectives.

The first category focuses on how individuals’ educational attainments influence their smoking-related behaviors in later life stages, including smoking initiation (Luis G. Escobedo, Anda, Smith, Remington, & Mast, 1990), cessation (B. Federico, Costa, Ricciardi, & Kunst, 2009; Gilpin, Pierce, & Farkas, 1997), and relapse (Garvey, Bliss,
Hitchcock, Heinold, & Rosner, 1992). Meanwhile, those studies measure how such education effect is moderated or mediated by crucial demographic factors, such as gender (Gritz et al., 1998; M Huisman, A E Kunst, & J P Mackenbach, 2005), race (King, Polednak, Bendel, Vilsaint, & Nahata, 2004), ethnicity (King, Grizeau, Bendel, Dressen, & Delaronde, 1998), personal or family income (Martijn Huisman, Anton E Kunst, & Johan P Mackenbach, 2005; Laaksonen, Prättälä, Helsasoja, Uutela, & Lahelma, 2003), and residential location (King, Polednak, & Bendel, 1999). Though very few research shows that education has null effect on smoking (Tenn, Herman, & Wendling, 2010), the majority of empirical studies from all over the world have repeatedly confirmed that even after controlling for important individual-, family-, community- and nation-level demographic factors, people’s educational attainments still play crucial roles in reducing their tobacco consumption. Such education gradient is especially pronounced among younger cohorts (Legleye, Khlat, Beck, & Peretti-Watel, 2011).

However, highly divergent and even conflicting results emerge when researchers further measure the causality in the education-smoking relationship, and little agreement has been achieved among economists regarding the mechanisms through which schooling affect health (Leigh, 1983). While some studies support the existence of such causal inference (Fujiwara & Kawachi, 2009; Jürges, Reinhold, & Salm, 2011), some others, mainly from the perspective of health economics, find no such causal effect of education (Albouy & Lequien, 2009; Braakmann, 2011). Besides possible measurement errors and functional forms, it is often argued that some unobservable factors or mechanisms account for the education effect on tobacco use.
Based on the conflicting findings from the literature, some scholars try to distinguish the direct and indirect effects of education on population health, including smoking behaviors. Direct effect refers to, for example, pursuing better medical treatments, and indirect effect of education works through certain mediators, such as income and socioeconomic status at individual or familial level (Lynch, 2006), health knowledge and attitudes (de Walque, 2004; Lange, 2011), or cognitive skills (David P. Baker, Leon, & Collins, 2011).

The second category of studies on the education effect on tobacco use is more specific, intending to evaluate how certain anti-smoking strategies or intervention programs function in reducing the smoking prevalence (Agyemang et al., 2010), especially how within-school health education and prevention programs decrease the possibility of schoolchildren’s smoking (H. M. Alexander et al., 1983; Pentz et al., 1989; Stead & Stradling, 2010). After all, age of adolescents’ smoking initiation has been proved to be strongly related to the possibility of quitting smoking in adulthood (Khuder, Dayal, & Mutgi, 1999). When adolescent smoking keeps increasing in many developing countries (Al-Sadat, Misau, Zarihah, Maznah, & Tin Tin Su, 2010), it is an imperative task to design and carry out effective health education and anti-smoking programs at school to prevent children and adolescents from tobacco use.

Both categories of studies above have extensively enriched public understanding about the relationship between education and tobacco use as well as the effectiveness of anti-smoking efforts. More importantly, they provide valuable implications for policymakers to create more efficient and targeted smoking-free laws and policies to reduce tobacco consumption. But unfortunately, the majority of prior empirical studies
only concentrate on western developed countries. In regions that are plagued by the tobacco epidemic most, the Asian and African developing countries, empirical studies haven’t been adequately conducted, which essentially hinders the implementation of tobacco control strategies.

This dissertation intends to examine the education effect on tobacco use in East and Southeast Asia, with a special focus on China. As mentioned above, those countries suffer most from the global tobacco epidemic but haven’t been examined sufficiently. This dissertation consists of three separate but substantially interrelated research papers that all focus on the relationship between education and smoking behaviors in China and 17 other East and Southeast Asian countries. Though they investigate different research questions with different data sets and analytical strategies, all the three papers serve for one same purpose to further clarify the relationship between education and tobacco use in Asia.

The first paper “Education disparities in the tobacco epidemic in China” investigates the association between educational attainment and individual tobacco consumption patterns across different age-cohorts in China, the largest smoking country in the world. By analyzing cross-sectional data from the 2010 Global Adult Tobacco Survey (GATS) in China, I employ cohort-analysis and multivariate logistic regression to examine how educational attainment is related to two crucial indicators of individuals’ tobacco use: their current smoking status, and tobacco-related behavioral change. Three age-cohorts, young (aged 16 to 40), middle-age (aged 41 to 60) and old (aged 61 and above), are analyzed individually as well as the full sample. Then, structural equation modeling (SEM) technique is used to examine two underlying crucial pathways of such
education-smoking relationship: individuals’ knowledge about tobacco use, and their attitudes toward smoking behaviors.

This study is among the first to analyze the education-smoking relationship by different age-cohorts in China. In addition to educational attainment, age-cohort is among the most notable demographic factors that are related to smoking behaviors. After all, the popularity of certain epidemics often varies largely by times, prompted by certain cultures, traditions, and especially the insufficient knowledge of their adverse consequences. One well-illustrated example is the prevalence of HIV/AIDS in Sub-Saharan Africa before 1990s was higher among more educated individuals, instead of less educated ones (David P Baker, Collins, & Leon, 2008). Therefore, considering that the harm of tobacco use hadn’t been well known until several decades ago, it is reasonable to assume that the relationship between education and tobacco use varies by age-cohorts, as shown in some research (Lynch, 2006).

On the basis of the findings in the first paper, the second paper takes one step further, analyzing the causality in the education-smoking relationship in China. My second paper “The causal effect of education on tobacco use: Evidence from China” attempts to test whether educational attainment casts a causal effect on adults’ tobacco use in this country. Previous studies on the education-health relationship often suffer from bias caused by endogenous problems, since some unobservable individual characteristics may influence both their educational attainments and health-related behaviors simultaneously. One commonly employed strategy to eliminate such endogenous bias is two-stage least square (2SLS) technique, by introducing some instrumental variable to replace the independent variable with potential endogenous bias.
In line with previous literature, I use data from China Health and Nutrition Survey (CHNS) in this study, and employ the same 2SLS technique to draw the causal inference between educational attainment and smoking behaviors.

The instrumental variable applied in this study is the first Compulsory Education Law in China enacted in early 1986, which requires all school-age children (seven years old and above) in the country must receive nine years’ free and compulsory education in school (generally six years in primary school and three years in junior high school), and therefore significantly increases the average years of schooling of Chinese population ever since then. Given the fact that the law only binds the students who got enrolled in 1986-1987 academic year and after, in this study, whether children entered primary school before or after the 1986-1987 academic year, in other words, whether they were influenced by the new Compulsory Education Law or not, could be used as the instrumental variable to replace the independent variable of years of schooling and then eliminate the endogenous bias.

This second study is able to add more empirical evidence to the current discussion on the causality in the education-smoking relationship. Though similar research has been conducted with the same 2SLS technique in many developed countries, such as the United States (de Walque, 2007; Grimard & Parent, 2007), England and the United Kingdom (Braakmann, 2011; Silles, 2009), Danish (Arendt, 2005), Sweden (Spasojevic, 2010) and West Germany (Jürges et al., 2011; Kemptner, Jürges, & Reinhold, 2011; Reinhold & Jürges, 2010), it hasn’t been really conducted in China, the largest battlefield for this global anti-smoking war.
The title of my third paper is “Making anti-smoking interventions work better for adolescents: Evidence of influential factors and implications from 17 Asian countries.” In this paper, I extend the research scope from China to 17 East and Southeast Asian countries, examining how adolescents’ smoking status is associated with the smoking-related factors in different social ecological environments they are frequently exposed to, including families, friends, schools, communities and societies. Furthermore, I provide a detailed discussion about the similarities and differences in the influential patterns across the 17 countries, and how promoting anti-tobacco education in school could substantially help reduce the smoking prevalence among Asian adolescents.

These 17 countries are worth studying for several reasons. First, in contrast with many developed countries where the smoking prevalence has gradually dropped, the ratio of smokers in those developing countries still increases (Al-Sadat et al., 2010; Nichter et al., 2010; Ntiribi, Kolawole, & McCurdy, 2009), especially among adolescents (Patton et al., 2010). Reducing adolescent smoking therefore becomes a crucial action to control smoking prevalence in the future.

Second, the tobacco market in those countries is often fragmented and highly unregulated. Compared with developed countries where only certain types or brands of cigarettes are accessible, popular tobacco products that are available in East and Southeast Asia include cigarettes, cigars, cigarillos, little cigars, snuff, pipes, water pipe, bidi, cheroots, dipping tobacco, smokeless tobacco, chewing tobacco, and so on. Especially in South Asia, in almost every country there are certain types of cheap, popular local tobacco products or substitutes, many of which are even planted and made by smokers themselves. The diversity of tobacco products and their sources adds more
difficulties to implementing effective laws and regulations on tobacco sales and consumption.

Third, the governmental powers in those developing countries often lack the will, financial budget and resources to carry out strict anti-smoking policies or campaigns. Therefore, the dilemma between expanding smoking population and limited resources calls for more cost-effective intervention strategies, with the emphasis on the most influential local factors and the focus on children and adolescents. In this study, I use data from the Global Youth Tobacco Survey (GYTS), and 17 participating East and Southeast countries with a nationally representative sample in the last decade are included: Bangladesh (2007), Bhutan (2009), Cambodia (2010), East Timor (2009), India (2009), Indonesia (2009), South Korea (2008), Lao (2011), Malaysia (2009), Maldives (2011), Mongolia (2007), Myanmar (2011), Nepal (2011), Philippines (2011), Sri Lanka (2011), Thailand (2009), and Vietnam (2007). With the sample size in each ranging from 1,500 to 15,000, those countries provide a broad scope of economic, political and cultural variances to examine the correlation between adolescents’ smoking status and influential factors in different social ecological environments.

As introduced above, there are two streams of the research on education effect on tobacco use, analyzing educational attainment and health-related educational programs separately. While my first two papers focus on the former stream, the third one switches to the latter, discussing how schools, as the institutions children and adolescents are most frequently exposed to in Asia, could contribute to eliminating the rising epidemic of adolescent smoking by promoting health education and imparting more tobacco-related knowledge. Furthermore, by comparing the similarities and differences in the influential
patterns across countries, it could be concluded how adolescents’ smoking behaviors are possibly moderated by regional characteristics.

Summing up, though the three papers investigate different research questions and are conducted from different perspectives, they carry out the same mission of deepening the understanding of the role education plays, or should play, in reducing the tobacco prevalence in East and Southeast Asia. Generally speaking, education is able to influence and reduce tobacco use in two different ways. One more indirect way is through education attainment, and the other more direct way is through health education or prevention programs. In this dissertation, the first two papers examine the effect of educational attainment, showing whether and how it is related to adults’ smoking behaviors, and whether such relationship could be regarded as causal. The third paper, on the other side, implies the importance of health education in school on adolescents’ smoking behaviors. By combining the three papers together, this dissertation can draw a full and clear picture about the relationship between education and tobacco use in China and 17 other East and Southeast Asian countries, including the causality of the relationship, the underlying influential mechanisms, and the cross-national similarities and differences. Such findings could shed light on the implementation of more effective anti-smoking policies.

This dissertation could make contributions in three major aspects. First, it deeply evaluates the education effect on tobacco use of both adults and adolescents in different Asian societies, which have not been given sufficient research attentions before. Therefore, the findings can enrich the literature on the complex relationship between education and tobacco use, as supplement to the findings in western countries. Second, it
provides a broad cross-national comparison, by which more influential factors at country level could be discovered and discussed. Third, by providing useful policy suggestions, this dissertation can help the public health policymakers in Asian developing countries to reconsider and promote their smoking-control policies and strategies for both adults and adolescents.
Chapter Two

Education disparities in the tobacco epidemic in China

Introduction

As tobacco use in high-income countries continues to steadily decline (Schiaffino et al., 2007; U.S. Department of Health and Human Services, 2014), smoking prevalence in low- and middle-income countries has increased (Musk & de Klerk, 2003; Oncken et al., 2010), redistributing the health burden associated with smoking-related disease worldwide (Li et al., 2010; Ortiz & Cummins, 2011). China is the largest contributor to the global tobacco epidemic with one third of the world’s one billion smokers, who regularly expose an additional half billion Chinese to second-hand smoke (World Health Organization, 2011). Tobacco-related mortality and morbidity have increased sharply in this country in recent decades with an estimated 1.1 million deaths each year (World Health Organization, 2011). Although this health crisis in China has been recognized both nationally and internationally, social epidemiological analyses of tobacco use in the country are still highly underdeveloped.

Research from other countries suggests that formal education decreases smoking behaviors (de Walque, 2004; Johnson et al., 2011; Kandel et al., 2009; G. X. Ma, Shive, Tan, & Toubbeh, 2002), and people with higher educational levels are less likely to ever use tobacco (Luis G. Escobedo et al., 1990; L. G. Escobedo & Peddicord, 1996; Jürges et al., 2011), or smoke on a regular basis (Grimard & Parent, 2007; Kestilä et al., 2006), and are more likely to reduce or quit smoking once they have initiated (B. Federico et al.,
2009; Giskes et al., 2005; Sander, 1995; Schaap et al., 2008; Schiaffino et al., 2007; Wetter et al., 2005; Wray, Herzog, Willis, & Wallace, 1998). The negative education gradient is especially pronounced among younger cohorts (Legleye et al., 2011).

Meanwhile, the dissemination of health information and the improvement of people’s attitudes have been found to be the crucial channels to pass the education effect (David P. Baker, Leon, & Collins, 2011; Cutler & Lleras-Muney, 2010; de Walque, 2004). In this study, I employ multivariate logistic regression techniques and structural equation modeling (SEM) to investigate the association between formal education and individual tobacco consumption patterns across different age-cohorts in China. The initial investigation examines how individuals’ educational attainment is associated with their likelihoods of being a regular smoker or changing their smoking-related behaviors. SEM is then applied to investigate the mechanisms in the relationship between education and individuals’ current smoking status by examining the mediating roles of tobacco knowledge and attitude. Three research hypotheses are examined: (1) individuals who have completed higher levels of education are less likely to smoke in China, (2) the education-smoking gradient differ by age-cohort, and (3) tobacco knowledge and individual attitude toward smoking mediate the relationship between education and tobacco use.

**Methods**

**Data and sample**
This study use data from 2010 Global Adult Tobacco Survey (GATS) in China. GATS China is a nationally representative household survey directed by the World Health Organization (WHO) and conducted by the Chinese Center for Disease Control and Prevention. 15,000 households from 100 counties or districts over total 28 provinces are randomly selected (G.-H. Yang et al., 2010). One individual aged 15 years and older is randomly chosen from each household to complete the survey through individual interview. The overall response rate is 96.0% and there are 13,354 interviewees in the data set. This study contrasts people who are most at risk with least at risk within the tobacco epidemic. Therefore, only regular daily smokers (n=3,500) and non-smokers (n=9,344) are included in the analysis. The analyzed sample size is 12,844.

Measures

Current smoking status and tobacco-related behavioral change

This study measures the dependent variable, tobacco use, in two ways: current smoking status and tobacco-related behavioral change. Current smoking status is measured as a dichotomous variable by the self-reported answer to the survey question, "Do you currently smoke tobacco on a daily basis, less than daily, or not at all?" If an individual answers he or she is a daily smoker, the case is coded as 1 (n=3,500). Non-smokers are coded as 0 (n=9,344) and other cases are excluded in order to compare daily smokers to non-smokers.

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1 Occasional smokers are omitted from the analysis also due to the small sample size across age-cohorts.
Tobacco-related behavioral change (mean=0.95) is examined in order to further investigate the effect of formal education on change of behaviors related to tobacco use overtime. I construct this variable based on a series of survey questions regarding interviewees’ previous and current smoking status and frequency, sorting it into four categories in ascending order: (1) smoking frequency remains unchanged overtime; (2) smoking frequency is reduced; (3) smoking is ceased; and (4) never smoke.

Educational attainment

As the key independent variable in this study, educational attainment is measured as participants’ highest level of education completed, and categorized into four groups: primary school completion and below (n=5,033, 37.7%), middle school completion (n=4,639, 34.8%), high school completion (n=2,244, 16.8%), and college completion and above (n=1,433, 10.7%). The first category, primary school completion and below, is used as the reference group.

Tobacco knowledge and attitude toward smoking

Two mediating variables are analyzed to examine the pathways in the education-smoking relationship. Previous empirical studies suggest that education enriches individuals’ information and facts about health risk, which leads to their better decisions about health behaviors, including tobacco use (de Walque, 2004; Nayga, 2001; Zhang et al., 2011). Therefore, tobacco knowledge is measured by the number of correct answers to nine tobacco-related questions, providing a composite score from zero to nine
The questions focus on how much the participants believe smoking or second-hand smoking causes serious illness or specific diseases such as stroke, heart attack or lung cancer.

Another commonly assumed pathway emphasizes change in attitude, arguing that education imparts positive attitude about healthier lifestyles to individuals, which drives better educated to adopt more preventative strategies (David P. Baker, Leon, & Collins, 2011). So attitude toward smoking, as a latent variable in this study representing the level of acceptance to tobacco use, are captured by the responses of two survey questions inquiring about individual attitude toward smoking: "Which of the following best describes the rules about smoking inside of your home?" and "inside your home, is smoking allowed in every room?" These two questions are measured on a four-point and three-point scale respectively, ranging from strictly forbidden to allowing smoking.

Control variables

Control variables in the analysis include gender (male=49.4%, female=50.6%), location of residence (urban=43.7%, rural=56.3%), geographic region (Eastern China=33.0%, Central China=29.5%, Western China=37.5%) and family wealth (mean=6.397). Since eastern China is more economically developed than central and western areas, the regional difference help us understand the influence of local economic development on the smoking behaviors of population. The family wealth index is created by summing the positive answers of eleven questions investigating whether or not the
household owns specific facilities and appliances, such as electricity, a flush toilet, a television and a car.

Analytical Strategies

Since the relationship between education and tobacco use has been reported to vary with historical change in population context over time (de Walque, 2004), clarifying the role of education at different developmental stages can provide insight into the ways smoking-related health disparities evolve in high-risk groups (Fagan et al., 2004). However, the lack of multiple birth-cohort data on tobacco use in China over past decades has set up barriers to capture the historical change in the education-smoking relationship. In this research, an alternative strategy is applied to examine and compare across different age-cohorts using the 2010 GATS data. This strategy facilitates a discussion about the influence of different social contexts and tobacco policies experienced by each age-cohort over time.

In order to discover the varying relationship between education and tobacco use by age, Figure 1 plots the percentage of smokers in China by age and educational level. In the overall sample, smoking rates rises as individuals enter middle age, and drops gradually among the elderly. Two notable turning points are apparent around age 40 and 60. Meanwhile, the relationship between education and tobacco use varies saliently across age-cohorts. For the youngest and oldest cohorts, the percentage of smokers in the lowest education category outnumbers their better educated peers, but for the majority of ages between 20 and 60, the rate of smokers with middle school diplomas is higher than
any other education levels. The illustrated pattern indicates that for certain ages in China, educational attainment works as a risk factor (David P Baker et al., 2008), where those with greater levels of education are more likely to practice unhealthy behaviors, instead of a social vaccine, where those with greater levels of education are less likely to practice such behaviors.

Figure 2.1: Prevalence of cigarette smoking in China by age and highest educational level

Data source: 2010 Global Adult Tobacco Survey (GATS) in China
Based on the turning points shown in Figure 1, the full sample is divided into three age-cohorts to examine the different relationship between education and tobacco use by time point: young cohort aged 16-40, born in 1970-1994 (n=4,742); middle cohort aged 41-60, born in 1950-1969 (n=5,599); and old cohort aged 61 and above, born before 1950 (n=3,013). To address the three hypotheses of this study, multivariate logistic regression is firstly used to examine the correlation between formal education and the odds of being a regular smoker compared to a non-smoker. The regression analysis is conducted for the full sample and for each age-cohort separately. Secondly, ordered logistic regression is employed to test the relationship between formal education and the odds of altering smoking behavior toward the smoking-free direction, such as reduced or ceased smoking. Lastly, structural equation modeling (SEM) is employed to explain the pathways of the education-smoking relationship, assuming tobacco knowledge and attitude toward smoking are mediating variables.

STATA statistical software (version 13) is used to carry out all the analyses in this study.

**Results**

Table 1 presents the relationship between educational attainment and the likelihood of being a current daily smoker for the full sample and for the three age-cohorts separately. Overall, the negative gradient of education is persistent and robust in all the analyses. For the full sample, after controlling for major background variables, the odds of being a daily smoker are markedly lower for high school educated (OR=0.67;
95% CI=0.57-0.78) and college educated (OR=0.50; 95% CI=0.42-0.61), relative to those that completed primary education. Meanwhile, the odds of being a daily smoker are lowest in the young cohort for high school achievers (OR=0.56; 95% CI=0.40-0.78) and college graduates (OR=0.45; 95% CI=0.31-0.64) compared to primary school achievers, and then increase slightly in middle-aged cohort and reach the peak in the old cohort. Comparing the same educational level across different age-cohorts can illustrate how the odds of becoming a daily smoker increase gradually with different age stages. The ameliorating effect of education on daily smoking is greater for the youngest cohort and declines, but does not disappear, in older age-cohorts.
**Table 2.1: The association between educational attainment and the odds ratio of being a daily smoker by age-cohort**

<table>
<thead>
<tr>
<th>Variables</th>
<th>All (Odds Ratio (95% CI))</th>
<th>Young (16 - 40) (Odds Ratio (95% CI))</th>
<th>Middle (41 - 60) (Odds Ratio (95% CI))</th>
<th>Old (61 and above) (Odds Ratio (95% CI))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary School</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Middle School</td>
<td>0.95 (0.84 to 1.07)</td>
<td>0.90 (0.68 to 1.20)</td>
<td>0.99 (0.82 to 1.19)</td>
<td>0.80 (0.61 to 1.04)</td>
</tr>
<tr>
<td>High School</td>
<td>0.67 (0.57 to 0.78)***</td>
<td>0.56 (0.40 to 0.78)**</td>
<td>0.67 (0.53 to 0.85)**</td>
<td>0.68 (0.47 to 0.98)*</td>
</tr>
<tr>
<td>College and above</td>
<td>0.50 (0.42 to 0.61)***</td>
<td>0.45 (0.31 to 0.64)***</td>
<td>0.52 (0.38 to 0.73)***</td>
<td>0.54 (0.31 to 0.92)***</td>
</tr>
<tr>
<td>Female</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Male</td>
<td>41.83 (35.88 to 48.76)***</td>
<td>129.15 (81.33 to 205.09)***</td>
<td>51.05 (40.85 to 63.81)***</td>
<td>16.28 (12.61 to 21.02)***</td>
</tr>
<tr>
<td>Rural</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Urban</td>
<td>0.80 (0.72 to 0.90)***</td>
<td>0.82 (0.67 to 1.00)</td>
<td>0.99 (0.83 to 1.19)</td>
<td>0.67 (0.52 to 0.86)***</td>
</tr>
<tr>
<td>West</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>East</td>
<td>0.76 (0.67 to 0.85)***</td>
<td>0.56 (0.45 to 0.69)***</td>
<td>0.89 (0.73 to 1.07)</td>
<td>0.79 (0.63 to 1.01)</td>
</tr>
<tr>
<td>Central</td>
<td>0.88 (0.78 to 0.99)*</td>
<td>0.73 (0.59 to 0.91)**</td>
<td>0.94 (0.79 to 1.13)</td>
<td>0.81 (0.65 to 1.03)</td>
</tr>
<tr>
<td>Wealth</td>
<td>1.00 (0.98 to 1.03)</td>
<td>1.05 (1.00 to 1.11)*</td>
<td>0.99 (0.95 to 1.03)</td>
<td>0.96 (0.92 to 1.01)</td>
</tr>
<tr>
<td>N</td>
<td>12800</td>
<td>4533</td>
<td>5354</td>
<td>2913</td>
</tr>
</tbody>
</table>

CI, confidence interval.

* p<0.05; ** p<0.01; *** p<0.001
In addition to educational attainment, gender (OR=129.15; 95% CI=81.33-205.09) and region explain some of the smoking behavior patterns present in China. Unlike in some developed countries where the gender disparities in tobacco use are less remarkable (L. G. Escobedo & Peddicord, 1996; Graham, 2009), tobacco use is substantially more prevalent among males in China than females. People living in urban areas and in the more developed eastern region have a significantly lower likelihood of consuming tobacco products. Family wealth is only related to increased likelihood of being a daily smoker in the young cohort, but has a nearly null correlation with middle and old cohorts.

Table 2 presents the odds of individuals’ changing tobacco-related behaviors by age-cohorts. Increasing negative effects of education are found in all age-cohorts. For example, compared to primary school achievers, the odds of maintaining smoking habits for college graduates are significantly lower in the full sample (OR=0.48; 95% CI=0.40-0.57) and in each age-cohort separately. Such negative relationship is strongest in young cohort (OR=0.48; 95% CI=0.35-0.67) and weakest in old cohort (OR=0.58; 95% CI=0.38-0.88).

However, unlike the findings in Table 1, the effect of formal education is weakest for the middle-aged cohort, where better educated people are more likely to maintain their smoking habits than both the young and old cohorts. This pattern is especially pronounced for middle school and high school graduates. Meanwhile, the effects of control variables show similar patterns with Table 1. In the full sample and each different age-cohort, males and individuals from less developed areas are more likely to maintain
their smoking habits, and family wealth has nearly no correlation with smoking behaviors.

Table 2.2: The association between educational attainment and tobacco-related behavioral change by age-cohort

<table>
<thead>
<tr>
<th>Variables</th>
<th>All</th>
<th>Young (16 - 40)</th>
<th>Middle (41 - 60)</th>
<th>Old (61 and above)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds Ratio (95% CI)</td>
<td>Odds Ratio (95% CI)</td>
<td>Odds Ratio (95% CI)</td>
<td>Odds Ratio (95% CI)</td>
</tr>
<tr>
<td>Primary School</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Middle School</td>
<td>0.86 (0.77 to 0.96)**</td>
<td>0.85 (0.66 to 1.09)</td>
<td>1.00 (0.84 to 1.19)</td>
<td>0.76 (0.60 to 0.96)*</td>
</tr>
<tr>
<td>High school</td>
<td>0.65 (0.57 to 0.75)***</td>
<td>0.58 (0.43 to 0.79)***</td>
<td>0.74 (0.59 to 0.92)**</td>
<td>0.68 (0.50 to 0.93)*</td>
</tr>
<tr>
<td>College and above</td>
<td>0.48 (0.40 to 0.57)***</td>
<td>0.48 (0.35 to 0.67)***</td>
<td>0.54 (0.40 to 0.73)***</td>
<td>0.58 (0.38 to 0.88)*</td>
</tr>
<tr>
<td>Female</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Male</td>
<td>49.23 (43.33 to 55.94)***</td>
<td>96.16 (68.57 to 134.85)***</td>
<td>65.70 (53.99 to 79.94)***</td>
<td>25.48 (20.59 to 31.55)***</td>
</tr>
<tr>
<td>Rural</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Urban</td>
<td>0.86 (0.77 to 0.95)**</td>
<td>0.87 (0.73 to 1.05)</td>
<td>0.98 (0.83 to 1.15)</td>
<td>0.75 (0.61 to 0.93)**</td>
</tr>
<tr>
<td>West</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>East</td>
<td>0.80 (0.72 to 0.89)***</td>
<td>0.58 (0.48 to 0.71)***</td>
<td>0.92 (0.77 to 1.09)</td>
<td>0.88 (0.72 to 1.08)</td>
</tr>
<tr>
<td>Central</td>
<td>0.97 (0.87 to 1.08)</td>
<td>0.76 (0.62 to 0.93)**</td>
<td>1.02 (0.86 to 1.21)</td>
<td>0.99 (0.81 to 1.21)</td>
</tr>
<tr>
<td>Wealth</td>
<td>1.00 (0.98 to 1.03)</td>
<td>1.05 (1.00 to 1.10)*</td>
<td>1.00 (0.96 to 1.03)</td>
<td>0.97 (0.93 to 1.01)</td>
</tr>
<tr>
<td>N</td>
<td>13305</td>
<td>4729</td>
<td>5578</td>
<td>2998</td>
</tr>
</tbody>
</table>

CI, confidence interval.
As shown in the Figure 2, the SEM analysis finds that, after controlling for mediating effects, the direct effect of education on the likelihood of being an active smoker diminishes drastically. On the one hand, formal education has a much stronger association with individuals' tobacco knowledge (0.314) than their attitudes toward smoking (-0.176). On the other hand, increased tobacco knowledge significantly reduces the likelihood of smoking, while more acceptance of tobacco use at home leads to higher odds of becoming a smoker. By contrast, attitude (0.120) has a greater influence than knowledge (-0.077). These findings illustrate that both tobacco knowledge and attitude toward smoking function as important mechanisms in the relationship between educational attainment and smoking behaviors. But tobacco knowledge plays a more important role in explaining the education effect on smoking in China, and there is still a lack of knowledge on the detrimental effect of smoking on population health within the country.
Discussion

This study examines how educational attainment is associated with people's current smoking status and their tobacco-related behavioral change in China. Though the relationship between education and tobacco use varies by age-cohorts, results suggest that education has a lasting negative effect on tobacco use in China (Johnson et al., 2011). As people achieve higher educational levels, the likelihood that they become daily smokers or maintain smoking habits drops gradually. These trends are persistent and robust across age-cohorts.

Among the possible mechanisms through which education can influence tobacco use, knowledge or information about smoking has a greater influence in a developing
country, such as China, compared to many developed countries where the health information has been widely spread. Despite the increased awareness about smoking-related hazards over the past two decades (Y. Yang, Wang, Wang, Li, & Yang, 2010), there is still insufficient accurate information, a necessary component in addressing people’s smoking behaviors in this country.

It is noteworthy that the effect of education in China is not as strong as that found in other studies on developed countries (de Walque, 2004; Wray et al., 1998; Zhu, Giovino, Mowery, & Eriksen, 1996), especially among the middle-aged population whose smoking habits are more persistent than both the young and old cohorts. It suggests that the education effect may be substantially moderated by the social, cultural, and political environments. The absence of a powerful anti-tobacco policy environment contributes largely to this phenomenon (G.-H. Yang et al., 2010). It is estimated that 72.4 percent of non-smokers in China are exposed in second-hand smoke, and 38 percent of them are daily passive smokers (World Health Organization, 2008). Although China joined the Framework Convention on Tobacco Control (FCTC) in 2006, there was no systematic anti-tobacco law or policy until early 2010, when the Chinese government banned smoking in public with its first smoke-free regulation. But even after policy adoption, the enforcement of the regulation remains a severe challenge.

The Chinese government places minimal restrictions on the manufacturing, sale, and advertisement of tobacco (T. Yang, Rockett, Li, Xu, & Gu, 2012), which essentially encourages tobacco production and consumption. Although tobacco industries are prohibited to advertise their products on mass media and in public places (Sussman et al.,
2007), they can still employ flexible marketing strategies to bypass regulations through funding public activities, promoting enterprise brands and decorating corporate images.

Meanwhile, in contrast to many developed countries, tobacco products in China are free from sales tax (Sussman et al., 2007), making cigarettes easily accessible due to the cheap price and mass production. Collecting data from the Chinese Tobacco Yearbook in the last two decades, Figure 3 shows the cigarette production by class in China from 1991 to 2011, from which two major phenomena could be concluded. First, the total production of cigarettes keeps rising steadily every year, and a large portion of the cigarettes are those with low and middle-low quality and therefore low price. Second, although the price standards to divide cigarette class are altered every a few years, the overall cigarette price remains very low. For example, according to the latest price standard, class A cigarettes, which represents the top quality of cigarettes in China, currently cost as low as 10 Yuan ($1.61) per pack. For the lowest quality cigarettes in class E, the price for each pack is even less than 1.6 Yuan ($0.26) (State Tobacco Monopoly Bureau, 2012), which is equivalent to about 3 percent of the country’s mean weekly wage. The affordable low price and easy access to cigarettes may also explain why family wealth has little correlation with tobacco use.
The conclusions illustrated in this study lead to the following policy suggestions. By increasing policy attention and funding mechanisms to support smoking prevention programs and health education in schools, the national government of China may be able to decrease smoking prevalence among youth. More information describing the hazard of tobacco use should be delivered to the public, especially adolescents. Strict comprehensive anti-smoking laws and regulations are urgently required to create a
smoking-free environment. Furthermore, prevention and cessation interventions, such as counseling or therapy for smoking cessation, should be established in China to provide professional assistance for potential quitters.

**Limitations**

The findings in this paper need to be considered with the following limitations. First, the cross-sectional nature of the 2010 GATS data rules out the possibility of addressing causality of the education-smoking relationship. Even if I measure the education gradient and the mediating effects of tobacco knowledge and attitude on people’s current smoking status by employing SEM technique, the causal correlation between educational attainment and smoking-related behavioral change cannot be established. Second, the analysis on the old cohort may contain the so-called survivorship bias. It is reasonable to believe that a sizable amount of daily smokers passed away at earlier age compared with the survived participants in the old cohort (age 61 and above). The estimates on this age-cohort therefore may be inflated.

Third, the data on individuals’ attitudes toward smoking are limited to their home environment. However, considering the widespread phenomenon of smoking in public in China, how people accept or deny such behaviors at home is very likely to represent their true feelings about smoking behaviors.
Chapter Three

The causal effect of education on tobacco use: Evidence from China

Introduction

As tobacco use has been globally identified as one leading cause of multiple chronic diseases and deaths for decades (Doll et al., 2004; U.S. Department of Health and Human Services, 2014), the influential factors that relate to or account for individuals’ smoking behaviors have been extensively examined and discussed to facilitate the implementation of more effective anti-smoking policies and intervention programs. Previous regional and cross-national empirical studies have indicated that educational attainment has a lasting negative association with tobacco use (de Walque, 2004; Johnson et al., 2011; Kandel et al., 2009; G. X. Ma et al., 2002). More educated individuals are constantly less likely to be frequent smokers (Grimard & Parent, 2007; Kestilä et al., 2006), and consume less tobacco products once they initiate smoking (Giskes et al., 2005). Such effect is especially strong and persistent among younger cohorts (Legleye et al., 2011).

While the majority of research has confirmed the existence of the relationship between educational attainment and tobacco use, also known as educational gradient, it remains under intense debate whether such education effect could be regarded as causal. That is to say, whether having more years of schooling or obtaining higher academic degrees can causally decrease the possibility of smoking, reduce the tobacco consumption, or improve the cessation rate. Some literature finds evidence suggesting
such causal relationship (Fujiwara & Kawachi, 2009; Jürges et al., 2011), but some other findings show the opposite (Gilman et al., 2008; Grimard & Parent, 2007; Reinhold & Jürges, 2010; Tenn et al., 2010). In fact, drawn from a much broader perspective, the same debate happens in all the discussions about the education effect on population health. Though education has been proved to be able to promote people’s overall health status as well as many specific healthy behaviors (Bloom, 2005; Cutler & Lleras-Muney, 2006, 2010; Goesling, 2007; Organisation for Economic Co-Operation and Development, 2010), there is still little agreement on the causality of the education gradient in the findings of empirical research (Arendt, 2005).

In line with previous literature, this study aims at examining the causality in the relationship between educational attainment and tobacco use in China. As the largest smoking country in the world with one third of the world’s 1.1 billion smokers living in this country (World Health Organization, 2011), China is carrying heavy health and financial burdens from the global tobacco epidemic. The estimated deaths caused by tobacco use are 1.1 million in China annually (World Health Organization, 2011), and the yearly death toll is expected to reach 2 million by 2025 (Zhang et al., 2011). Meanwhile, five billion dollars were spent on the health care costs associated with smoking in 2000. With a long historical tradition of tobacco use and the absence of strict anti-smoking laws and regulations, there is no sign that such disease epidemic will be alleviated. Meanwhile, due to the lack of large-scale surveys and census data in the past, empirical studies on the relationship between education and smoking in China are highly underdeveloped, which further hinders the implementation of effective tobacco control strategies.
To be specific, this study has two main research questions: (1) what is the relationship between educational attainment and individuals’ smoking behaviors in China? And (2) can such relationship be identified as causal? By answering these two questions, this study can make contributions to both the field of empirical research and policy implication. While it adds more evidence to the existing literature on the causal relationship between education and tobacco use, this study can also provide useful recommendations for public health policymakers in China to employ better anti-smoking intervention strategies.

**Literature Review**

In the past few decades, the relationship between educational attainment and tobacco use has been well documented globally (Cavelaars et al., 2000; de Walque, 2007; B. Federico et al., 2009; M Huisman et al., 2005; Johnson et al., 2011; Maralani, 2013; Tenn et al., 2010; Winkleby, Jatulis, Frank, & Fortmann, 1992). Numerous research has indicated that, compared with less educated counterparts, individuals with higher educational levels have less likelihood of initiating smoking (L. G. Escobedo & Peddicord, 1996; Jürges et al., 2011). Even after become smokers, they consume less tobacco products (Giskes et al., 2005; Grimard & Parent, 2007; Kestilä et al., 2006) and have higher possibilities to quit (B. Federico et al., 2009; Sander, 1995; Schaap et al., 2008; Schiaffino et al., 2007; Wetter et al., 2005; Wray et al., 1998). Such relationship persists and consolidates gradually over individuals’ lifetime.
However, researchers encounter inconsistent and even conflicting evidences when manage to discover the causality in the education-smoking relationship. Even though some findings provide supports for the causal effect of education on smoking behaviors (Fujiwara & Kawachi, 2009; Jürges et al., 2011), more empirical studies find no causality, even if the OLS estimations report a significant relationship between educational attainment and tobacco use (Gilman et al., 2008; Grimard & Parent, 2007; Reinhold & Jürges, 2010; Tenn et al., 2010).

From a broader perspective, the conflicting evidences on the causal effect of education are reported far beyond the field of tobacco use. The causal effect of education on population health is always under debate. Employing various experimental, quasi-experimental designs such as regression discontinuity model, or econometric models like two-stage least square (2SLS) approach, researchers have richly examined the causal effect of education on health by analyzing different cross-sectional, longitudinal or twins datasets in many countries. But the results remain inconclusive. Some studies find the causality (David P. Baker, Leon, & Collins, 2011; Conti, Heckman, & Urzua, 2010; Kawachi, Adler, & Dow, 2010; Silles, 2009; Spasojevic, 2010), but some others report the opposite results (Albouy & Lequien, 2009; Braakmann, 2011; Clark & Royer, 2010), or the causal effect is present but not conclusive (Arendt, 2005), suggesting the causality should be addressed with caution.

What adds more complexity to the current debate on the education-health relationship is that when researchers estimate the education effect on multiple indicators of population health simultaneously, the causality is sometimes found on different indicators, varying from research to research. For example, Kemptner et al. (2011) report the causal
effect of education on long-term illness and weight problems but not on tobacco use. On the contrary, the research by Fujiwara and Kawachi (2009) and the one by Jürges et al. (2011) find causal education effect on smoking behaviors but not on other indicators like obesity.

In sum, the causal inference in the education-smoking relationship, or more broadly, in the education-health relationship, is still under discussion. More empirical studies in different societal settings are still needed to further examine the existence and conditions of causality.

Data, Methods and Analytical Strategies

This study uses data from the China Health and Nutrition Survey (CHNS). Jointly conducted by Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute of Nutrition and Food Safety at the Chinese Center for Disease Control and Prevention, CHNS survey was designed to examine the effects of the health, nutrition, and family planning policies and programs implemented by national and local governments and to see how the social and economic transformation of Chinese society is affecting the health and nutritional status of Chinese population. As a longitudinal data set, the currently available CHNS data include nine waves: 1989, 1991, 1993, 1997, 2000, 2004, 2006, 2009, and 2011.

Endeavors in drawing causal inference between education and population health are often challenged by endogenous problems, since certain unobserved factors may be accounted for both people’s educational attainment and their health-related lifestyles and
behaviors. For instance, people with strong aspiration for high quality lives are more likely to pursue higher educational degrees, as well as get engaged in healthier lifestyles and behaviors. Thus, the estimates of education effect on health outcomes will surely be inflated. Though some studies use regression discontinuity technique (Clark & Royer, 2010) or special dataset on twins (Amin, Behrman, & Spector, 2013; Fujiwara & Kawachi, 2009) to eliminate such endogenous bias and draw causal inference, the most common analytical strategy employed in previous literature is two-stage linear square (2SLS) analysis with the introduction of instrumental variables (Eide & Showalter, 2011). The basic logic behind this approach is to find a proper instrumental variable which is correlated with the endogenous variable, such as the educational attainment in this study, but has no correlation with the dependent variable. So theoretically, by substituting the endogenous variable with the expression of instrumental variable, the inflated bias will be eliminated.

This study applies the same 2SLS approach to analyze whether educational attainment casts a causal effect on adults’ tobacco use in China. The most frequently used instrumental variables in previous literature are often drawn from the occurrence of some significant education events, such as the implementation of compulsory education law (Braakmann, 2011; Kemptner et al., 2011; Silles, 2009), compulsory educational reform (Arendt, 2005; Spasojevic, 2010), school expansion (Jürges et al., 2011), the abolition of secondary school fees (Reinhold & Jürges, 2010), and Vietnam War draft (de Walque, 2007; Grimard & Parent, 2007). Those events are ideal for constructing instrumental variables since their consequences in the field of education are significantly attributed to
people’s increased educational attainment or years of schooling, but are not related to their smoking behaviors. 

Similarly, the instrumental variable adopted in this study is the first Compulsory Education Law in China which was carried out in the summer of 1986. In 1960s and 1970s, the entire fundamental educational system in China was heavily wrecked by a variety of natural disasters and political turbulences, especially during the period of the Cultural Revolution from 1966 to 1976. Even after the revolution was ended, the average educational attainment of Chinese population remained very low. For example, the average years of schooling of adults in China in 1980 were merely 3.7 years, compared to 11.9 years in U.S. ¹ Under such condition, Chinese government launched its first Compulsory Education Law in 1986, requiring that since the 1986-1987 academic year, all school-age children (aged 7 and above) must receive nine years’ compulsory education, which refers to six years in primary school plus three years in junior high school in most regions. Meanwhile, the nine years compulsory education is totally government-funded for all students. This education law laid the foundation for the rapid educational expansion in China in the next two decades, resulting in a significant increase in the average years of schooling of Chinese population ever since then. By 2010, the average years of schooling of adults in China has reached 7.5 years, ² almost double what they were thirty years ago.

¹ Data source: the website of United Nations Development Programme: http://hdr.undp.org/en/content/mean-years-schooling-adults-years
² Data source: the website of United Nations Development Programme: http://hdr.undp.org/en/content/mean-years-schooling-adults-years
Theoretically, children who were enrolled in primary schools after 1986 were much more likely to finish junior high school and therefore receive more years of schooling, compared to those who had entered primary schools before 1986 and had not been bounded by the Compulsory Education Law. So for this study, whether children entered primary schools before or after 1986 could be used as the dummy instrumental variable to relate to their educational attainment.

It should be noted that in this research design, the division between the control group (students enrolled before 1986) and the treatment group (students enrolled after 1986) might be flawed, since the students in control group and their families might also have been motivated or stimulated by the influence of the Compulsory Education Law, and therefore were more willing to finish junior high schools as their younger peers did. However, such concern could be meliorated by the fact that even after the Compulsory Education Law was implemented in 1986, it had not been fully enforced in the country for years. People still lacked strong motivation to provide their children with more education. Especially in the majority of underdeveloped rural areas, the insufficient local educational revenue was not even able to sustain the free education for all school-age children. As a result, the average years of schooling in China by early 1990s were still around five. Therefore, it could be assumed that the impact of the Compulsory Education Law on the educational expectation of earlier cohorts in the control group and their families should be rather limited.

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1 Data source: the website of United Nations Development Programme: http://hdr.undp.org/en/content/mean-years-schooling-adults-years
Previous empirical studies using 2SLS technique and instrumental variables usually run analysis for males and females separately (Arendt, 2005; Atella & Kopinska, 2014; Braakmann, 2011; de Walque, 2007; Grimard & Parent, 2007; Jürges et al., 2011; Kemptner et al., 2011; Reinhold & Jürges, 2010; Silles, 2009), since the education effect on population health is often differential by gender. Meanwhile, a salient gender discrimination in education has persisted for a long period in China. The dropout rates among girls have always been higher than boys, especially in rural regions (P. H. Brown & Park, 2002). So comparatively, girls should be imposed more beneficial influence by the Compulsory Education Law than boys. Therefore, this study also runs analysis on males and females separately.

The empirical models I employ to estimate the return of nine years’ compulsory education in terms of smoking behaviors are specified as follows:

\[ E_i = \alpha_1 R_i + \alpha_2 X_i + \gamma_i \]

for the first stage, and

\[ Y_i = \beta_1 \hat{E}_i + \beta_2 X_i + \mu_i \]

for the second stage. \( E_i \) denotes the endogenous variable, indicating the years of schooling interviewees received. \( R_i \) is the dummy variable of Compulsory Education Law, showing whether those individuals were enrolled before or after the implementation of the law in 1986. \( \hat{E}_i \) represents the first stage predicted value of \( E_i \). \( Y_i \) refers to individuals’ smoking status, measured by whether they are current active smokers or not.
Individuals who consume any type of tobacco products regularly, cigarette or pipe, are treated as active smokers. \( X_i \) represents a vector of independent variables, including age, residential location (urban or rural), net personal income (in natural logarithm form), employment status (employed, unemployed, and students), and a series of dummy variables indicating the province interviewees reside in. Twelve provinces and provincial-level cities are included in the CHNS survey: Beijing, Liaoning, Heilongjiang, Shanghai, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, Chongqing, and Guizhou. The development of economics and the level of urbanization vary largely in different provinces. As the least economically developed province, Guizhou is used as the reference in this analysis. The descriptive information of the variables for both males and females is shown in Table 1.

Table 3.1: Descriptive information of dependent and independent variables by gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>1364</td>
<td>0.542</td>
<td>0.498</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Years of schooling</td>
<td>1440</td>
<td>11.035</td>
<td>4.296</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>Agedummy5</td>
<td>1443</td>
<td>0.475</td>
<td>0.500</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Age</td>
<td>1443</td>
<td>28.733</td>
<td>4.068</td>
<td>20</td>
<td>36</td>
</tr>
<tr>
<td>Rural (reference=urban)</td>
<td>1443</td>
<td>0.642</td>
<td>0.480</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Personal income (ln.)</td>
<td>1312</td>
<td>8.843</td>
<td>1.657</td>
<td>1.671</td>
<td>12.794</td>
</tr>
<tr>
<td>Employed</td>
<td>1360</td>
<td>0.898</td>
<td>0.303</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Unemployed</td>
<td>1360</td>
<td>0.076</td>
<td>0.266</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Students</td>
<td>1360</td>
<td>0.026</td>
<td>0.158</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Province: Beijing</td>
<td>1443</td>
<td>0.080</td>
<td>0.271</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Province: Liaoning</td>
<td>1443</td>
<td>0.082</td>
<td>0.275</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Province: Heilongjiang</td>
<td>1443</td>
<td>0.092</td>
<td>0.289</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Province: Shanghai</td>
<td>1443</td>
<td>0.059</td>
<td>0.236</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Province: Jiangsu</td>
<td>1443</td>
<td>0.077</td>
<td>0.267</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Province: Shandong</td>
<td>1443</td>
<td>0.083</td>
<td>0.276</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Province: Henan</td>
<td>1443</td>
<td>0.094</td>
<td>0.291</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Province: Hubei</td>
<td>1443</td>
<td>0.104</td>
<td>0.305</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Province: Hunan</td>
<td>1443</td>
<td>0.118</td>
<td>0.322</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Province: Guangxi</td>
<td>1443</td>
<td>0.097</td>
<td>0.296</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Province: Guizhou</td>
<td>1443</td>
<td>0.104</td>
<td>0.305</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Province: Chongqing</td>
<td>1443</td>
<td>0.033</td>
<td>0.178</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>N.</td>
<td>1443</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Female**

| Active | 1717  | 0.008  | 0.087  | 0   | 1 |
| Years of schooling | 1777  | 10.660  | 4.699  | 0   | 21 |
| Agedummy5 | 1780  | 0.454  | 0.498  | 0   | 1 |
| Age | 1780  | 29.196  | 3.609  | 20  | 36 |
| Rural (reference=urban) | 1780  | 0.638  | 0.481  | 0  | 1 |
| Personal income (ln.) | 1470  | 8.722  | 1.475  | 2.130  | 12.795 |
| Employed | 1665  | 0.784  | 0.412  | 0   | 1 |
| Unemployed | 1665  | 0.201  | 0.401  | 0   | 1 |
| Students | 1665  | 0.015  | 0.122  | 0   | 1 |
| Province: Beijing | 1780  | 0.078  | 0.268  | 0   | 1 |
| Province: Liaoning | 1780  | 0.078  | 0.268  | 0   | 1 |
| Province: Heilongjiang | 1780  | 0.084  | 0.277  | 0   | 1 |
| Province: Shanghai | 1780  | 0.060  | 0.238  | 0   | 1 |
| Province: Jiangsu | 1780  | 0.097  | 0.296  | 0   | 1 |
| Province: Shandong | 1780  | 0.071  | 0.257  | 0   | 1 |
| Province: Henan | 1780  | 0.113  | 0.317  | 0   | 1 |
| Province: Hubei | 1780  | 0.078  | 0.268  | 0   | 1 |
| Province: Hunan | 1780  | 0.109  | 0.312  | 0   | 1 |
| Province: Guangxi | 1780  | 0.107  | 0.309  | 0  | 1 |
| Province: Guizhou | 1780  | 0.084  | 0.278  | 0 | 1 |
| Province: Chongqing | 1780  | 0.042  | 0.201  | 0 | 1 |
| N. | 1780  |        |        |     |   |
As introduced above, the 1986 Compulsory Education Law was not fully carried out throughout the country immediately. If we consider the 1986-1987 academic year as a cut-off point, there might be no instant substantial change between the two groups of students who got enrolled right before and after the cut-off point. Meanwhile, the sample size for those two groups would be too small to guarantee the statistical validity. Therefore, two strategies are employed in this analysis to increase accuracy and validity. First, I use five-year period to select control and treatment groups in the pooled sample, instead of just one-year. I compare those who were enrolled in primary schools between 1987 and 1991 with those enrolled between 1982 and 1986. That is to say, I compare the group born from 1980 to 1984, with the one born from 1975 to 1979. Second, instead of analyzing only one wave of the CHNS data, I use four waves to maximize the sample size: 2004, 2006, 2009 and 2011. All participants in the four waves are contained in the sample, including those who dropped out from the survey overtime. The earlier waves from 1989 to 2000 are excluded because the survey time was too close to the 1986-1987 academic year. The individuals in the treatment group theoretically had not completed their nine years’ compulsory education in school by the time they were surveyed. Meanwhile, for those who participated in the CHNS survey for more than one waves, only their first participations are counted. The final analytical sample size is 3,223, including 1,443 males and 1,780 females.

Figure 1 shows the ratio of individuals in the pooled sample who completed junior high school and therefore nine years’ compulsory education by birth years. Overall, it is apparent that girls benefited far more than boys in the ten years. The percentage of individuals who completed junior high school increased sharply for girls
who were born from 1975 to 1984. Furthermore, a steep increase in the curve happened to the girls born around year 1979 and 1980. But for boys, such increase appeared in later born cohorts. The patterns imply that the immediate influences of the Compulsory Education Law are mainly casted on girls, instead of boys, when the law was just launched.

**Figure 3.1**: The percentage of individuals born from 1975 to 1984 who completed junior high school (nine years’ education)
To illustrate the overtime change of educational attainment and the effect of the Compulsory Education Law more thoroughly, Figure 2 depicts another more accurate indicator of educational attainment, showing the difference of average years of schooling by gender and birth year from 1975 to 1984. The overall patterns in Figure 2 are similar to Figure 1, in which the gender disparity in educational attainment was reduced intensively in those ten years. Moreover, though there was no significant increase for both gender groups around year 1979 and 1980, girls’ average years of schooling rose more sharply than boys after 1980, implying that they still received more beneficial effects from the education law.

Both Figure 1 and Figure 2 exhibit significant gender difference in the impact of the Compulsory Education Law on individuals’ educational attainment. As predicted, the law exerted much stronger influence on girls’ education than boys. So it is reasonable to proceed with the analysis for males and females separately.

Besides 2SLS analysis, I also run multiple logistic regression on the relationship between years of schooling and smoking status as references. STATA statistical package (version 13) is used to conduct all the analysis.
Figure 3.2: The mean years of schooling of individuals born from 1975 to 1984 (nine years’ education)

Results

Table 2 shows the coefficients of years of schooling on smoking behaviors for males and females separately. Overall, the relationship between years of schooling and smoking status is significantly negative for both genders, especially for females. After controlling for all other important influential factors, the likelihood of being an active smoker for females drops 18.96 percent as they receive one more year of education, in contrast with 6.37 percent for males.
However, except for years of schooling, all other individual-level factors, including age, residential location, employment status and personal income, show no significant impact on individuals’ smoking status.

The last notable predictor is the province people reside in, but the pattern is highly inconclusive. Loosely speaking, the provincial difference is not notable for females. For males, compared with Guizhou Province, the least economically developed region in the sample, individuals from all other provinces show less possibility of becoming an active smoker. However, such correlations are only significant in five of the eleven provinces: Heilongjiang, Shandong, Jiangsu, Hubei and Guangxi. These five provinces vary largely in geographic location, economic development, cultural tradition, and population composition. Therefore, despite that regional economic development seems to be related to less tobacco consumption of residents, it can hardly be attributed to any specific regional factors that actually account for such regional disparities based on the findings in this study.
Moreover, Table 3 shows the coefficients of years of schooling on individuals’ current smoking status from the 2SLS model. First, in the first stage analysis, being influenced by the Compulsory Education Law is only notably related to more years of schooling for females, not for males. Such findings are consistent with the patterns in
Figure 1 and 2, suggesting females benefit substantially more than males. Second, in contrast with the results from multiple logistic regression in Table 2, in spite that individuals’ years of schooling still negatively influence their current smoking status for both males and females, both coefficients turn to insignificant. All other control variables show no significant effects, either. Therefore, the results suggest that more years of schooling can lead to lower possibility of being an active smoker in China, but the causal relationship between education and tobacco use cannot be established.
Table 3.3: Two-stage least squares (2SLS) regression models, where the first-stage estimates the effect of the Compulsory Education Law on years of schooling and the second-stage estimates the effect of instrumented years of schooling on current smoking status

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First stage of 2SLS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years of schooling</td>
<td>0.080</td>
<td>1.103***</td>
</tr>
<tr>
<td></td>
<td>0.227</td>
<td>0.222</td>
</tr>
<tr>
<td>Compulsory Education Law</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Second stage of 2SLS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years of schooling</td>
<td>-0.148</td>
<td>-0.029</td>
</tr>
<tr>
<td></td>
<td>0.235</td>
<td>0.047</td>
</tr>
<tr>
<td>Age</td>
<td>-0.005</td>
<td>-0.004</td>
</tr>
<tr>
<td></td>
<td>0.009</td>
<td>0.008</td>
</tr>
<tr>
<td>Rural (reference=urban)</td>
<td>-0.369</td>
<td>-0.086</td>
</tr>
<tr>
<td></td>
<td>0.635</td>
<td>0.136</td>
</tr>
<tr>
<td>Personal income (ln.)</td>
<td>0.086</td>
<td>0.030</td>
</tr>
<tr>
<td></td>
<td>0.158</td>
<td>0.053</td>
</tr>
<tr>
<td>Employed</td>
<td>-0.041</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>0.160</td>
<td>0.045</td>
</tr>
<tr>
<td>Student</td>
<td>0.363</td>
<td>0.139</td>
</tr>
<tr>
<td></td>
<td>0.642</td>
<td>0.231</td>
</tr>
<tr>
<td>Unemployed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Province: Beijing</td>
<td>0.499</td>
<td>0.140</td>
</tr>
<tr>
<td>Province: Liaoning</td>
<td>0.069</td>
<td>0.078</td>
</tr>
<tr>
<td>Province: Heilongjiang</td>
<td>-0.029</td>
<td>0.047</td>
</tr>
<tr>
<td>Province: Shanghai</td>
<td>0.530</td>
<td>0.115</td>
</tr>
<tr>
<td>Province: Jiangsu</td>
<td>0.020</td>
<td>0.040</td>
</tr>
<tr>
<td>Province: Shandong</td>
<td>0.047</td>
<td>0.049</td>
</tr>
<tr>
<td>Province: Henan</td>
<td>0.148</td>
<td>0.037</td>
</tr>
<tr>
<td>Province: Hubei</td>
<td>0.052</td>
<td>0.016</td>
</tr>
<tr>
<td>Province: Hunan</td>
<td>0.115</td>
<td>0.061</td>
</tr>
<tr>
<td>Province: Guangxi</td>
<td>-0.099</td>
<td>0.005</td>
</tr>
<tr>
<td>Province: Chongqing</td>
<td>0.027</td>
<td>0.082</td>
</tr>
<tr>
<td>Province: Guizhou</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cons.</td>
<td>1.757</td>
<td>0.159</td>
</tr>
<tr>
<td></td>
<td>1.592</td>
<td>0.256</td>
</tr>
</tbody>
</table>

*** p<0.001; ** p<0.01; * p<0.05
Conclusions and Discussion

As the negative relationship between educational attainment and tobacco use has been widely examined and documented internationally, it is still under fierce discussion whether the education effect could be looked as causal. This study adds another piece of empirical evidence to such an ongoing discussion. In line with previous empirical studies that examine the causality in the education-smoking relationship, this study investigates the same question in China by employing 2SLS regression technique, which has been most commonly used in literature in health economics. The results of this study could be divided into two parts. First, the findings show that years of schooling people accomplished are negatively associated with their current smoking status, and such association is in particular predominant among females. Second, consistent with many previous research (Albouy & Lequien, 2009; Braakmann, 2011; Clark & Royer, 2010), the 2SLS regression analysis finds no causal effect of education on tobacco use for both genders in the analyzed sample.

The results imply that in China, schooling mainly influences individuals’ smoking behaviors indirectly, instead of directly. That is to say, schooling casts its influence on health outcomes through certain mediating mechanisms or pathways. Prior literature has identified income (Lynch, 2006), health knowledge and attitude toward health (David P. Baker, Leon, & Collins, 2011), and cognitive ability (Cutler & Lleras-Muney, 2010) as leading pathways. But in the case of China, personal income or socioeconomic status is very unlikely to play the mediating role in the education-smoking relationship. The cheap price and mass production of cigarettes have removed the economic barriers of people accessing tobacco products. In this study, neither personal income nor employment status

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shows any significant correlation with individuals’ smoking behaviors, suggesting that in current China, socioeconomic background has little impact on people’s tobacco consumption. But future studies still need to further examine the mechanisms of tobacco knowledge, attitude toward smoking and cognitive skills.

This study also shows there are huge gender disparities in the education-smoking relationship in China. Education casts much stronger influence on reducing the possibility of smoking among females than males. In fact, such gender disparities are also found in many other Asian countries (Tsai, Tsai, Yang, & Kuo, 2008; Waldron et al., 1988). Nichter et al. (2010) attribute the gender difference in tobacco use in many low- and middle-income countries to the stigma traditionally associated with female smoking, and believe such stigma is a key factor restricting tobacco use by women and girls. Accordingly, it could be inferred that females with better education care more about such stigma and therefore show much less interest in initiating smoking.

The insignificant role of age on tobacco use in this study could be explained by its small variance in the sample. The age of interviewees only ranges from 20 to 36. But as the first study in this dissertation shows, patterns of tobacco use and the education-smoking relationship may both vary notably by age-cohorts, if measured from a life-course perspective (Lynch, 2003).

Last, even after careful manipulation, the 1986 Compulsory Education Law in China doesn’t seem to be a very effective instrumental variable. It is significantly associated with females’ more years of schooling, but has nearly null association with males’ years of schooling. More potential instrumental variables are still needed to be
tested in the future to better analyze the causality in the education-health relationship in China.

**Limitations**

The findings of this study are subject to at least two limitations. First, the analyzed sample in this study are individuals aged between 20 and 36. Findings from such a young group cannot be generalized to the entire adult population in China. Especially, as my first study shows, the tobacco prevalence differs significantly by age-cohorts. Second, as mentioned above, the instrumental variable in this study, the 1986 Compulsory Education Law, does not work ideally. The results from 2SLS analysis therefore should to be considered with caution. Future studies still need to discover more instrumental variables to re-examine the causality in the relationship between educational attainment and tobacco use in China.
Chapter Four

Making anti-smoking interventions work better for adolescents:
Evidence of influential factors and implications from 17 Asian countries

Introduction

Tobacco use has been widely documented as one leading cause of morbidity and mortality worldwide (Doll et al., 2004; U.S. Department of Health and Human Services, 2014), and the regional disparity of this epidemic has kept widening in recent decades (Musk & de Klerk, 2003; World Health Organization, 2009). As the prevalence of tobacco use has declined gradually in many developed countries (Schiaffino et al., 2007; U.S. Department of Health and Human Services, 2014), it remains as a serious public health hazard in underdeveloped Asian countries or other low- and middle-income countries, with the number of smokers continuing increasing notably (Al-Sadat et al., 2010; Nichter et al., 2010; Nturibi et al., 2009; Oncken et al., 2010). Such health hazard has been further exacerbated by the widespread tobacco use among adolescents (Patton et al., 2010).

Previous studies have indicated that adolescents’ smoking initiation is associated with others’ smoking behaviors and attitudes toward tobacco use in different social ecological environments they are often exposed to, based on which some intervention strategies and anti-smoking policies have been constantly proposed and implemented. The frequently examined environments and the corresponding influential factors include: (1) family, such as parental smoking preference (Avenevoli & Merikangas, 2003;
Distefan, Gilpin, Choi, & Pierce, 1998; Greenlund et al., 1995); (2) peer network, such as having smoking friends and peer pressure (C. Alexander, Piazza, Mekos, & Valente, 2001; Allen, Donohue, Griffin, Ryan, & Turner, 2003; Aloise-Young, Graham, & Hansen, 1994; Hoffman, Sussman, Unger, & Valente, 2006; H. Ma et al., 2008); (3) school, including smoking prevalence on campus (Huang et al., 2008), school culture (Aveyard et al., 2006), and tobacco-related education and prevention programs (Catford, Nutbeam, & Woolaway, 1984; Stead & Stradling, 2010); and (4) community and society, including second-hand smoking environment (Ellickson, Tucker, & Klein, 2001), tobacco marketing (Biener & Siegel, 2000; Botvin, Goldberg, Botvin, & Dusenbury, 1993; A. Brown & Moodie, 2009; Dalton et al., 2003; Lovato, Linn, Stead, & Best, 2003; Wellman, Sugarman, DiFranza, & Winickoff, 2006), and anti-tobacco campaigns and policies (Zawahir et al., 2012). Based on those findings, typical intervention strategies often involve restricting tobacco advertising and promotion (A. Brown & Moodie, 2009), enforcing anti-tobacco laws and regulations (Ganatra, Kalia, Haque, & Khan, 2007), creating smoking-free school environment (Huang et al., 2008), promoting health education at school (Wen et al., 2008), or a combination of some of them above.

Besides those crucial social ecological factors, it has also been repeatedly found that adolescent tobacco use is associated with such individual-level demographic characteristics as gender (Lucas & Lloyd, 1999; Mercken, Snijders, Steglich, Vertiainen, & de Vries, 2010), race (Landrine, Richardson, Klonoff, & Flay, 1994), ethnicity (Scarinci, Robinson, Alfano, Zbikowski, & Klesges, 2002), family income and socioeconomic status (SES) (Avenevoli & Merikangas, 2003), and personal knowledge about tobacco smoking (H. M. Alexander et al., 1983; Wen et al., 2008).
None of those factors works alone. More importantly, the influential powers of those social and demographic factors may vary remarkably across different countries, mediated by such regional characteristics as culture, history, tradition and tobacco-related policy environment. Therefore, to deepen our understanding of the influential factors and make anti-smoking intervention strategies more targeted and effective in a given society, it is necessary to evaluate the influence of each factor on adolescent tobacco use in different countries, with the discussion of cross-national similarities and differences.

In contrast to western developed countries, most Asian countries haven’t been sufficiently studied in this tobacco epidemic. Drawn from a comparative perspective, this study is aimed at examining the relationship between selected smoking-related influential factors in different social ecological environments and adolescent tobacco use in 17 East and Southeast Asian countries, most of which belong to low- and middle-income developing countries, and share similar local cultures and beliefs to certain degree. The main research questions are twofold: (1) how are those factors associated with adolescents’ current smoking status in those Asian countries? And (2) what are the cross-national similarities and differences in the influential patterns? By illustrating the variations of influential factors on adolescent tobacco use across different countries, this study could shed light on the implementation of more effective smoking-control intervention strategies among adolescents in each individual country and East and Southeast Asia overall.

**Methods**
Data and Sample

This study uses data from Global Youth Tobacco Survey (GYTS). Conducted by the World Health Organization (WHO), GYTS is a school-based survey that collects data on students aged 13-15 years by using a standardized methodology for constructing the sample frame, selecting schools and classes, and processing data. 17 countries in East and Southeast Asia have participated in GYTS national surveys in the last decade for at least once. This study only analyzes the nearest wave for those who participated for multiple times. Thus, the countries and their years of participation include: Bangladesh (2007), Bhutan (2009), Cambodia (2010), East Timor (2009), India (2009), Indonesia (2009), South Korea (2008), Laos (2011), Malaysia (2009), Maldives (2011), Mongolia (2007), Myanmar (2011), Nepal (2011), Philippines (2011), Sri Lanka (2011), Thailand (2009), and Vietnam (2007). The sample size of each national survey ranges largely from around 1,500 to 15,000.

Measures

The main dependent variable in this study is adolescents’ current smoking status. A new binary variable active smoker is created, measured by whether the interviewees had smoked during the past 30 days, regardless of the amount and frequency of their tobacco consumption.

It should be noted that the type of popular tobacco products varies broadly in different Asian regions. Accordingly, the GYTS survey in each country provided additional questions regarding the consumption of local tobacco products as supplements
to regular cigarettes, including cigars, cigarillos, little cigars, snuff, pipes, water pipe, bidi, cheroots, smokeless tobacco, dipping tobacco, chewing tobacco, and so on. This study doesn’t distinguish among different tobacco types. The interviewees are coded as active smokers as long as reported having used any type of tobacco products in the past 30 days. The numbers and percentages of active and non-active smokers (and non-smokers) in each country are shown in Table 1. The regional variances of the percentage of adolescent smokers are notable, ranging from 3.9 percent in Vietnam to 67.4 percent in East Timor.
Table 4.1: The numbers and percentages of active and non-active smokers (and non-smokers) in 17 East and Southeast Asian countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Survey Year</th>
<th>Active smokers</th>
<th>Non-active smokers (and non-smokers)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>2007</td>
<td>341 (11.2)</td>
<td>2713 (88.8)</td>
</tr>
<tr>
<td>Bhutan</td>
<td>2009</td>
<td>442 (25.1)</td>
<td>1321 (74.9)</td>
</tr>
<tr>
<td>Cambodia</td>
<td>2010</td>
<td>336 (7.6)</td>
<td>4077 (92.4)</td>
</tr>
<tr>
<td>East Timor</td>
<td>2009</td>
<td>984 (67.4)</td>
<td>476 (32.6)</td>
</tr>
<tr>
<td>India</td>
<td>2009</td>
<td>1548 (13.5)</td>
<td>9943 (86.5)</td>
</tr>
<tr>
<td>Indonesia</td>
<td>2009</td>
<td>1066 (21.9)</td>
<td>3806 (78.1)</td>
</tr>
<tr>
<td>South Korea</td>
<td>2008</td>
<td>835 (14.0)</td>
<td>5121 (86.0)</td>
</tr>
<tr>
<td>Laos</td>
<td>2011</td>
<td>882 (14.3)</td>
<td>5286 (85.7)</td>
</tr>
<tr>
<td>Malaysia</td>
<td>2009</td>
<td>790 (24.7)</td>
<td>2404 (75.3)</td>
</tr>
<tr>
<td>Maldives</td>
<td>2011</td>
<td>407 (15.8)</td>
<td>2170 (84.2)</td>
</tr>
<tr>
<td>Mongolia</td>
<td>2007</td>
<td>364 (20.5)</td>
<td>1410 (79.5)</td>
</tr>
<tr>
<td>Myanmar</td>
<td>2011</td>
<td>513 (19.8)</td>
<td>2078 (80.2)</td>
</tr>
<tr>
<td>Nepal</td>
<td>2011</td>
<td>687 (24.6)</td>
<td>2108 (75.4)</td>
</tr>
<tr>
<td>Philippines</td>
<td>2011</td>
<td>1016 (17.8)</td>
<td>4701 (82.2)</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>2011</td>
<td>580 (11.8)</td>
<td>4334 (88.2)</td>
</tr>
<tr>
<td>Thailand</td>
<td>2009</td>
<td>1670 (17.2)</td>
<td>8040 (82.8)</td>
</tr>
<tr>
<td>Vietnam</td>
<td>2007</td>
<td>593 (3.9)</td>
<td>14829 (96.1)</td>
</tr>
</tbody>
</table>

The independent variables in this study include selected smoking-related factors in different social ecological environments adolescents are frequently exposed to. First of all, three variables are examined at familial level. *Parental smoking status* measures
whether any of the parents was an active smoker, regardless of the type of tobacco products they usually smoked. *Familial smoking talk* investigates whether any family member had discussed the harm of smoking with the adolescents. *Home smoking environment* is measured by the frequencies of people smoking in the presence of adolescents at home during the past seven days, which helps evaluate how the second-hand smoking environment in their houses is associated with adolescents’ smoking preference.

Second, for peer influence, one binary variable *smoking friends* is created and measured by whether the adolescents had any closest friends who were active tobacco consumers.

Third, at school level, two variables reflecting the tobacco-related education in school are examined. *Learned about smoking in class* investigate whether students had been taught about the harm of smoking. *Class discussion about smoking* measures whether there had been class discussion about the reasons why people at young ages smoked. The only exception is East Timor, whose survey did not contain such school-level information.

At last, two variables are examined at community and societal level. One is *public smoking environment*, measured by the amounts of days people had smoked in their presence during the past seven days. The other is *tobacco advertisement*, representing the degree of adolescents’ exposure to tobacco advertisements. In each national survey, interviewees were asked a series of questions about how often they saw tobacco-related scenes, messages or advertisements in all types of public media and affairs, including TV, movies, billboards, newspapers, magazines, sports events, concerts and community
events. All the answers were measured by 3-point or 4-point scales ranging from never to very often. The variable tobacco advertisement is created by summing up all the self-reported answers.

This study also controls variables of gender, age, grade and tobacco knowledge. The last variable is measured by summing up the wrong answers to a series of questions regarding the hazard of tobacco use, such as: “Do you think cigarette smoking is harmful to your health?” “Once someone has started smoking, do you think it would be difficult to quit?” And “do you think second-handed smoking is harmful?” Higher scores refer to more ignorance of tobacco knowledge.

The descriptive information of all the variables for the pooled data is shown in Table 2. The detailed information for each individual country is also available upon request.

Multivariate logistic regression technique is employed to evaluate the relative importance of those variables in each country. STATA (version 13) is used to carry out all the analyses.
Table 4.2: The descriptive information of the variables for the pooled data of 17 East and Southeast Asian Countries

<table>
<thead>
<tr>
<th>Variables</th>
<th>Obs.</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
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<td>Active smoker</td>
<td>205442</td>
<td>0.193</td>
<td>0.395</td>
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<td>Gender</td>
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<td>0.483</td>
<td>0.500</td>
<td>0</td>
<td>1</td>
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<td>Age</td>
<td>194118</td>
<td>4.174</td>
<td>1.427</td>
<td>1</td>
<td>8</td>
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<tr>
<td>Grade</td>
<td>207983</td>
<td>2.173</td>
<td>0.995</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Tobacco knowledge</td>
<td>204110</td>
<td>8.081</td>
<td>3.276</td>
<td>2</td>
<td>28</td>
</tr>
<tr>
<td>Parental smoking status</td>
<td>206236</td>
<td>0.500</td>
<td>0.500</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Familial smoking talk</td>
<td>210177</td>
<td>0.707</td>
<td>0.494</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Home smoking environment</td>
<td>207026</td>
<td>1.038</td>
<td>1.454</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Smoking friends</td>
<td>210920</td>
<td>0.569</td>
<td>0.764</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Learned about smoking in class</td>
<td>193903</td>
<td>0.627</td>
<td>0.484</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Class discussion about smoking</td>
<td>194465</td>
<td>0.397</td>
<td>0.489</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Public smoking environment</td>
<td>207047</td>
<td>1.455</td>
<td>1.610</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Tobacco advertisement</td>
<td>189205</td>
<td>5.003</td>
<td>4.144</td>
<td>0</td>
<td>66</td>
</tr>
</tbody>
</table>

Data source: Global Youth Tobacco Survey (GYTS)
for 17 East and Southeast Asian countries

Results

The relationship between selected tobacco-related influential factors and the likelihood of being an active smoker in 17 East and Southeast Asian countries are presented in Table 3. Generally speaking, adolescents’ smoking status is strongly
associated with those factors, in spite that the pattern in each individual country varies notably.

First of all, the influence of family smoking environment is not ubiquitous. The three familial-level indicators examined in this study are only significantly related to the likelihood of being an active smoker in a few countries. Having at least one smoking parent is remarkably more likely for adolescents to maintain smoking habits in Bangladesh (OR=1.78; 95% CI=1.30-2.44), India (OR=3.24; 95% CI=2.69-3.90), Malaysia (OR=1.29; 95% CI=1.02-1.64), Nepal (OR=1.63; 95% CI=1.30-2.04), Philippines (OR=1.44; 95% CI=1.20-1.73), Sri Lanka (OR=1.37; 95% CI=1.06-1.78) and Thailand (OR=1.25; 95% CI=1.07-1.46), but such correlation is not salient in any other countries. In Mongolia, the correlation is even negative though insignificant (OR=0.77; 95% CI=0.56-1.06), implying that adolescents’ odds of smoking decline when having parents smoke.

Meanwhile, having talked about the hazard of smoking at home only strongly relates to lower possibilities of adolescents’ smoking in India (OR=0.70; 95% CI=0.59-0.83) and Vietnam (OR=0.67; 95% CI=0.52-0.87). In countries like East Timor (OR=1.57; 95% CI=1.20-2.06), Laos (OR=1.28; 95% CI=1.02-1.60) and Myanmar (OR=1.18; 95% CI=1.01-1.36), adolescents are even more likely to smoke if there are more conversations about the hazard of smoking at home. As for the second-hand smoking environment at home, it is only associated with higher likelihood of adolescent tobacco use in India (OR=1.20; 95% CI=1.14-1.26), Indonesia (OR=1.10; 95% CI=1.02-1.18), Malaysia (OR=1.14; 95% CI=1.05-1.23), Maldives (OR=1.14; 95% CI=1.03-1.27) and Thailand (OR=1.12; 95% CI=1.07-1.17).
India is the only country where all the three familial-level variables work as strongly and conformably as predicted. By contrast, in Bhutan, Cambodia, South Korea and Mongolia, none of the familial factors shows any notable correlation with adolescent smoking status.

Second, as the only factor that has significant correlation with adolescents’ smoking status in every single country, having close friends who smoke plays the dominant role in this cross-nation analysis. In all the 17 countries, the number of close friends who smoke is among the most influential factors, and in 12 of them (except for East Timor, India, Indonesia, Myanmar and Sri Lanka) it is the single most significant predictor.

Third, the effect of smoking-related health education on adolescent smoking is surprisingly inconsistent. Although having been taught about the harm of smoking in class is normally related to lower likelihood of tobacco use, such effect is not strong, except for in Laos (OR=0.68; 95% CI=0.54-0.86) and Nepal (OR=0.70; 95% CI=0.53-0.92). Meanwhile, having discussed about the reasons of smoking in class plays contradicting roles in different societies. It has negative association with adolescents’ smoking status in Vietnam (OR=0.72; 95% CI=0.56-0.91), but has strong positive association in countries like India (OR=1.69; 95% CI=1.38-2.07), Laos (OR=1.38; 95% CI=1.10-1.72), Malaysia (OR=1.29; 95% CI=1.02-1.62), Myanmar (OR=1.48; 95% CI=1.11-1.98), and Thailand (OR=1.50; 95% CI=1.29-1.74). Therefore, the effect of health education in school on adolescent tobacco use is highly inconclusive in those Asian countries.
Fourth, at the society level, the impact of second-hand smoking is substantial. In all the 17 countries, adolescents’ smoking status is slightly but positively related to the frequencies of being exposed to second-hand smoking in the society. Such correlations are significant in more than half of the countries, especially in South Korea (OR=1.31; 95% CI=1.22-1.41).

The influence of tobacco advertisements on adolescent smoking is also widely salient. In 13 countries, adolescents’ smoking status is significantly associated with the frequencies of tobacco advertisements they saw on public media and affairs, especially in Thailand (OR=1.16; 95% CI=1.12-1.20). Only in Bangladesh, Indonesia and Malaysia, the association between tobacco advertisements and adolescent smoking is insignificant or null. India provides the only exception, where such correlation is strongly negative (OR=0.94; 95% CI=0.91-0.97), suggesting that more exposure to tobacco advertisements in public for adolescents is associated with lower likelihood of tobacco use.

Among the individual demographic factors, huge gender disparities in adolescent tobacco use are found in all countries but South Korea. Boys are always more likely to smoke tobacco than girls. India represents the peak of the gender disparities in adolescent smoking in East and Southeast Asia, where the odds of being an active smoker for boys is almost six times higher than girls (OR=5.98; 95% CI=4.86-7.36).

Adolescents’ knowledge about tobacco plays another highly important role in reducing their smoking behaviors in all the analyzed Asian countries but East Timor. The more knowledge adolescents understand correctly about the hazard of tobacco and second-hand smoking, the less likely they become active smokers. At last, the effects of age and grade on adolescent smoking are both insignificant and inconclusive. Either of
them is positively associated with the odds of tobacco use in some countries but negatively in some others, while the effects are null in the majority of countries.

Discussion

The increasing prevalence of adolescent tobacco use raises an inevitably urgent challenge for educators and policymakers in East and Southeast Asia. But the low and lower-middle income countries often confront dual challenges when attempting to control or reduce tobacco consumption: the continuous development and expanded marketing of tobacco industries, and the insufficient resources to implement strict tobacco control policies (Cussen & McCool, 2011). Especially, as an effort to reduce the prevalence of tobacco use, most Asian countries have implemented anti-smoking laws or policies. All countries included in this study have also ratified the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) except for Indonesia. But the inadequate enforcements of those laws are often addressed and criticized (Sinha et al., 2008).

In the quest for more cost-efficient intervention strategies, this study provides some empirical evidences on the relationships between adolescents’ smoking status and the smoking-related influential factors in different social ecological environments to which they are exposed in 17 East and Southeast Asian countries. Both remarkable similarities and differences are found across countries, which could lead to some useful implications to help bring prevention and cessation interventions to fruition.
On the one hand, three ubiquitous factors are found to be notably associated with adolescent tobacco use in almost every country: having close friends who smoke, tobacco-related knowledge and gender. First, in line with previous studies that point out the importance of peer network in diffusing tobacco use (C. Alexander et al., 2001), the findings in this study show that the number of close friends who smoke is indeed a highly strong predictor of adolescents’ smoking status in East and Southeast Asia. In 12 of the 17 countries, peer even surpasses any other social and demographic factors, acting as the single most important determinant of tobacco use. Second, consistent with previous studies that identify the lack of health knowledge as one major cause of many health-hazard behaviors including tobacco use (David P. Baker, Leon, Greenaway, Collins, & Movit, 2011), adolescents who misunderstand or underestimate the hazard of smoking are more likely to smoke in every analyzed Asian country. Third, as gender disparities in adolescent smoking tend to diminish in many developed countries (Baška, Warren, Bašková, & Jones, 2009), the likelihood of being an active smoker for boys is greatly higher than girls in 16 Asian countries except for South Korea. Such disparities may be largely attributed to cultural and historical trends (Hammond et al., 2008), since smoking is often looked as a common misbehavior or stigma among girls in Asian cultures. As Nichter et al. (2010) introduce, in many low- and middle-income countries, the stigma traditionally associated with female smoking has been a key factor restricting tobacco use among women and girls.

In addition, the influence of external social environment on adolescent tobacco use is noteworthy in more than half of the countries in this study. As previous studies attribute adolescent smoking initiation to the impact of second-hand smoking (Ellickson
et al., 2001; Hanewinkel, Isensee, Sargent, & Morgenstern, 2011) and tobacco advertisements (Biener & Siegel, 2000; Botvin et al., 1993; A. Brown & Moodie, 2009; Lovato et al., 2003), being exposed to second-hand smoking environment and tobacco advertisements are significantly related to increased likelihood of smoking in 11 and 13 countries respectively. Therefore, restricting smoking behaviors in public is still a challenging task for Asian developing countries in the future.

On the other hand, compared with the similarities, the cross-national differences in the influential patterns are more worth noting. First, unlike in some European countries where parental effect is comparable to peer effect on children’s smoking behaviors (de Vries, Engels, Kremers, Wetzels, & Mudde, 2003), the influences of family smoking environment in the 17 Asian countries are neither strong nor conclusive. Though parental smoking behaviors and their attitudes toward smoking play key roles in India, as well as in Bangladesh, Nepal and Thailand, they have nearly null correlation with their children’s smoking in Bhutan, Cambodia, South Korea and Mongolia. This concurs with what has been found in other Asian countries like China (H. Ma et al., 2008). Avenevoli and Merikangas (2003) conclude three possible explanations for the inconsistent findings in the parental effect on adolescent smoking: measurement issues, moderators and mechanisms, suggesting that some underlying indicators or pathways may mediate or moderate the influence of parental smoking behaviors. But another reason should be taken into account in those Asian societies: when there is a high prevalence of tobacco use in the entire society, especially in every available public place, the influence of smoking behaviors at home will be of less importance.
Second, huge cross-national variances are also found in the estimates of school effect. Teaching the harm of smoking in school only significantly relates to lower possibility of adolescent smoking in Laos and Nepal. But ironically, in India, Laos, Malaysia, Myanmar and Thailand, having class discussion about the reason why adolescents smoke, which is supposed to help reduce their tobacco use, relates to higher likelihood of smoking.

The conflicting patterns in school effect imply that though anti-smoking education and prevention programs have been widely implemented and proved effective in reducing adolescents’ substance misuse in developed countries (Catford et al., 1984; Stead & Stradling, 2010), such efforts haven’t gained sufficient attention in most Asian countries. They might even be improperly conducted in certain regions, since smoking-related class discussion increases, not decreases, the odds of adolescent smoking. In fact, other findings in this study, especially the extraordinary importance of peer effect and smoking-related knowledge, also suggest that scientific health education and prevention programs in school are urgently needed in those Asian countries. By contrast, such health education and anti-smoking programs in school are even more in need, and could be more effective in reducing adolescent smoking, than the smoking-control laws and policies in general. It should be the best pathway to deliver information about the harm of smoking to adolescents and cut off the diffusion of smoking through peer network, especially when the society is filled with inducing tobacco advertisements and smoking population.

The cross-national differences also suggest that the influential factors and their strengths vary remarkably by societies. Therefore, effective intervention programs and
policies in each country need to concentrate on both universal and local influential factors, in conjunction with the full consideration of the tobacco-related cultures and traditions in the country.

From the universal perspective, while conventional strategies usually emphasize restricting or banning smoking in public, this study suggests that more policy attentions and resources should be given to anti-smoking education and prevention programs in school in Asia. Health education has a lasting and manifold effect on adolescent smoking. With rich components about the short-term and long-term hazard of tobacco use, such programs are able to reduce the initiation rate of smoking and help potential quitters by imparting tobacco knowledge and enhancing dialogues between adolescents and their friends.

From the local perspective, anti-smoking policy initiatives and prevention campaigns need to target the most influential local factors accordingly. For example, in countries like India and Thailand where family plays a key role in triggering adolescent smoking, community-based health-promotion programs that involve both parents and their children should be enhanced. In countries like South Korea, Laos, Malaysia, Maldives, Mongolia and Vietnam where public smoking environment is of particular importance, systematic anti-smoking laws and regulations need to be established and strictly enforced to restrict second-hand smoking in public and tobacco marketing.

Lastly, in spite of the huge gender disparities in adolescent tobacco use in Asian countries, policymakers should still beware the potential increasing prevalence of smoking among girls in the future, which have occurred in other countries where smoking rates among females have been traditionally low (Page, Huong, Chi, & Tien,
As Pampel (2001) discusses, gender differential in smoking could diminish as a byproduct of a female lag in the process of cigarette adoption, diffusion, and abatement, especially in countries with a long history of tobacco use. Therefore, girls should be given equal policy attention and health education in the Asian countries to prevent the increase of their tobacco consumption.

**Limitations**

The findings in this study are subject to at least two limitations. First, as a cross-national survey, the nature of GYTS data set rules out the possibility of drawing causal inference. Second, the GYTS survey does not investigate more demographic information of interviewees such as parental educational levels, occupations, family wealth and race/ethnicity, which have all been reported before as important determinants. GYTS survey inquires about the amount of pocket money in several countries but not for the majority. However, considering the relatively low price and mass production of tobacco product in Asia compared with developed countries, the effect of family socioeconomic status on smoking behaviors should not be as high as developed countries.
Table 4.3: Multiple logistic regression analysis of adolescents’ current smoking status on selected influential factors in 17 East and Southeast Asian countries

<table>
<thead>
<tr>
<th></th>
<th>BGD</th>
<th>BTN</th>
<th>KHM</th>
<th>TMP</th>
<th>IND</th>
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<tr>
<td>OR (95% CI)</td>
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<tr>
<td>OR (95% CI)</td>
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<td>1.09</td>
<td>0.70</td>
<td>1.16</td>
<td>1.28</td>
<td>1.08</td>
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<td>1.10</td>
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<td>1.14</td>
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<td>1.05</td>
<td>1.12</td>
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<tr>
<td>Home smoking environment</td>
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<tr>
<td>Learn about smoking in class</td>
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<td>1.10 (0.99-1.23)</td>
<td>1.05 (1.00-1.09)*</td>
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<td>1.16 (1.07-1.26)***</td>
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<td>1.19 (1.10-1.29)***</td>
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<td>1.06 (0.90-1.25)</td>
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*p<0.05, **p<0.01, ***p<0.001

OR: odds ratio. CI: confidence interval.
Chapter Five

Conclusion

Tobacco use has been widely documented as a leading cause of many lethal chronic diseases all over the world, with a large amount of population voluntarily or involuntarily living under the smoking dome. In the pursuit of more effective anti-smoking policies and intervention strategies, previous literature have identified some crucial influential factors strongly associated with individuals’ smoking behaviors, which provide important breakthrough points for public health policymakers.

Among the most notable factors, the effect of education has gained increasing attention and empirical evidence supports in recent decades (Cavelaars et al., 2000; de Walque, 2004; Bruno Federico, Costa, & Kunst, 2007). Generally speaking, research on the education effect on tobacco use could be sorted into two streams. This first stream examines how educational attainment of individuals influences their tobacco use in later life course (Luis G. Escobedo et al., 1990; B. Federico et al., 2009), based on which a sizeable number of studies have further examined the causality and underlying mechanisms in such education-smoking relationship (Braakmann, 2011; Fujiwara & Kawachi, 2009; Leigh, 1983). The second stream, drawn from more specific perspectives, focuses on the effect of certain anti-smoking intervention programs or health education on individuals’ smoking behaviors (Agyemang et al., 2010), especially those targeting children and adolescents in school (H. M. Alexander et al., 1983; Pentz et al., 1989; Stead & Stradling, 2010). Both streams continuously deepen people’s
understanding with clarity to the irreplaceable role education plays in controlling the global tobacco epidemic.

In line with previous research, the three studies in this dissertation provide a multi-dimensional and in-depth examination on the education effect on tobacco use in different age-cohorts and social settings in 18 East and Southeast Asian countries, with a particular focus on China. Both streams of the empirical research are addressed separately. The findings exhibit the crucial role education plays in reducing adult and adolescent smoking in East and Southeast Asia, as well as the underlying mechanisms through which education casts its effect on tobacco use. Useful implications can also be inferred from the studies to improve the effectiveness of anti-smoking policies and intervention programs.

In this closing chapter, I’ll summarize the findings of all the three studies, followed by a concluding discussion and policy suggestions for the public health policymakers in East and Southeast Asia.

Summary of findings

The major findings of the three studies in this dissertation could be summarized as follows.

The first study “Education disparities in the tobacco epidemic in China” is among the first to examine the education-smoking relationship by different age-cohorts in China. Consistent with the results from many other countries, I find significant negative associations of education with two key indicators of tobacco use across all age-cohorts:
current smoking status and smoking-related behavioral change. But for the latter indicator, the negative association of education is weaker in middle-age cohort than young and old cohorts, implying that education could play as a risky factor of smoking for middle-age group in China. I further confirm that the insufficiency of individuals’ tobacco knowledge in the society, instead of their attitude toward tobacco use, should be the primary mechanism through which education affects people’s smoking behaviors in China.

Based on the findings in the first study, my second one “The causal effect of education on tobacco use: Evidence from China” investigates whether the education effect on adult tobacco use in China is causal by analyzing different data set and analytical strategies. On the one hand, the logistic regression analysis confirms the presence of the saliently negative relationship between individuals’ years of schooling and smoking status. But on the other hand, no causality in such relationship is found in the analyzed sample through a two-stage least square approach. Therefore, the argument of the causal effect of education on population health still needs to be processed with caution.

The third study extends the research scope from China to another 17 East and Southeast countries, inquiring the correlation between adolescents’ smoking status and the smoking-related influential factors in different social ecological environments they are constantly exposed to, including family, peer, school and society. Cross-national differences and similarities in the influential patterns are also concluded. The results show that adolescents’ smoking status is strongly associated with those factors in different environments, in spite that the pattern in each individual country varies notably.
But overall, having smoking friends, lack of tobacco knowledge and gender are found to be three overwhelmingly significant predictors of adolescent smoking in the Asian countries. Enhancing health education and prevention programs in school could be a more effective way to reduce the odds of smoking in adolescents.

Concluding discussion

Summing up altogether, the findings in the three papers lead to the following conclusions:

First, consistent with the findings from numerous empirical research in other countries and continents (Cavelaars et al., 2000; de Walque, 2007; L. G. Escobedo & Peddicord, 1996; Kandel et al., 2009; Sander, 1995), the negative relationship between educational attainment and tobacco use is found robust and persistent in current China. As my first and second papers have shown, with higher educational level achieved or more years of schooling accomplished, individuals are significantly less likely to smoke tobacco. Meanwhile, more educated smokers are also more likely to reduce and cease smoking. Such relationship remains substantial and negative across different age-cohorts, even after controlling for crucial demographic factors, such as gender, age, residential location, employment status, family wealth and personal income.

Second, as Lynch (2003) suggested, the strength of the education effect on tobacco use in China is found varied across age stages or life courses. My first paper exhibits that for middle and high school achievers, the education effect on individuals’ tobacco-related behavioral change is weaker in middle-age cohort than in both young and
old cohorts. Such non-linear pattern concurs with the argument by David P Baker et al. (2008) that in certain occasions, education plays as a risk factor that increases the possibility of individuals getting engaged in health-related risky behaviors, instead of a social vaccine that reduces such behaviors. More research is still needed in the future to discover what occasions, historically, culturally, economically and geographically, may account for the direction of education effect.

Third, this dissertation adds another piece of empirical evidence to the heated discussion about the causality in the relationship between individuals’ years of schooling and their smoking behaviors. In accordance with what a sizeable majority of economic analyses show (Gilman et al., 2008; Grimard & Parent, 2007; Reinhold & Jürges, 2010; Tenn et al., 2010), there is no causality found in the relationship between people’s years of schooling and smoking behaviors in China in the sample, even though the logistic regression results indicate that the relationship is substantially negative. As Chandola, Clarke, Morris, and Blane (2006) predict, improvements in educational attainment may not necessarily and automatically cause increase of population health in later life stages in China, including less likelihood of smoking. There should be certain unrevealed mediators or mechanisms through which the education effect is transmitted. My first paper particularly analyzes tobacco knowledge and attitude toward smoking as two crucial mechanisms, revealing the former is of more importance than the latter in passing the education effect on tobacco use. But more underlying mediators, such as personal income, socioeconomic status and personal cognitive skills, are still worth examining further in China by future research.
The findings also lead us to reconsider the long-lasting discussion about the direct and indirect effects of schooling on population health, including smoking behaviors. As a matter of fact, the dividing line between direct and indirect education effects on population health is often vague in previous literature. While indirect effect is commonly believed to be casted through certain mediating mechanisms, such as personal or familial economic resources (Lynch, 2006), social psychological resources (David P. Baker, Leon, & Collins, 2011; de Walque, 2004; Lange, 2011) and health behaviors (Mirowsky & Ross, 2003; Ross & Wu, 1996), the direct effect of education is often interpreted and measured in very different ways. For example, Leigh (1983) regards the direct education effect on health as allowing wise use of medical care, but Lynch (2006) insists that the direct effect should be captured through age and cohort. Undoubtedly, the imprecise definitions of direct and indirect effects lead to inconsistent measurements and incomparable results. If we have to use those terms in studying the education effect on population health, the more scientific way should be equating direct effect with causal effect from the perspective of econometrics, while indirect effect still refers to functioning through certain mediating mechanisms. If the causality in the education-health relationship couldn’t be detected, there will be no direct education effect on population health.

Fourth, health education and prevention programs in school are highly needed to reduce the possibility of adolescent smoking. My third paper shows the strongest predictors of adolescents’ smoking behaviors in most or even all the 17 East and Southeast Asian countries, including peer influence, lack of tobacco knowledge and the quality of health class, are all associated with health education in school. Therefore,
improving anti-tobacco education or prevention programs in school should be an
effective strategy to control the tobacco prevalence among adolescents in East and
Southeast Asia, as proved by the experience of developed countries (Catford et al., 1984;
Stead & Stradling, 2010).

Last, the third paper also indicates that the influential patterns in East and
Southeast Asia are very different from western developed countries, which raises an
exigent call for more indigenous empirical research. For example, parental smoking
preference is among the most significant predictors of adolescent smoking in Europe (de
Vries et al., 2003), but it is only associated with higher possibility of smoking in 4 out of
17 Asian countries in this study. Another example is gender disparities. Compared with
most western countries where smoking prevalence among females is comparable with
males (Baška et al., 2009; Pampel, 2001), girls are substantially less likely to smoke
tobacco in all the Asian countries in the sample except for South Korea. Two
implications could be drawn from the findings. On the one hand, it suggests that the
moderating effects of community-, region-, and even nation-level factors should be taken
into analysis in future empirical research. Further studies need to examine thoroughly
how and why the influences of education and other social and demographic factors on
tobacco use differ largely across social settings. And they can surely throw light on
deeper and more comprehensive understanding about the education-smoking relationship
in Asia.

On the other hand, it is without any doubt that effective intervention programs
must be established on the basis of fully understanding the influential factors in local
settings. Therefore, for those Asian countries who suffer severely from the tobacco
epidemic but haven’t been fully analyzed, more indigenous research is strongly required in order to design and carry out effective anti-smoking approaches with their limited local financial and human resources.

**Implications and policy suggestions for East and Southeast Asian countries**

When we seek for possible explanations for the above findings, it is worth noting that they are largely attributed to the economic, social, cultural and policy environments of those Asian countries. Except for Indonesia, all the other 17 Asian countries analyzed in this dissertation have ratified the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) and implemented some kind of smoking-free laws and regulations, the power of law enforcement is always questionable, which brings many inevitable adverse consequences.

Due to the poor enforcement of smoking-free laws, smoking tobacco in public has always been a common phenomenon in most Asian developing countries. The pervasive second-hand smoking environment not only harms the health of surrounding non-smokers, but also triggers them to initiate smoking, especially for adolescents. According to the findings in the third paper, the positive influence of second-hand smoking behaviors in the society on adolescents’ smoking status is significant in almost every analyzed country.

Another example to illustrate the hazard of widespread second-hand smoking in public is how education is identified as a risky factor, instead of a type of social vaccine, in Chinese middle-age cohort in the first paper. Unlike the young and old cohorts, the
The majority of middle-age population are fully or partly employed and are therefore most frequently exposed to all kinds of public places as well as second-hand smoking. Especially in China where exchanging cigarettes is a long-lasting traditional workplace etiquette, it is reasonable to believe that some people have to smoke in order to facilitate their work process.

The loose enforcements of anti-tobacco laws and regulations also exempt tobacco industries of plentiful liabilities, including heavy sale taxes, restricted advertising strategies and highly regulated marketing approaches. With relatively cheap price and mass production, the tobacco products in those Asian countries are quite affordable and easily accessible to the public, even adolescents. That explains why in both papers focusing on China in this dissertation, neither personal income nor family socioeconomic status (SES) has notable correlation with people’s smoking behaviors. The price and supply of tobacco products are never barriers for potential smokers. That also explains why income or SES couldn’t be identified as a significant mediating mechanism through which education influences smoking in China, and probably in other Asian developing countries as well. People’s access to tobacco products is not limited by their economic and social status.

In most developing countries, the lack of powerful intervention programs are caused by insufficient financial and human resources of the governments. For example, in 2000, the estimated smoking-related economic cost was 16.6 billion EURO in Germany (Ruff et al., 2000), but only 5 billion dollars in China (Sung et al., 2006). Considering the fact that the smokers in China largely outnumber Germany, it is apparent that the financial investment in tobacco-related healthcare and intervention programs is highly
inadequate in China. The limited resource also results in the deficient dissemination of smoking-related knowledge among both adults and adolescents, which could have been a highly efficient path to reduce smoking prevalence in those developing countries.

Based on the findings and implications above, some useful policy suggestions could be raised for those East and Southeast Asian countries which have been deeply affected by the global tobacco epidemic. First, it is highly necessary to enact and carry out strict anti-smoking laws and regulations. Smoking behaviors in public places should be banned, including workplace, schools, public transportations and restaurants. Also, tobacco companies should be given more restriction on their production, marketing and sale.

Second, as the lack of tobacco knowledge has been proved to be a crucial predictor of both adult and adolescent smoking, local governments in those developing countries need to creatively employ various media forms, such as newspapers, brochures, flyers, television shows, radios and online social media, to disperse the accurate information and knowledge about tobacco use to the population, especially how harmful smoking tobacco could be to human health.

Third, health education and prevention programs in school are indispensable for developing countries to reduce the tobacco epidemic in the future. They can not only impart smoking-related knowledge, but also create a smoking-free teaching and learning environment, which could eventually counter the huge peer influence in the spread of adolescent smoking and cultivate healthier habits among students. By investing in those school-based health education and programs, the prevalence of tobacco use among
children and adolescents will be substantially reduced, and so will the prevalence among
the entire population in the long run.


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