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Students' Attitudes, Knowledge, and Behaviors towards Tobacco Use, Passive Smoking, and Smoking Cessation across Three Cities in China: an Evaluation of School Smoke-free Interventions

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Abstract

Students' Attitudes, Knowledge, and Behaviors towards Tobacco Use, Passive Smoking, and Smoking Cessation across Three Cities in China: an Evaluation of School Smoke-free Interventions

By Dan Su

Objective: This study was designed to measure the effectiveness of the one-year GHI-CTP smoke-free interventions (school intervention, social media intervention, and technical assistance); to examine students' attitudes, knowledge, and behaviors towards smoking, passive smoking and smoking cessation; and to identify indicators associated with students' current smoking status.

Methods: A pooled sample of students aged 12 to 17 (N=8,419 for baseline survey and N=8,967 for evaluation survey) was drawn from the Emory Global Health Institute China Tobacco Control Partnership (GHI-CTP) data that were collected from 54 schools in Bayannouer, Changchun, and Dalian during 2011-2012. Tetrachoric Principal component analysis was used to group variables regarding students' attitudes of smoking, media message exposure, and school curriculum. Logistic regression models were built to examine the significant change of variables of interest between two phases, as well as the associations between students' current smoking status and their smoking attitudes, media message exposure, and school curriculum in both phases.

Results: After the intervention, the pooled students across these three cities were more likely to be non-smokers [AOR=1.23, 95% CI (1.07, 1.41)]. More students reported that they would refuse to smoke if cigarettes offered [AOR=1.36, 95% CI (1.21, 1.54)], would not smoke in next 12 months [AOR=1.45, 95% CI (1.28, 1.65)] or 5 years [AOR=1.38, 95% CI (1.22, 1.55)], and were in favor of banning smoking [AOR=2.58, 95% CI (2.41, 2.77] than before. More students would be prevented from parent smoking [AOR=1.32, 95% CI (1.24, 1.41)] or friend smoking [AOR=1.13, 95% CI (1.06, 1.21)], and exposed to anti-smoking media messages [AOR=1.88, 95% CI (1.73, 2.05)] than before. Factors associated with students' current smoking status after the intervention included: negative attitudes of smoking, media message exposure, and having school curriculum.

Conclusion: There was a regional difference in tobacco use for students in the three cities. In general, families, media, and school curriculum helped to establish a smoke-free environment for students. However, continuous cigarette access and existing smoking habits on campus indicated poor enforcement of the smoke-free interventions that were introduced to students. The enforcement of smoke-free interventions should be strengthened in the future.

Key words: tobacco control, China, students, smoke-free intervention

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Chapter One: Introduction

Introduction and rationale

Smoking prevalence

Global smoking prevalence:

Tobacco use is a serious public health problem on a global scale. A global smoking prevalence study indicated that there was a continuous rising number of current smokers, given the facts that daily tobacco users have increased from 721 million in 1980 to 967 million in 2012. Between 1980 and 2012, the global cigarette consumption grew by 26%. Also, an estimated 5.5% of disability-adjusted life-years (DALYs) and 6.9% of all deaths in 2010 can be attributed to tobacco use. Tobacco use remains the primary risk factor for global disease burden, and leads to 5.7 million deaths in 2010. If further actions toward tobacco control are not taken, tobacco use will claim about one billion lives by the end of this century (Ng, Freeman, et al., 2014).

Smoking prevalence in China:

Previous survey reported that approximately 80% of smokers were from developing countries (Boutayeb, 2006). Among them, China has the most serious tobacco control problem. China is the largest tobacco producer and consumer in the world, which account for more than one-third of the global tobacco market (WHO, 2008). China produces 43% of the world's tobacco (Eriksen, et al., 2012) and the cigarette sales generate 7% to 10% of the government revenue (Li, et al., 2012). In 2010, an estimated 28.1 % of Chinese residents aged 15 years old or above were current smokers based on the results of the Global Adult Tobacco Survey (GATS). More specifically, smoking prevalence was 52.9% for males and 2.4% for females (Yang, et al., 2010).

In China, nearly one million smokers die each year due to smoke-related diseases and the number is still growing and could reach two million by 2020 without effective smoke-free policies or interventions (Eriksen, et al., 2012). According to the Chinese national surveys conducted in 1984, 1996, and 2002, the scale of youth smoking is increasing and the age of people who smoke tends to be lower. The average age of "trying first cigarette" was 22.4 years old in the 1980s and it fell to 19.7 years old in 2006 (Ministry of Health of China, 2006). These various changes in smoking trends have contributed to increasing healthcare costs over time, e.g., the direct smoking-related healthcare costs in China were 4.2 billion dollars in 2003 and 6.2 billion dollars in 2008, the increasing healthcare costs due to smoking would lead to a heavier health and financial burdens to families and societies in the 21st century than times before if no effective smoke-free intervention is implemented (L. Yang, 2011).

Tobacco control implementation in China

With increasing awareness of the dangers of smoking, more and more regulations have been enacted to ban smoking in China. Since 1991, the Youth Protection Act of China has required parents or guardians to use appropriate methods to educate minors and prevent them from developing smoking habits. In China, smoking is no longer allowed indoors, e.g., in classromms or dormitories at schools, where minors are concentrated. Furthermore, in 1999, the law of Preventing Minors from Committing Crimes added a new item that makes it illegal for businesses to sell cigarettes or alcoholic drinks to juveniles.

In 2005, China was the 78th country that signed the WHO Framework Convention on Tobacco Control (FCTC). The FCTC is an international treaty that calls on governments and individuals

to take steps to reduce smoking-attributed diseases and deaths. Under the conditions of the FCTC, China has completely implemented a comprehensive ban on all forms of tobacco advertising, including bans on promotions on radio, television, print media and the Internet. However, regardless to these regulations and efforts, you can still see some tobacco companies sponsoring activities or events. This kind of advertising can also increase consumer exposure to the tobacco market in 2009; an 18-month project conducted in 7 universities in China was the first to introduce tobacco control curricula to school students. It was supported by the Bloomberg Initiative and completely prohibited smoking on campus (Yang and Yang, et al., 2009). In 2011, the Ministry of Health of China issued rules on implementing the Regulations on the Hygienic Management in Public Places. These rules explicitly stipulate that smoking is prohibited in indoor public places, such as hotels, restaurants, bars, gyms, museums, libraries, etc.

A national law will probably be more widespread and enforced, thus more effective at prohibiting smoking in public places than current regulations placed by other levels of organizations. Currently, China still does not have a national law or regulation that completely bans indoor smoking in public places. The tobacco industry makes great profits and has been China's largest source of revenue since 1987; tobacco is the local pillar industry in many places of China, such as Yunnan Province and Henan Province; cigarettes are commonly given as gifts and tightly woven into Chinese culture. All of these reasons are barriers for effective tobacco control implementation in China. In addition, although more than 100 cities in China have enacted smoking bans in public places, the effect of these regulations is not positive as expected. Possible reasons are that there are few corresponding penalties or sanctions and poor enforcement for those who smoke in public places. The authorities have failed to ensure

adequate supervision for people's smoking behavior in public places. Thus, to a large extent, building smoke-free environments relies on human consciousness and self-discipline, which is proved to be difficult to control and measure. In general, thus far, smoke-free policies were better implemented and enforced in hospitals, public transportation, and museums than restaurants, hotels, pubs, parks, and other outdoor places.

Clearly, current smoke-free policies in China are too vague and lack concrete and effective measures or penalties. Policies and strategies aimed to improve public health must include control of tobacco use, decreasing the smoking rate, and accelerating the decline in the tobacco epidemic, in order to set up healthier life-styles and habits for individuals in China. In addition, strengthening the law enforcement and regulations is necessary to improve the supervision of people's smoking behavior in public places.

Secondhand smoke exposure among school students in China

Prevalence of secondhand smoking exposure:

The dangers of smoking are not limited to just smokers. At a global level, each year there are more than 60 million deaths from diseases that result from secondhand smoke exposure. Children are the most vulnerable group and account for over a quarter of the total deaths. (WHO, 2009).

According to the 2010 Global Adult Tobacco Survey, 72.4% of non-smokers aged 15 years old or above in China have suffered from the effects of secondhand smoke (Yang, et al., 2010). The 2011 China Tobacco Control Report released by the Chinese Centers for Disease Control and

Prevention suggested that there were approximately 560 million Chinese adults and 180 million Chinese teenagers experiencing exposure to secondhand smoke. That is, secondhand smoke exposure has affected an estimate of 740 million non-smokers in China (Chinese CDC, 2011). An editorial from the Lancet in 2014 suggested that tobacco use leads to nearly 1.2 million deaths per year in China, of which 100,000 are related to secondhand smoke exposure (Ramin, T, 2014). Feasible recommendations were also provided to support legislation about secondhand smoke exposure.

The harm of secondhand smoke:

Research has proved that exposure to secondhand smoke is harmful to health. Unfortunately, there is no safe level of exposure to secondhand smoke, the longer of the exposure period, the more dangerous it is. Secondhand smoke can put people at high risk for bronchitis, pneumonia, asthma, heart disease, and cancer. The Centers for Disease Control and Prevention suggested that experiencing secondhand smoke exposure could increase the risk of having coronary heart diseases by 25%-30% and lung cancer by 20%-30% (CDC, 2010). Secondhand smoke can also lead to sudden infant death syndrome, otitis media, and low birth weight. Even brief contact with smoke could cause damage to the upper respiratory tract, stimulate frequent episodes of asthma, and increase the risk of heart attack. (Chinese CDC, 2011). Researchers in China showed that public places were the most frequent sites for secondhand smoke exposure.

The importance of implementing smoke-free interventions among school students

The earlier one starts smoking, the more self-harm occurs.

Previous research has found that most smokers tried their first cigarette when they were teenagers and then they easily formed a habit of smoking afterwards. Furthermore, those who began smoking as younger teenagers are more likely to consume larger amount of cigarettes, smoke for longer periods, and have more difficulties quitting smoking (Pokorny, et al., 2004).

Tobacco control should focus on teenagers.

The peak years for initial cigarette use are between the ages of 11 and 13 (Johnston, et al., 2012). According to the 2010 report composed by the European Union, people who consume tobacco have a higher risk of becoming addicted than those who consume heroin, cocaine, alcohol, or cannabis (SCENIHR, 2010). Tobacco is addictive because it contains nicotine, which is a highly additive drug. As a result, teenagers who have already experimented with cigarettes can easily become new regular smokers. Therefore, it is important to raise students' awareness of smoke-related health hazards and help them learn and form healthy choices, especially at a young age when various youth are undergoing a period of rebellion and are at the peak stage of possibly yielding to the temptation to initiate smoking and ongoing smoking behavior. In addition, teenagers who smoke are more willing to use illegal drugs and alcohol compared to teenagers who do not smoke (Newcomb, et al., 1986). Furthermore, students spend most of their time at school and there is no doubt that school intervention is a crucial aspect for smoke control strategies among teenagers.

Smoking increases the risk of varieties of diseases.

The public health systems of today's world aim at reducing the dangers of tobacco in order to protect and promote human health. In China, more than 3,000 people die each day due to

smoking-related diseases; and in 2005, the number of deaths due to tobacco was nearly 1.2 million in China (Chinese CDC, 2011). Smoking and passive smoking are two important risk factors for non-communicable diseases, such as lung cancer, chronic respiratory disease, coronary heart disease, and stroke. Several researchers have reported a higher probability of asthma and cardiovascular diseases among teenage smokers compared to their non-smoking peers (Flouris, Faught, et al., 2008). It is worth noting that exposure and addiction to tobacco at an early age can also have negative influences on neurological development. Thus, tobacco control among teenagers has a great significance for both physical and psychological aspects.

Purpose statement

This study was designed to examine the smoking attitudes, knowledge, and personal experience of students aged 12 to 17 from 54 selected primary and secondary schools in three cities of China: Dalian, Changchun, and Banyannour; and, to assess the effectiveness of smoke-free interventions in these schools through conducting a comparison for the results of a baseline survey and a post-intervention survey. This study focused on, target population's change in knowledge, attitudes, and behaviors regarding tobacco use, secondhand smoke, smoking cessation, family and peer factors, and how social context and school environment impacted students' smoking behaviors. An additional objective of our study is to identify the indicators associated with students' current smoking status and to what extent.

Research questions

The study objectives are explored through the following research questions:

- What was the personal experience of tobacco use among primary and secondary school students in Dalian, Changchun, and Banyannour, China? (Including ever-smoked rate, age of first smoke, current smoke rate, daily consumption of cigarettes, youth access to cigarettes, and where to smoke)
    - Students' personal experience of tobacco use before the implementation of smoke-free interventions.
    - Students' personal experience of tobacco use after the implementation of smoke-free interventions.
    - Examine changes in students' personal experience of tobacco use.

- What was the personal experience of secondhand smoke exposure among primary and secondary school students in Dalian, Changchun, and Banyannour, China? (Including where to smoke, in home secondhand smoke exposure, and other secondhand smoke exposure)
    - Students' personal experience of secondhand smoke exposure before the implementation of smoke-free interventions.
    - Students' personal experience of secondhand smoke exposure after the implementation of smoke-free interventions.
    - Examine changes in students' personal experience of secondhand smoke exposure.

- What were the attitudes and knowledge level about smoking and passive smoking among primary and secondary school students in Dalian, Changchun, and Banyannour, China? (Including whether or not smoke if best friend offer cigarettes, whether or not smoke in next 12 months/next 5 years)

- Students' attitudes and knowledge level about smoking and passive smoking before the implementation of smoke-free interventions.
- Students' attitudes and knowledge level about smoking and passive smoking after the implementation of smoke-free interventions.
- Examine changes of students' attitudes and knowledge level about smoking and passive smoking.

- What was the attitude and personal experience towards quitting smoking among primary and secondary school students in Dalian, Changchun, and Banyannour, China? (Including favor of banning smoking, intention to quit smoking, ever tried to quit smoking in last year, main reason of quitting smoking, and ever received help to quit smoking)
  - Students' attitude and personal experience of stopping smoking before the implementation of smoke-free interventions.
  - Students' attitude and personal experience of stopping smoking after the implementation of smoke-free interventions.
  - Examine changes of students' attitude and personal experiences of stopping smoking.

- How was the social environment of tobacco control for primary and secondary school students living in Dalian, Changchun, and Banyannour, China? (Including family/peer factors, media messages, and school environment.)
  - Social environment of tobacco control before the implementation of smoke-free interventions.
  - Social environment of tobacco control after the implementation of smoke-free interventions.

- Examine changes of social environment of tobacco control.

- What are the major findings across these three cities and the differences between cities?

Significance statement

Although China has issued several smoke-free policies and regulations, tobacco control is still facing lots of barriers, including cultural, economic and political ones. The public should be made aware of the dangers of smoking and passive smoking and of the need to adopt tobacco control to sparkplug healthy life styles in order to improve teenagers' growth and development. So far, there is a very little knowledge about the effectiveness of the smoke-free policy implementation among school students in China. Few studies have examined the changes in students' smoking-related knowledge, attitudes, and multiple behaviors toward smoking after the smoke-free intervention, especially in such a large sample size. Besides knowing the smoking prevalence and smoking status among teenagers, it is even more important to evaluate the effect of an intervention on tobacco control. This kind of evaluation will enable planning and implementation of the next-step measures needed to improve the smoke-free interventions and it also enables more effective and reliable tobacco control strategies to be made.

This study was conducted in three cities of China; they are Dalian, Changchun, and Bayannouer. In terms of school smoke-free interventions, these three cities all have smoke-free policies for schools. In Dalian, the Smoke Free Schools Policy went into effect in April 2012, four months after the conduction of our baseline survey. In Changchun, Standards for Changchun Tobacco Free Schools went into effect in July 2011, four months prior to the conduction of our baseline

survey. And for Bayannouer, the Smoke Free Schools Policy went into effect in October 10th, 2011, 20 days prior to the conduction of our baseline survey. After a one-year smoke-free intervention, the effectiveness of these smoke-free policies will be examined and discussed in our study.

Definition of terms

Passive smoking (Secondhand smoke or environmental tobacco smoke): the inhalation of smoke produced by other smokers. Passive smoking increases the risk of sudden infant death syndrome, otitis media, asthma, respiratory illnesses, lung cancer and coronary heart disease.

Gross domestic product (GDP): GDP is defined by the Organization for Economic Cooperation and Development (OECD) as a sum measure of the total value from all production, including taxes but excluding the value of all subsidies.

State Tobacco Monopoly Administration: A national tobacco monopoly system that was created by China National Tobacco Corporation in 1984. The purpose of its establishment is to provide centralized management of the national tobacco industry, especially in finance, production, supply, marketing, and internal and external trade. Each province and main cities in China have provincial or municipal tobacco monopoly bureau.

Per-capita urban disposable income: The IBISWorld Business Environment Report defines per-capita urban disposable income as a way to determine an urban individual's ability to purchase goods or services." It is calculated by taking household income earned from all sources

(wages, government transfers, rental income etc.) minus taxes, savings and some non-tax payments (e.g. fines, forfeitures and donations) and dividing by the number of people in each household" (IBSWorld, 2014).

Cluster sampling: The National Bureau of Statistics of the People' Republic of China defines cluster sampling as a sampling method conducted when homogeneous groups are evident in a target population. Units are drawn in groups from a population rather than extracted one by one. This method is used when the investigation unit is relatively concentrated, for then it is more convenient to organize and carry out the survey. However, the survey units are unevenly distributed in the population and the accuracy is less satisfactory. Therefore, this method can be used when there is little difference among groups or it is inappropriate to select the sample individually and separately.

China Healthy Provinces Index (CHPI): the Economist Intelligence Unit (EIU) created the China's Healthy Provinces Index, which synthesizes the health status (supplies a snapshot of general health levels by province), health awareness (measures awareness based on individual actions related to preventative care and overall education levels), health resources (measures the access to healthcare personnel and health service centers), and health financing (assesses the level of financial support offered by local government and spending on healthcare more broadly).

Chapter Two: Review of the Literature

Studies on current smoking prevalence among teenagers

China:

In 2014, The National Children's Study of China (NCSC) has recruited 24,013 fourth to ninth grade students (elementary and middle school students) from 100 counties in 31 provinces in China. This nationally representatives sample was used in order to examine the smoking prevalence and smoking risk factors among Chinese elementary and middle school students. Based on the results of this study, the prevalence of ever smokers and current smokers were 19.0% and 5.4%. Participants with these following characteristics were more likely to smoke compare to those who don't have such characteristics. These characteristics including: boys, middle school students, rural students, boarding students, non-only children, and low education level parents (X Zhang, et al., 2014).

A study conducted in December 2009 has recruited 3,221 middle school students aged 12-17 years old in Anhui Province in China. This study was designed to figure out the status of tobacco use and related factors among Chinese middle school students. Stage stratified cluster sampling was used and participating students completed the survey by self-reported questionnaires and interviews. This study reported a 10.6% prevalence of current smokers and a 19.7% prevalence of ever smoked. More specifically, 16.2% of males and 4.3% of females were current smokers. 25.3% of males and 13.4% of females have ever smoked. In addition, there were 0.7% of middle school students having used other forms of tobacco products other than cigarettes (Qing, Yue, et al., 2011). Another study conducted in Beijing reports that 17.02% of elementary and middle

school students were ever smokers and 7.05% of them are current smokers (Guo, Deng, et al., 2009).

A baseline survey that has an effective sample size of 3,519 secondary school students was to access the risk factors of students tobacco use in Henan Province in China. These students were aged 10 to 19 years old and participated in this study through self-completed questionnaires. This study has given a list of data about smoking prevalence. There were 15.1% of boys and 1.4% of girls reported they smoked at least occasionally. The percentage of daily smoker was 2.3% for boys and 0.1% for girls. The percentage of weekly smoker was 1.9% for boys and 0.1% for girls. The percentage of occasional smoker was 10.8% for boys and 1.2% for girls. The percentage of ever-tried smoking was 16.9% for boys and 4.0% for girls. The percentage of never smoked was 68.0% for boys and 94.6% for girls. In addition, this study has explained the importance of implementing effective smoke-free interventions for young teenagers (Zhang, Lian, et al., 2000).

A 2001 study reports the smoking prevalence among seventh- to ninth-grade students in Wuhan, China. 22 schools in the urban and rural area of Wuhan were randomly selected and there were 6,994 students participating this survey. 16% of those boys reported past-30-day smoking and 4% of girls reported past-30-day smoking. This study also indicated that smoking was more prevalent among rural boys than among urban boys, however, an opposite situation was presented among rural girls and urban girls ($p<0.05$). This study recommended smoke-free program, restrictions on tobacco industry, and limit youth access to cigarettes to effectively implemented tobacco control and reduce smoke-related diseases among Chinese students (Unger, Jennifer B., et al., 2001).

Worldwide:

A 2008 study used the data from the 2003 Tobacco Survey has examined the prevalence of adolescents smoking in Northwest Ohio. The researchers have collected data from a representative sample consisted of 5,392 adolescents who have aged from 10 to 18 years old. Weighted chi-square and multiple logistic regressions were used for this study. Results show that among these participating adolescents, the prevalence rates for having ever smoked vary among different grade groups. For elementary level students (grades 4-5), the rate was 7.4%; for middle level students (grades 6-8), the rate was 17.7%, and for high-level students (grades 9-12), the rate was 41.4%. Overall, smoking prevalence was 26.8% among males and 25.6% among females. The difference in gender is not statistically significant (P-value=0.332)(Khuder, Sadik A., et al., 2008).

According to a 2011 study that using the self-administered survey, the National Youth Tobacco Survey (NYTS), which conducted in the U.S. in 2004 and included 22,111 students with a age range of 10 to 17 years old, the prevalence of current smokers was 6.0% (95% CI: 5.1%–7.0%) among early adolescents compared to 18.8%(95% CI: 16.9%–20.9%) among middle adolescents with aged from 14–17 years. Among early adolescents, the prevalence of former smoking was 12.2% (95% CI: 10.9%-13.5%); while among middle adolescents, the prevalence of former smoking is 24.9% (95% CI: 23.6%–26.3%).

Studies on current secondhand smoking exposure among teenagers

Based on the 2010 Global Adults Tobacco Survey, the China's data showed that an estimated of 72.4% non-smokers were exposed to secondhand smoke and there were 180 million Chinese children under 15 years old experiencing secondhand exposure (Yang, 2011). Nearly 43.9% teenagers have exposure to secondhand smoking at home and 88.2% of teenagers reported there were smokers among their close relatives or friends (Tian, Qian, Zhang, et al., 2006).

A multistage cluster-sampling design was used to examine the risk factors of students' secondhand smoking exposure in Yunnan Province, China. A total of 800 students from colleges, secondary schools, and primary schools in 3 cities (Kunming, Qujing, and Chuxiong) of Yunnan were included in this study. There were 799 valid questionnaires and the age range of participants was from 10 to 27 years old. The results showed that there were 53.32% participating students facing secondhand smoking exposure in home and 53.93% facing secondhand smoking exposure outside home. Both of these two data were higher than the national average (Chinese Ministry of Health). An estimated of 70.59% students claimed that they exposed to secondhand smoking inside or outside home, which is lower than the national average (72.4%) (Yang, 2011; Liu, 2014).

A 2014 study conducted in Beijing, Zhengzhou, and Kaifeng by the Chinese Association on Tobacco Control (CATC) showed that an estimated 18.1% of overall secondhand smoking exposure among primary school students. The exposure rates in Beijing, Zhengzhou, and Kaifeng were 19.3%, 17.1%, and 15.7%, respectively. The difference of between these cities has no statistics significance (P=0.188). In addition, there were 59.3% primary students claimed that

restaurants were the most likely place for secondhand smoking exposure, which was followed by home exposure (35.9%) and Internet café exposure (10.5%) (Zhao, Ni, Xu, et al., 2014).

Another 2013 study conducted in 3 cities (Weihai, Jinan, and Liaocheng) of Shandong Province has included 5861 valid responds from primary school students. Approximately 49.7% of them were exposed to secondhand smoking and the rural exposure rate was higher than the urban. The majority of smokers in home were fathers (80.4%) and grandfathers (24.7%). The percentage of having smoked for over 10 years in home was 43.4% for fathers and 74.0% for grandfathers (Sun, Wei, Zhou, et al., 2013). The author warned that primary school students in Shandong Province faced a high rate of secondhand exposure in home.

A 2007 Chinese national survey conducted in 31 provinces and Xinjiang Production and Construction Corp has collected 24,773 valid questionnaires among students in order to examine the Chinese teenagers' secondhand smoke exposure status and its risk factors. According to the results, 23.1% of the participants reported they have ever smoked, 6.3% of the participants were current smokers. The passive smoking rate was as high as 57.5%. The students faced almost the same secondhand smoke exposure rates in home and outside home. The percentage was 42.3% for in home exposure and 42.0% for outside home exposure. 26.8% of the students reported they exposed to secondhand smoking both in home and outside home. The multi-factor logistic regression analysis shows that students aged from 8 to 12 were less likely to experience secondhand smoke exposure. But students aged from 13 to 19 years old were the high-risk group that facing secondhand smoke exposure. There was no statistics significance between different cities (P=0.249). In addition, students that have parents, friends, or teachers smoked, or

students that study in a school without any tobacco control activities were more likely to suffer passive smoking (Wu X, Yang Y, et al., 2008).

A 2006 survey has examined the situation of passive smoking among students in Hebei Province. There were 818 students aged from 9 to 25 years old has completed the self-report survey. The overall reported passive smoking rate was 56.8%. And the passive smoking rate was 50.7% for primary school students, 52.0% for middle school students, 70.3% for high school students, and 63.0% for college students ($P< 0.01$). An estimated of 63.3% of boys claimed that they have suffered passive smoking, which is higher than the amount of girls (50.9%). Students who have parents, teachers, or friends smoke were more likely to exposure to secondhand smoke. Among students who have suffered passive smoking, 70.5% of them reported they had exposure at home, while 75.7% of them reported they were exposed to environmental tobacco smoke (Sun J, Zhang X, et al., 2008).

The Zhejiang Centers for Disease Control and Prevention has conducted a survey in 2011 in order to determine the situation of secondhand smoke exposure among secondary school students in Zhejiang Province. Multistage cluster-sampling design was used to select 3,799 students coming from 22 schools in 11 cities of Zhejiang. Students should complete a self-report survey, which was modified by the Zhejiang CDC based on the Global School-based Student Health Survey. The passive smoking rate was 60.59% for boys, 56.96% for girls, 56.89% for middle school students, and 60.50% for high school students. And the overall passive smoking rate was 59.44%. In terms of exposed places, home and schools were the most likely places for secondhand smoke exposure. The percentage of secondhand smoke exposure was 44.85% for

home and 32.28% for schools. Having smokers in surrounding population will increase the risk of secondhand smoke exposure among teenagers. However, having education courses related to skills of reject smoking offered by others will decrease the risk of secondhand smoke exposure among teenagers (Xu Y, Xu S, et al., 2013).

Current tobacco control policies and smoke-free interventions implemented in China

In 1987, the "Regulations of Health Management in Public Places" was issued by the State Council of China, while the "Law of People's Republic of China on Tobacco Monopoly" and the "Law of the People's Republic of China on the Protection of Minors" were passed by the National People's Congress of China in 1991. Laws forbid selling cigarettes to minors under 18 and it is the legal guardians' obligations to prevent minors from tobacco use. In addition, the Patriotic Health Campaign Committee, the Ministry of Health, and the Ministry of Construction passed the "Ban of Public Smoking on Public Transports and Waiting Rooms" in 1997. Furthermore, the Ministry of Health issued the "Detailed Rules for the Implementation of the Regulations on the Administration of Sanitation in Public Places" in 2011. China dose have government regulations and laws regarding tobacco control, however, this country still lacks a national law with complete legislations.

More and more regulations and laws were issued in order to build a smoke-free environment. To date, over 45% of cities in China has proposed local smoking ban in public places. However, the implementations of some regulations are facing problems. For example, a 2012 report about China's tobacco industry and anti-smoking campaign said that the government of Beijing in China has planed to fully implement school smoke-free interventions by 2011, but this plan was

postponed four years (Li. 2012). The recent Lancet report also pointed out the unsuccessfulness in the implementation of WHO Framework Convention on Tobacco Control (FCTC) in China. Even though China signed the WHO FCTC in 2003, the annual tobacco production still increased from 1,789 billion unites in 2003 to 2,516 billion units in 2012. The main reason was described as the serious conflict of interest between tobacco control and the State Tobacco Monopoly Administration (STMA). The STMA has controlled the national tobacco industry, therefore also plays an important role in the implementation of the FCTC and tobacco control in China (The Lancet, 2014). In addition, many other factors may also have negative impact on the implementation of tobacco control regulations or laws, which will be discussed below.

Studies on the implementation of smoke-free interventions for school students

Worldwide:

School-based tobacco use prevention programs have been proved effective in preventing teenagers from forming a habit of smoking. A WHO report showed that the smoking rate was nearly 25% to 60% lower among intervention group compared to control group, after 1 to 4 years' effective smoke-free intervention (WHO, 1999). Another study indicated that good school tobacco control programs would positive prevent or delay the tobacco use among 20% to 40% of the participating teenagers (CDC, 2000).

China:

A 2006 study conducted in Shanghai has accessed the effectiveness of smoke-free intervention implemented in 2 middle schools. There were a total of 963 students participating in this study. Students from the intervention school received a 1-year smoke-free intervention, while students

from the control school received regular school education as usual. The average age was 13 for those students. Boys and girls have similar proportion. There was no statistically significant difference between these two schools in terms of age, grade, and gender ($P > 0.05$). This study included 3 phases: baseline, after intervention, and 6-month after intervention. The interventions included aspects of policy, environment, and education. After 1-year intervention, the attempt-smoking rate has declined from 9.7% to 4.2% for intervention group; the heavy passive smoking rate has declined from 15.5% to 12.2%. In addition, students in the intervention group have better knowledge, awareness, and skills of tobacco control. Obvious results on tobacco control have been achieved after 1-year intervention and these results still existed 6-month after the intervention (Zheng P, Cui H, et al., 2006).

In order to clarify the changes of smoking-related health knowledge, attitudes and behaviors after the school-based smoking prevention, 627 middle school students aged from 12 to 17 years old in Yanji were recruited to complete a self-reported survey. This survey includes 4 parts: demographic information, knowledge and attitudes of the harm of smoking, smoking behavior, and smoking intention. The 3-week intervention program mainly consisted of smoke-free lectures, activities, and movies, and was conducted once a week. The evaluation survey was conducted 3 month after the intervention among the same students to appraise the effectiveness of smoke-free intervention. The results showed that the knowledge related to tobacco prevention were significantly improved among these students ($P<0.05$). However, students still faced the same situation of secondhand smoking exposure and the smoking prevalence did not change too much after the intervention. But more students said they would persuade others not to smoke in public places ($P< 0.05$). The author indicated the positive impact of short-term smoke-free

interventions on the improvement of students' tobacco control knowledge and attitudes. However, more efforts should be done in order to reduce the smoking prevalence and secondhand smoking exposure (Guo Y, 2013).

A two-year smoke-free intervention from 1998 to 2000 was conducted in 21 schools in Jiangxi Province. 4 secondary schools and 6 primary schools were selected as intervention group, while another 4 secondary schools and 6 primary schools with similar conditions were selected as control group. The intervention methods included sending out smoke-free announcements by the Municipal Education Bureau, carrying out large-scale publicity activities and knowledge contests in schools, gaining support from parents, implementing smoke-free regulations, and set up smoke-free supervisor system. After two years' intervention, the smoking prevalence of intervention group has declined from 1.77% to 1.68%, while the smoking prevalence of control group has increased from 1.71% to 3.53%. In the intervention group, the percentage f students that had awareness of tobacco's harm has increased from 67.28% to 75.66%; while in the control group, the percentage f students that had awareness of tobacco's harm has increased from 65.03% to 75.51%. There was a significant difference between the pre-and post- interventions ($P<0.05$). However, there was no significant difference between the intervention group and the control group ($P>0.05$). In the intervention group, the percentage f students that would reject cigarettes offered by others has increased from 60.90% to 75.89%; while in the control group, the percentage f students that would reject cigarettes offered by others only increased from 61.03% to 64.86%. There were significant differences both between the pre-and post- interventions and between the intervention and the control group ($P<0.05$) (Long J, Huang Y, 2003).

The Dalian Municipal Centers for Disease Control and Prevention has released a report in 2011 to introduce the effect of smoke-free intervention among secondary schools in Dalian. 4 middle schools and 2 high schools were selected to participate in this study. Only boys were included in this study since there was a general higher smoking prevalence among boys compared to that among girls. Smoke-free interventions were conducted after the baseline survey, such as smoke-free school education, lectures, publicity among parents, and sending out promotional literature. The final evaluation was conducted 6 month after the baseline evaluation. The results of final evaluation suggested a significant increase of students' awareness and knowledge of tobacco control ($P < 0.01$).

Studies on risk factors that associated with teenagers' smoking behaviors and the implementation of smoke-free interventions in schools

Support and trust:

This nationally representatives sample collected by the National Children's Study of China (NCSC) in 2014, which contains records from 24,013 elementary and middle school students from 100 counties in 31 provinces in China, has suggested that trust, support from others and parent-child conflict significantly associated with students' smoking status. Low trust and support from teachers and higher parent-child conflict would positively predict both students' smoking and smoking frequency. Students have lower trust and supports from classmates were more likely to smoke. While those with higher trust and support form classmates have a higher smoking frequency. Overall, students who smoke reported a significantly lower trust and support from others and less parent-child satisfaction compared to non-smokers ($P <0.001$).

Family/school smoking environment:

This study suggested that there was a significant association between teacher/friend smoking and student smoking ($\chi 2 = 254.25$, p b 0.001; $\chi 2 = 1290.66$, p b 0.001). However, smoking status of teacher and friends only predicted student smoking, but not smoking frequency. This study also examined the associations between smoking and family/school smoking environment. (X Zhang, et al., 2014).

Peers:

2004-The Youth Tobacco Access Project's Student Survey was conducted among 5925 students at 14 middle schools that had sixth through eighth grade structures in Illinois. This was an anonymous student self-report survey conducted during March and April in 1999, and the data was used as current data. 5399 valid responding were used for analyses. The baseline data was collected form a 3-year intervention study that provided data form 11 randomly selected towns in northern and central Illinois. The study was to assess school based contextual norms for current smoking among young adolescents. The study used a bivariate correlation that shows peer tobacco use was highly correlated with the proportion of current student smokers ($r=0.92$, $p<0.001$). School students who reported a higher peer tobacco use were more likely to be current smokers compared to those who reported a lower peer tobacco use (Pokorny, et al., 2004).

Peers and family:

In 2003, a cross sectional study based on the Northwest Ohio Youth Tobacco Survey (NOYTS) was conducted in a total of 124 schools in Northwest Ohio. These schools include elementary, middle, and high schools and there were 5,392 students aged 10 to 18 years old participating in

this study. Multi-stage cluster sampling technique was used to select participants. In this study, results indicated peer and/or family influence was significant related to smoking among students. Among students who do not have closest friend smoke, the smoking prevalence rates were 4.5% for grades 4-5, 9.6% for grades 6-8, and 26.3% for grades 9-12. Among students who have one closest friend smoke, the smoking prevalence rates were 26.5% for grades 4-5, 34.4% for grades 6-8, and 48.7% for grades 9-12. Among students who have two or more closest friends smoke, the smoking prevalence rates were 30.9% for grades 4-5, 42.3% for grades 6-8, and 61.6% for grades 9-12. From these above data, we can see the smoking prevalence was higher among those students who had more friends smoke compared to those who had less or none friends smoke fro all grades. In addition, the researchers checked the relationship between having closest friend smoke and early initiation of smoking among adolescents in Northwest Ohio. Participants reported 3 times more likely to smoke at earlier age if having a close friend who smokes compared to those who do not have any closest friend smoke (OR= 2.93; P=0.001). Similarly, participating students who have 2-4 closest friends smoke were 4 times the odds of starting smoking at earlier age compared to those who do not have any closest friend smoke (OR= 4.14; P=0.001). Furthermore, students who have a family member smoke were also more likely to initiate smoking at an earlier age. Thus, family environment and peer influence should be considered and included in smoking prevention programs for school students.

Media exposure:

The 2004 wave of the National Youth Tobacco Survey (NYTS) is a self-administered survey for middle and high school students in the U.S. in order to evaluate the current situation of youth tobacco use. This survey was conducted at 267 schools and there were a total of 27,933

respondents. The age range of these participants was from 9 to 21 years old. A 2011 study conducted by Dr. Andrea Villanti used this 2014 NYTS and includes 22,111 students aged from 10 to 17 years old since people elder than 18 years can purchase cigarettes legally. The results of this study reflected an increased current and former smoking among adolescences that exposure to tobacco-related media. High exposure to tobacco advertising has a positive association with former smoking ($P < 0.05$) among students aged 10-17 years old, and also has a positive association with current smoking among students aged 10-13 years old (Villanti, et al., 2011).

Skilled personnel and school curriculum:

2009- A 2009 study was conducted to evaluate China's first efforts to introduce tobacco control courses in public health schools at 7 Chinese universities. It was an 18-month project to build tobacco control training infrastructure and improve graduates' smoking-free related knowledge and skills in universities of China. The result shows that the public health students' knowledge and skills of tobacco control advocacy has increased in these 7 universities after teaching the new curriculum. However, this paper did not provide specific data (Yang T., Yang X., 2009).

Summary and Knowledge gaps

In general, the prevalence of ever smoked was 19% and the prevalence of current smokers was 5.4% among Chinese teenagers, which is lower than the number in the United States. Male students have a larger number of ever-smokers or current smokers than female students. Middle school students are more likely to smoke than primary school students.

The secondhand smoking exposure varies in different places of China. In general, a majority of cities have high passive smoking rates among teenagers. Studies conducted in Yunnan, Shandong, Hebei, and Zhejiang province all reported nearly half or over half of the participating students experienced secondhand smoking exposure. A nation-wide survey conducted in 2007, which covered students from 31 provinces and Xinjiang Production and Construction Corp, has a passive smoking rate as high as 57.5%. However, based on a 2014 study conducted in Beijing, Zhengzhou, and Kaifeng among primary school students, the passive smoking rate was much lower (18.1%). In terms of exposed places, home, schools, restaurants, and Internet Cafes were most likely places for secondhand smoke exposure.

Most of the school-based smoke-free interventions were effective and feasible in tobacco control. The studies conducted in Shanghai, Yanji, Jiangxi, and Dalian all reported an increasing percentage of awareness and attitudes on tobacco control, as well as an increasing percentage of rejecting cigarettes offered by others after the effective smoke-free interventions. In addition, for students who received long-term smoke-free interventions (more than 6 months), the smoking prevalence has declined. However, most studies were conducted in one city. A larger investigation scale and a more representative sample are necessary for future study.

Among all the risk factors that may lead to teenagers' smoking behaviors, family environment, school environment, peers, and media exposure were considered as the most important factors.

In conclusion, smoking and secondhand smoking exposure among teenagers is a serious issue in China. School education, positive media exposure, and having fewer smokers in surrounding

population will have a positive impact on reducing the risk of secondhand smoking exposure and developing a habit of smoking among teenagers. Although more and more cities have issued local tobacco control regulations, a national ban of smoking is still needed to support the complete smoking ban in public places, especially in schools.

Chapter Three: Methodology

Objectives

The study was part of the Tobacco Free Cities Program that was supported by Emory University Global Health Institute-China Tobacco Control Partnership (GHI-CTP) (Emory Global Health Institute, 2014). We conducted a secondary analysis of data collected from 54 primary and secondary schools in three Chinese cities: Dalian, Changchun, and Banyannouer. The purpose of this study was to test the effectiveness of school smoke-free interventions that began in 2011 among these 54 enrolled schools. A variety of factors were discussed to illustrate the impact of these smoke-free interventions. Additionally, we identified several indicators that may be associated with participating students' current smoking status. Furthermore, we explored the regional differences to see if the implementation of these smoke-free interventions varied by geographic location within China.

Study Setting and Sample

The pooled dataset used for this study contains data generated from the pre- and post-intervention surveys conducted in Bayannouer, Changchun, and Dalian in 2011 and 2012. These three cities are among the second batch of pilot Chinese cities that participated in the GHI-CTP. The GHI-CTP was established in 2008 with the support of a five-year grant from the Bill & Melinda Gates Foundation to facilitate the implementation of tobacco control policies and establishment of tobacco-free cities in 17 selected cities of China through providing knowledge, information, technical assistance, and strategies to the target population. The three cities discussed in this study have conducted smoke-free interventions to create smoke-free schools and agreed to provide GHI-CTP with de-identified datasets.

Bayannouer, Changchun, and Dalian are three geographically dispersed cities in China with different socioeconomic status, health levels, education levels, policies, and tobacco consumption. According to the unofficial Tiers of Cities in China, Bayannouer is a fifth-tier city, Changchun is a second-tier city, and Dalian is a first-tier city. In 2012, Bayannouer had a population of 1.67 million and the GDP reached 81.33 billion yuan. The per-capita urban disposable income was 16,36 yuan in 2011 and increased to 18,455 yuan in 2012. There is a municipal tobacco monopoly bureau in Bayannouer but no tobacco manufacturer there. The number of cigarette retail stores was 4,624.

Changchun is a city that was named the Hygiene City, Civilized City, and rated as the best city in that nation for quality of life. In 2012, Changchun had a population of 7.57 million and the GDP was 445.66 billion yuan. The per-capita urban disposable income increased from 20,487 yuan in 2011 to 23,089 yuan in 2012. In addition to a municipal tobacco monopoly bureau, Changchun also has a tobacco manufacturer named Hongta Group Changchun Cigarette Factory. There were 30,000 cigarette retail stores in Changchun and the cigarette sales volume was as many as 14.77 billion cigarettes in 2013.

Dalian is also named as the Hygiene City and Civilized City of China. The population of Dalian was 5.90 million in 2012 and the GDP has reached 700.28 billion Yuan in 2012. The per-capita urban disposable income was 24,276 Yuan in 2011 and 27,480 Yuan in 2012. Dalian does not have any tobacco manufacturer but do have a municipal tobacco monopoly bureau. In 2010, 13.50 cigarettes were sold, contributing in tax revenue. Its cigarette sales volumes were 13.50

billion cigarettes in 2010, which contributed 1.02 billion yuan for the revenue. There are approximately 24,000 cigarette retail stores in Dalian.

Local CDCs of all the cities identified similar criteria to select eligible students, which will be introduced in the Procedures section. In the 2011 baseline survey, a total of 8,419 students aged 12 to 17 from these 54 primary and secondary schools in Bayannouer, Changchun, and Dalian were included, and 8,313 of them provided valid data. After the one-year school smoke-free intervention, the evaluation survey was conducted among the same 54 schools. Of the 8,967 students aged 12 to 17 who completed the evaluation survey, 7,518 provided valid data.

The smoke-free interventions include three parts: school intervention, social media intervention, and technical assistance from GHI-CTP. Among other activities, the school intervention included formulating and implementing a smoke-free policy, training staff, and developing an enforcement team, health education brochure pamphlet, knowledge competition, and smoke-free signage. The enforcement of intervention activities was once a quarter in Dalian, monthly in Changchun, and monthly in Bayannouer. The media intervention included smoke-free related news/advertisement on a TV station, radio, newspaper, and the Internet. In addition, GHI-CTP provided technical assistance that included bi-annual progress reports, a monthly conference call, and site visits. The purpose of these interventions was to create a smoke-free environment in schools and supervise its implementation.

Procedures

As a part of the Tobacco Free Cities Program, this survey was conducted in 54 selected primary and secondary schools in Bayannouer, Changchun, and Dalian. With the technical guidance of Emory University Global Health Institute, city-level Chinese Centers for Disease Control and Prevention (CDCs) in these three cities had assisted with conducting the survey and organizing a variety of tobacco control campaigns.

The baseline survey was completed in December 2011 and the evaluation survey was completed in December 2012 after the one-year smoke-free intervention among these pilot schools. This school-based survey was anonymous and self-reported. School students aged 12 to 17 years old were eligible for this survey. This self-administered survey was designed based on the Global Youth Tobacco Survey (GYTS) and its reliability and validity had been tested in a prior study (Chen, P.L., 2008). There are seven modules in this assessment instrument: tobacco use, knowledge and attitudes, secondhand smoke, stopping smoking, media messages, curriculum, and participant characteristics (a.k.a., demographics).

Local CDCs used a standardized methodology for sampling frame construction, participant recruitment, field procedure conduction, and data collection. Local institutional review boards approved the research protocol. In this research, a multi-stage cluster sampling technique was used. In stage one, 54 participating schools in Bayannouer, Changchun, and Dalian were initially chosen based on agreement to participate in this survey (convenience sampling), including 33 primary schools and 21 secondary schools in total. In stage two, certain classes were selected as systematic samples in each school. All students in these selected classes were required to

complete this survey by themselves. After completing data collection, staff in these three municipal CDCs and GHI-CTP worked together to perform data entry and build the de-identified school dataset for each city.

Data Analysis

The GHI-CTP and the municipal CDCs in Bayannouer, Changchun, and Dalian granted permission to access and use these datasets. Double entry was performed for collected data by using EpiData 3.1. Data was then transformed from EpiData format into SAS format for secondary analysis. All statistical analyses were conducted using SAS 9.4 (32). Ink (SAS Institute Inc., Cary, NC, USA.).

Data Cleaning and Recoding

School datasets of Bayannouer, Changchun, and Dalian were merged into one dataset. For each variable, extreme values, improbable values, and outliers were set as missing values. Cases without complete information about gender, age, grade, and ethnicity were excluded from the analysis sample in this study. All variables were recoded and examined according to specific analysis objective and exclusion criteria.

Demographic information of participating students included gender, age, grade, and ethnicity. These information were collected from the following questions: What is your gender? How old are you? In what grade are you? And which of the following best describes your ethnicity? The response options for age were: 12, 13, 14, 15, 16, and 17. The response options for grade were

7th grade, 8th grade, 9th grade, 10th grade, 11th grade and 12th grade. The options for ethnicity were Han and Other.

In each city, tobacco use among target students was examined by asking: Have you ever tried or experimented with cigarette smoking, even one or two puffs (Ever tried smoking)? How old were you when you first tried a cigarette (Age of first smoking)? During the past 30 days, on how many days did you smoke cigarettes (Days smoked)? During the past 30 days, on the days you smoked, how many cigarettes did you usually smoke (Daily cigarettes consumption)? During the past 30 days, how did you usually get your own cigarettes (Access to cigarettes)? And where do you usually smoke (Where to smoke)? Respondents who chose "I have never smoked cigarettes" for "Age of first smoked" and "Where to smoke" were set as missing values. "Age of first smoking" was categorized as less than 7, 8 to 11, 12 to 15, and greater than 16. "Days smoked" was divided into 0, 1 to 9, 10 to 19, and greater than 20. "Daily cigarettes consumption" also had four groups: 0, 1 to 5, 6 to 10, and greater than 10. "Access to cigarettes" included bought from store/shop/street vendor or vending machine, got from others, stole, and some other way. Options for "Where to smoke" included at home, at school or at work, in friends' houses or social events, public places, and other. With regard to "days smoked", students who reported "0 days" were considered as "non-smoker", which would be used as the dependent variable to examine the association between indicators and students' current smoking status.

For students' secondhand smoke exposure, three questions were asked: Where do you usually smoke (Where to smoke)? During the past 7 days, on how many days have people smoked in your home, in your presence (home SHS exposure within 7 days)? And during the past 7 days,

on how many days have people smoked in your presence, in places other than in your home (Other SHS exposure within 7 days)? Respondents who chose "I have never smoked cigarettes" for "Where to smoke" were set as missing values. Both "Home SHS exposure within 7 days" and "Other SHS exposure within 7 days" were divided into 0 days, 1-4 days, and 5-7 days.

The attitudes and knowledge level about smoking and passive smoking including two parts: Attitudes of smoking and knowledge of smoking. The former was examined by three questions: Would you smoke if your best friend offered you a cigarette (Best friend offered)? Do you think you will smoke at any time during the next 12 months (Smoke next 12 months)? Do you think you will be smoking 5 years from now (Smoke 5 years from now)? The latter was examined by: Do you think cigarette smoking is harmful to your health (Smoking is harmful)? Do you think the smoke from other people's cigarettes is harmful to you (SHS is harmful)? Response options for all these questions were dichotomous. Students who answered "No" in the attitudes of smoking part were believed to be willing to refuse cigarettes in certain situation. Students who had a "Yes" option in the knowledge of smoking part were believed to have awareness of the harms of smoking and passive smoking.

As for students' attitude and experience of quitting smoking, five questions were asked. Attitudes: Are you in favor of banning smoking in public places (Favor of banning smoking)? And do you want to stop smoking now (Intention to stop smoking)? Experience: Have you ever tried to stop smoking during the past year (Ever tried to stop smoking last year)? What was the main reason you decided to stop smoking (Main reason of stopping smoking)? Have you ever received help or advice to help you stop smoking (Received help to stop)? Respondents who

chose “I have never smoked cigarettes”, “I do/did not smoke”, or “I have not stopped smoking” were set as missing values. The first three questions all had dichotomous responses. Response options for “Main reason of stopping smoking” were: improve health, save money, family/friends don't like, and other. For students who reported they have received help or advice of stopping smoking “from a program or professional”, “from a friend, from a family member”, or “from both programs and professionals and from friends” were all recoded as “Yes”. For students who reported they have never received help or advice of stopping smoking were still recoded as “No”. Students who chose “Yes” in the attitudes part were believed to be willing to quit smoking.

The social environment of tobacco control includes two parts: Family/peer factors and Media message. Family/peer factors: Do your parents smoke (Parents smoke)? Has anyone in your family discussed the harmful effects of smoking with you (Family discussion)? Do any of your closest friends smoke cigarettes (Closest friends smoking)? Which of the following best describes the rules about smoking inside of your home (Smoking rules inside home)? Media message: How many anti-smoking media messages have you seen or heard during the past 30 days (Anti-smoking media message)? How often do you see anti-smoking messages when you go to sports events, fairs, concerts, community events, or social gatherings (Anti-smoking messages in social events)? For “Parents smoke”, students who reported “Both”, “Father only”, or “Mother only” were recoded as “Yes”; students who reported “No” were still recoded as “No”. For “Closest friends smoking”, students who reported “Some of them”, “Most of them”, or “All of them” were recoded as “Yes”; students who reported “None of them” were recoded as “No”. For “Smoking rules inside home”, students who reported “Smoking is allowed inside of your

home", or "Smoking is generally not allowed inside of your home, but there are exceptions" were recoded as "Smoking is allowed"; students who reported "Smoking is never allowed inside of your home" were still recoded as "Smoking is never allowed"; students who reported "There are no rules about smoking in your home" are recoded as "No rules". For "Anti-smoking media messages", students who reported "A lot" or "A few" were recoded as "Yes"; students who reported "None" were recoded as "No". For "Anti-smoking media messages in social events", students who reported "A lot" or "Sometimes" were recoded as "Yes"; students who reported "Never" were recoded as "No". For all the questions above that have these following 4 choices: definitely not, probably not, probably yes, and definitely yes, answers are regrouped into two categories: "Yes" and "No".

In addition, for all these dichotomous variables described above, comparisons were conducted to examine whether there were statistically significant differences before and after the smoke-free intervention in each city. Variables with a phase value coded as "1" means "before intervention" while "2" means "after intervention". Furthermore, for the same binary variables, whether there were statistically significant differences across these 3 cities were also tested to understand the regional differences regarding students' attitudes, knowledge, and experience of smoking, SHS, and smoking cessation, as well as family, peer, media factors. Two more variables were recoded into two categories to do the comparisons between two phases and across cities. Students who reported "0 days" for Home SHS exposure within 7 days were recoded as "No". Similarly, students who reported "0 days" for Other SHS exposure within 7 days were recoded as "No". In short, these variables including Current smoker (No); Attitudes of smoking: Best friends offer cigarettes (No), Smoke next 12 month (No), Smoke next 5 years (No); Knowledge of smoking:

Smoking is harmful (No), SHS is harmful (No); Secondhand smoke exposure: Home SHS exposure within 7 days (No), Other SHS exposure within 7 days (No); Attitudes of quitting smoking: Favor of banning smoking (Yes), Intention to stop smoking (Yes); Quitting smoking: Ever tried to stop smoking (Yes), Received help to stop smoking (Yes); Family/peer factors: Parents smoke (No), Family discussed harm of smoking (No), Friends smoke (No); Media message: Anti-smoking media messages (Yes), Anti-smoking messages in social events (Yes). The event values were indicated in the parentheses.

To identify factors associated with students' current smoking status in these 54 selected schools, "non-smoker" who reported "0 days" for "Days smoked" served as the dependent variable by answering: During the past 30 days, on how many days did you smoke cigarettes? Independent variables including attitudes of smoking, media message exposure, and school curriculum. These three independent variables were created by using Principal Component Analysis (PCA) to group similar sub-variables under each theme, more details will be provided in the Statistical Analysis part. First, the Attitudes of Smoking were measured by asking: Do you think boys who smoke cigarettes have more or fewer friends? Do you think girls who smoke cigarettes have more or fewer friends? Does smoking cigarettes help people feel more or less comfortable at celebrations, parties, or in other social gatherings? Do you think smoking cigarettes makes boys look more or less attractive? And do you think cigarettes makes girls look more or less attractive? The event value for the first two questions was responses of "Fewer friends". For the last three questions, "less comfortable" or "less attractive" were the event values.

Second, examined questions for the Media Messages Exposure including: When you watch TV, videos, or movies, how often do you see actors smoking? During the past 30 days, when you watched sports events or other programs on TV how often did you see cigarette brand names? When you go to sports events, fairs, concerts, or community events, how often do you see advertisements for cigarettes? During the past 30 days, how many advertisements for cigarettes have you seen on billboards? During the past 30 days, how many advertisements or promotions for cigarettes have you seen in newspapers or magazines? And do you have something (e.g., t-shirt, pen, backpack, etc.) with a cigarette brand logo on it? For the first three questions, responses of "A lot" and "Sometimes" were recoded as "Yes" while responses of "I never watch TV, videos, or movies", "I never go to sports vents, fairs, concerts, or community events" and "Never" were recoded as "No". For the following two questions, responses of "A lot" and "A few" were recoded as "Yes" while response of "None" were recoded as "No". The last question has dichotomous options that were "Yes" and "No".

Third, School Curriculum was assessed by the following questions: During this school year, were you taught in any of your classes about the dangers of smoking? During this school year, did you discuss in any of your classes the reasons why people your age smoke? During this school year, were you taught in any of your classes about the effects of smoking such as it makes your teeth yellow, causes wrinkles, or makes you smell bad? And how long ago did you last discuss smoking and health as part of a lesson? The first three questions all had three response options: Yes, No, and Not sure. Responses of "Yes" were recoded as "Yes" and responses of "No" and "Not sure" were recoded as "No". As for the last question, choices of "This term or semester" and "Last term or semester" were recoded as "Yes", which means students had

discussed smoking and health as part of a lesson in this school year. Choices of "Never" and "More than a year ago" were recoded as "No", which means students had not discussed smoking and health as part of a lesson in this school year.

Statistical Analysis

Descriptive analysis by using PROC FREQ procedure in SAS was carried out for each demographic variable to provide an overview of this sample. Additionally, PROC MEANS procedure was used to examine the age distribution of the target population. For each variable, Chi-square tests were performed for univariate analysis to test whether there were significant changes before and after the smoke-free interventions. Furthermore, a multivariate analysis was conducted to determine whether there was a statistically difference for one selected variable in one city between the two phases. Logistic regression models were built to calculate the odds ratios between phase and variables of interest. For one variable in the same phase, whether there was statistically significant difference across these three cities was also examined. We conducted logistic regression analysis to obtain the odds ratios between city and variables of interests. The other two cities were compared with Dalian, which was considered as the reference group. The odds ratios were adjusted for students' gender, age, grade, and ethnicity to control for possible contributions from these variables. The 95% confidence intervals were calculated for all the odds ratios. All tests of statistical significance were two-sided and the significance level was set at 0.05.

We utilized the tetrachoric Principal Component Analysis (PCA) to create principal components in order to measure the association between indicators (attitude of smoking, media messages, and

school curriculum) and students' current smoking status in a simple way. Tetrachoric correlations were first computed for all those dichotomous variables. PROC FREQ procedure in SAS was used to obtain tetrachoric correlations. We then performed Principal Component Analysis (PCA) to group a number of similar sub-variables under each of these three indicators in order to create a smaller number of artificial variables. We ran PROC FACTOR procedure to analyze these obtained tetrachoric correlation matrix. Since principal components can explain meaningful accounts of variance in these original variables, we could only use and interpret these components in subsequent analyses (details are provided in the following paragraphs). Later, associations between indicators (smoking attitudes, media messages, and school curriculum) and students' current smoking status in both phases were measured by building logistic regression models. Both unadjusted and adjusted odds ratios were included. For adjusted analysis, these principal components were adjusted for age, gender, grade, and ethnicity. A 95% confidence interval for each assessment was calculated. We considered a two-sided p value less than 0.05 as a statistically significant value.

Attitude towards smoking:

The tetrachoric PCA has grouped all the five indicators of smoking attitudes into one group according to the eigenvalues-greater-than-one rule. This group was defined as ""negative attitude of smoking", which including "boys who smoke have fewer friends", "girls who smoke have fewer friends", "smoking makes people less comfortable", "smoking makes boys less attractive", and "smoking makes girls less attractive". Taking the baseline study of Bayannuoer as an example, this group accounted for 61.88% of the standardized variance and the loading factors were 0.74, 0.79, 0.69, 0.85, and 0.85, respectively.

Media message exposure:

In terms of media messages, the tetrachoric PCA has divided these six related indicators into small groups with different combinations. For baseline study in Bayannuoer, the two groups were defined as “cigarettes brand/advertisements” and “actors smoking”. The former included “own something with logo”, “see brands on TV”, “ad on billboards”, “ad in newspaper/magazines”, and “ad in social events”, which accounted for 47.37% of the variance in the model. The factor loadings were 0.35, 0.78, 0.84, 0.88, and 0.74, respectively. The latter was “see actors smoking”, which accounted for 18.18% of the variance in the model. The factor loading was 0.80. Since the two largest eigenvalues accounted for 65.55% of the standardized variance, the first two principal components can explain the data for the most purpose. For evaluation study in Bayannuoer, these six indicators have been divided into two groups in the same way. The “cigarettes brand/advertisements” group accounted for 58.15% of the variance while the “actors smoking” group accounted for 17.35% of the variance. The factor loadings for the fist group were 0.16, 0.92, 0.90, 0.94, and 0.93, respectively and the factor loading for the second group was 0.79.

Similarly, these six indicators have also been divided into “cigarettes brand/advertisements” and “actor smoking” for the baseline study in Changchun, the evaluation study in Dalian, and the baseline and evaluation study for the pooled analysis. For evaluation study in Changchun, they were grouped into another two groups. The first group named “Media message1” included “own something with logo”, “ad on billboards”, and “ad in newspaper/magazines”, which accounted for 53.11% of the variance. And the factor loadings were 0.96, 0.85, and 0.80. The second group

named “Media message2” included “see actors smoking”, “see brands on TV”, and “ad in social events”, which accounted for 34.33% of the variance with factor loadings as following: 0.41, 0.95, and 0.87.

For baseline study in Dalian, indicators have been divided into “media message on TV” and “other media message”. The composition of the first group was “see actors smoking” and “see brands on TV”, which accounted for 18.85% of the variance. The factor loadings were 0.90 and 0.66. The composition of the second group was “ad in newspaper/magazines”, “ad on billboards”, “own something with logo”, “ad in social events”. The second group has accounted for 53.36% of the variance and the loading factors were 0.85, 0.64, 0.73, and 0.61.

School Curriculum:

In evaluation study of Bayannuoer, these four indicators regarding School curriculum has divided into two groups: “school smoking education” and “last discussed smoking”. The first group was consisted of “taught in classes”, “taught reasons youth smoke”, and “taught effects”. It accounted for 60.09% of the variance and the loading factors were 0.87, 0.86, and 0.82. The second group only has one indicator: “last discussed smoking”. This group accounted for 25.28% of the variance. The loading factor was 0.95.

For baseline study in Bayannuoer and all studies in Changchun and Dalian, as well as the pooled analysis in both phases, the tetrachoric PCA has grouped all the four indicators of school curriculum into one group, which included “taught in classes”, “taught reasons youth smoke”, “taught effects”, and “last discussed smoking”. Take baseline study of Bayannuoer as an

example, this group has accounted for 55.28% of the variance and the loading factors were 0.78, 0.80, 0.71, and 0.68, respectively.

Chapter Four: Results

For the baseline survey completed in 2011, the number of collected valid questionnaires in Bayannouer, Changchun, and Dalian were 2,047, 1,369, 5,002, respectively. There were a total of 8,418 valid questionnaires collected for this pre-intervention survey with a 98.74% participation rate. For the evaluation survey completed in 2012, the number of collected valid questionnaires was 2,205 in Bayannouer, 1,344 in Changchun, and 5,599 in Dalian. There were a total of 8,968 valid questionnaires collected for this post intervention survey and the participation rate was 83.84% (Table 1). Only significant differences are listed below.

Demographic information of study participants

In Bayannuoer, the ratios of males to females were approximately 1.0 both in the baseline study (48.33% vs. 51.67%) and in the evaluation study (47.96% vs.52.04%). In Changchun, a larger proportion of respondents after the smoke-free intervention were males compared to before the intervention (59.42% vs.52.95%). In Dalian, the ratios of males to females were also approximately 1.0 both in the baseline study (48.46% vs.51.54%) and in the evaluation study (49.38% vs.50.62%). Likewise, for the pooled analysis, there was no significant difference in gender in both phases. The percentage was 49.10% for male and 50.90% for female in the baseline study, while 50.33% for male and 49.67% for female in the evaluation study (Table1).

Table 1. Demographic information of students before and after the smoke-free intervention in Bayannuoer, Changchun, and Dalian.

Characteristics	Bayannuoer (N=9114)			Changchun (N=2645)			Dalian (N=4072)		
	Before intervention (n1=4927)	After intervention* (n2=4187)	p value	Before intervention (n1=1339)	After intervention* (n2=1306)	p value	Before intervention (n1=2047)	After intervention*(n2=2025)	p value
Gender,%									
Male	48.33	47.96		52.95	59.42		48.46	49.38	
Female	51.67	52.04		47.05	40.58		51.54	50.62	
Age,%			<0.0001			<0.0001			<0.05
12	18.17	5.99		11.58	24.58		7.96	7.01	
13	13.86	5.4		21.58	11.26		21.01	20.1	
14	10.98	12.09		14.71	10.18		20.91	19.85	
15	10.72	18.1		14.26	17.76		19.59	17.43	
16	16.38	19.18		26.36	17.38		14.95	17.19	
17	29.9	39.24		11.5	18.84		15.58	18.42	
Grade,%			<0.0001			<0.0001			
7^{th} grade	29.67	13.18		34.5	36.52		21.01	20.79	
8^{th} grade	21.37	20.83		15.38	8.58		21.06	21.38	
9^{th} grade	13.23	14.69		5.97	12.63		20.91	20.94	
10^{th} grade	15.04	17.75		44.06	21.52		13.43	12.3	
11^{th} grade	13.23	22.47		0.07	20.14		12.7	12.25	
12^{th} grade	7.45	11.08		0	0.61		10.89	12.35	
Ethnicity,%			<0.05						
Han	88.9	91.31		96.19	95.02		94.38	94.12	
Other	11.1	8.69		3.81	4.98		5.62	5.88	

* Different sample group.

The ages of respondents range from 12 to 17 years old and all students were from 7th grade to 12th grade. Before intervention, the average age of these 8,313 students in all cities was 14.73 with a standard deviation of 1.78. After intervention, the average age of these 7,518 students in all cities was 15.15 with a standard deviation of 1.66. In Bayannuoer, the mean age of respondents was 14.83±1.91 in the baseline study, and 15.57±1.52 in the evaluation study; while in Changchun, the mean age of respondents was 14.56±1.61 in the baseline study, and 14.49±1.85 in the evaluation study. Likewise, in Dalian, the mean age of respondents was 14.59±1.54 in the baseline study, and 14.73±1.57 in the evaluation study. In all cities, the majority of the respondents (over 88.00%) were Han ethnicity. The evaluation study was conducted in the same schools and same grades as the baseline study, but with different students. (Table 1)

Tobacco use

Ever-tried smokers and current smokers

Overall, the prevalence of ever-tried smokers who reported having ever tried or experimented with cigarettes was 14.30% before the intervention compared to 14.28% after the intervention. Generally, there was no significant difference in the prevalence of ever-tried smokers between the two phases, while significant changes exist in the analysis for each city. In Bayannuoer, the prevalence of ever-tried smokers was 20.89% among 4,924 students before the intervention compared to 17.19% among 4,178 students after the intervention. Fewer students in Bayannuoer reported they had ever tried smoking after the intervention ($p<0.0001$). However, the prevalence of ever-tried smokers increased after the intervention in both Changchun (5.46% vs.15.10%) and Dalian (4.45% vs.7.75%) (Table 2).

Table2. Tobacco use among students in Bayannuoer, Changchun, and Dalian.

Characteristics	Bayannuoer (N=9114)			Changchun (N=2645)			Dalian (N=4072)		
	Before intervention	After intervention	p value	Before intervention	After intervention	p value	Before intervention	After intervention	p value
Ever tried to smoke,%	4924*	4178*	<0.0001	1336*	1305*	<0.0001	2047*	2015*	<0.0001
Yes	20.8	17.19		5.46	15.1		4.45	7.75	
No	79.2	82.81		94.54	84.9		95.55	92.25	
Age of first smoking,%	966*	714*	<0.0001	73*	142*	<0.05	91*	147*	<0.0001
≤7	18.94	15.83		10.96	19.01		3.3	22.45	
8 to 11	25.36	17.09		19.18	30.99		16.48	26.53	
12 to 15	38.41	49.58		53.42	32.39		73.63	39.46	
≥16	17.29	17.51		16.44	17.61		6.59	11.56	
Days smoked,%	4927*	4187*	<0.05	1335*	1306*	<0.05	2047*	2025*	<0.05
0	92.06	91.55		96.55	95.48		96.97	98.67	
1 to 9	4.4	3.65		2.62	2.14		1.66	0.74	
10 to 19	1.06	1.46		0.22	0.61		0.64	0.1	
≥20	2.48	3.34		0.6	1.76		0.73	0.49	
Daily cigarettes consumption,%	4927*	4187*		1331*	1306*		2047*	2025*	<0.05
0	92.06	91.52		96.62	95.33		96.97	98.22	
1 to 5	6.19	6.02		2.48	3.37		2.39	1.38	
6 to 10	0.95	1.15		0.6	0.69		0.44	0.15	
≥10	0.79	1.31		0.3	0.61		0.2	0.25	
Access to cigarettes,%	391*	357*		46*	63*		63*	38*	
Bought from SSSV	71.61	77.87		63.04	76.19		74.6	57.89	
Got from others	14.58	13.17		23.91	11.11		9.52	13.16	
Stole	2.81	2.52		2.17	1.59		3.17	10.53	

Some other way	11	6.44		10.87	11.11		12.7	18.42	
Where to smoke,%	643*	386*	<0.0001	70*	81*	<0.05	73*	62*	<0.05
At home	14	14.77		22.86	24.69		2.74	16.13	
At school or work	30.79	52.33		11.43	29.63		19.18	11.29	
In friends' houses or social events	14.46	14.77		12.86	2.47		15.07	14.52	
Public places	8.86	8.03		17.14	20.99		54.79	33.87	
Other	31.88	10.1		35.71	22.22		8.22	24.19	

SSSV=store, shop, street vendor or vending machine.

*Total number of respondents under each variable.

After the smoke-free interventions, the participating students in all cities showed a significant increase in the rate of non-smokers (93.99% vs. 94.15%, p<0.05). The pooled students were 1.23 times more likely to be non-smokers after the intervention [AOR=1.23, 95% CI (1.07, 1.41)]. Students in Dalian were 2.54 times more likely to be non-smokers [AOR=2.54, 95% CI (1.60, 4.06)]. (Table 3)

Table 3. Comparisons of students' attitudes, knowledge, and experience of smoking, SHS, and smoking cessation, as well as family, peer, media factors before and after the smoke-free intervention.

Characteristics	Bayannuoer (N=9114)	Changchun (N=2645)	Dalian (N=4072)
	Adjusted OR (95%CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI)
Current smoker (No)	1.17(1.00,1.37)	1.02(0.66,1.58)	2.54(1.60,4.06)*
Attitudes of smoking			
Best friends offer cigarettes (No)	1.19(1.02,1.38)*	1.93(1.47,2.54)*	1.70(1.26,2.31)**
Smoke next 12 month (No)	1.27(1.08,1.48)*	2.35(1.76,3.15)*	1.56(1.11,2.19)**
Smoke next 5 years (No)	1.33(1.14,1.54)*	1.50(1.12,2.01)**	1.60(1.20,2.14)**
Knowledge of smoking			
Smoking is harmful (No)	0.66(0.53,0.83)*	1.40(1.12,1.75)**	0.91(0.68,1.21)
SHS is harmful (No)	0.50(0.41,0.61)*	1.75(1.41,2.16)*	1.04(0.80,1.36)
Secondhand smoke exposure (SHS exposure)			
Home SHS exposure within 7 days (No)	1.07(0.98,1.17)	2.19(1.84,2.60)*	0.91(0.80,1.03)
Other SHS exposure within 7 days (No)	1.01(0.93,1.10)	1.76(1.49,2.08)*	0.97(0.85,1.10)
Attitudes of quitting smoking			
Favor of banning smoking (Yes)	5.17(4.65,5.75)*	2.08(1.75,2.47)*	1.25(1.11,1.42)**
Quitting smoking			
Ever tried to stop smoking (Yes)	1.47(1.07,2.02)**	2.34(0.83,6.59)	15.32(4.08,57.46)*
Received help to stop (Yes)	10.73(8.18,14.07)*	0.91(0.41,2.01)	66.49(8.47,521.77)*
Family/peer factors			
Parents smoke (No)	1.34(1.22,1.46)*	1.57(1.33,1.85)*	1.06(0.94,1.20)
Family discussed harm of smoking (No)	0.83(0.76,0.91)*	0.95(0.80,1.12)	0.79(0.69,0.91)**
Friends smoke (No)	1.01(0.92,1.11)	2.09(1.76,2.49)*	1.02(0.89,1.17)
Media message			
Anti-smoking media messages (Yes)	2.43(2.17,2.72)*	1.44(1.12,1.84)**	1.34(1.15,1.57)**
Anti-smoking messages in social events (Yes)	1.30(1.14,1.48)*	1.18(0.86,1.62)	2.10(1.72,2.57)*

*P<0.0001 **P<0.05 ***Adjusted for age, gender, grade, and ethnicity.

Age of first smoking

When asked about the age of first smoking, most of the students in all cities were in the "12 to 15" group. In all cities and in both phases, over 90.00% of the students reported they have not smoked cigarettes during the past 30 days. In Dalian, more students after the intervention reported that they have not smoked during the past 30 days compared to that before the intervention (98.67% vs.96.07%, $p<0.05$). However, fewer students after the intervention reported they have not smoked during the past 30 days in Bayannuoer (91.55% vs.92.06%) and Changchun (95.48% vs.96.55%) (Table 2).

Daily cigarettes consumption

In general, the proportions of no daily cigarettes consumption were all greater than 91.00% in all cities. For those who had occasionally cigarettes consumption, most of them smoked 1 to 5 cigarettes per day (Table 2).

Access to cigarettes

Among current smokers who reported had smoked cigarettes during the past 30 days, over half of them had access to cigarettes through buying from store, shop, and street vending machines. The second most important source of cigarettes was offering by other people (Table 2).

Where to smoke

In Bayannuoer, most students smoked at school or at work, and the second most common sites to smoke were at home and friends' houses or social events. More students in Bayannuoer smoked at school or work even after the school smoke-free intervention (30.79% vs.52.33%, $p<0.0001$).

In Changchun, most students smoked at home before the intervention (22.86%) while school or worksites became the most popular places for smoking after the intervention (29.63%). In Dalian, the majority of students reported that they smoked in public places in both phases. After the school smoke-free intervention, the proportion of students who smoked in public places has decreased from 54.79% to 33.87%; the proportion of smoking at school or work has decreased from 19.18% to 11.29%; the proportion of smoking at friends' houses or social events has also decreased from 15.07% to 14.52%. However, the proportion of smoking at home has increased from 2.74% to 16.13%. All these changes have statistical significance ($p<0.05$). (Table 2)

Secondhand smoke (SHS) exposure

Where to smoke

In Bayannuoer, the most popular places of smoking for respondents were schools or workplaces both before (30.79%) and after (52.33%) the intervention, which means students experienced the most serious SHS exposure at school or at work. In Changchun, the most common sites of smoking changed from home (22.86%) in the baseline study to schools or workplaces (29.63%) in the evaluation study. Students still had a great possibility to suffer SHS exposure at schools or workplaces. In contrast, most students in Dalian reported they smoked in public places both before (54.79%) and after (33.87%) the intervention (Table 4).

Table 4. Secondhand smoke exposure among students in Bayannuoer, Changchun, and Dalian.

Characteristics	Bayannuoer (N=9114)			Changchun (N=2645)			Dalian (N=4072)		
	Before intervention	After intervention	p value	Before intervention	After intervention	p value	Before intervention	After intervention	p value
Where to smoke,%	643*	386*	<0.0001	70*	81*		73*	62*	<0.005
Home	14	14.77		22.86	24.69		2.74	16.13	
At school/work	30.79	52.33		11.43	29.63		19.18	11.29	
Friends' houses/social events	14.46	14.77		12.86	2.47		15.07	14.52	
Public places	8.86	8.03		17.14	20.99		54.79	33.87	
Other	31.88	10.1		35.71	22.22		8.22	24.19	
Home SHS exposure within 7 days,%	4927*	4185*		1337*	1306*	<0.0001	2047*	2025*	
0 days	56.97	57.75		59.01	74.96		65.17	62.72	
1-4 days	29.92	30.27		22.96	16.54		24.62	25.23	
5-7 days	13.11	11.97		18.03	8.5		10.21	12.05	
Other SHS exposure within 7 days,%	4927*	4186*		1338*	1306*	<0.0001	2047*	2025*	
0 days	59.1	56.98		59.49	71.21		66.1	64.84	
1 to 4 days	30.59	32.61		29.67	20.06		26.14	26.32	
5 to 7 days	10.31	10.42		10.84	8.73		7.77	8.84	

*Total number of respondents under each variable.

SHS exposure within 7 days

The majority of the students claimed that they have not experienced SHS exposure in home during the past 7 days. In general, the rates of no home SHS exposure increased after the intervention (59.32% vs. 62.08%, $p<0.05$). Among these three cities, only Changchun had a significant increase in the proportion of never exposed to home SHS exposure during the past 7 days (59.01% vs.74.96%, $p<0.0001$). The majority of the students reported that they have not experienced SHS exposure in other places during the past 7 days. Additionally, Changchun had a significant increase in the proportion of never exposed to SHS in other places during the past 7 days (59.49% vs.71.21%, $p<0.0001$) (Table 4). The pooled data reported that students were more likely to have no SHS exposure within the past 7 days after the intervention; the odds ratios were 1,16 for no home SHS exposure and 1,09 for no other SHS exposure [AOR=1.16, 95% CI (1.09, 1.24); AOR=1.09, 95% CI (1.02, 1.16)]. More specifically, after intervention, students in Changchun were 2.19, 1.76 times more likely to have no home SHS exposure and other SHS exposure within 7 days [AOR=2.19, 95% CI (1.84, 2.60); AOR=1.76, 95% CI (1.49, 2.08)], respectively]. (Table 3)

Attitudes and knowledge level towards smoking and passive smoking

Attitude towards smoking

In all these three cities, the majority of respondents had negative attitude of smoking. The pooled dataset that combined all cities indicated that more students would refuse to smoke if their best friends offered them cigarettes (91.19% vs.92.48%, $p<0.05$), and more students would refuse to smoke in the next 12 months (92.34% vs. 93.83%, $p<0.05$) or next 5 years (91.36% vs.92.68%, $p<0.05$) after the intervention. More specifically, in Changchun and Dalian, more students after

the intervention said they would not smoke even if their best friends offered them cigarettes, and more students also claimed that they would not smoke in the next 12 months or next 5 years ($p<0.05$) (Table 5). After adjusted for age, gender, grade, and ethnicity, students in all these cities were generally more likely to refuse smoking after the intervention if their best friends offered them cigarettes [AOR=1.36, 95% CI (1.21, 1.54)]. The adjusted odds ratios for Bayannuoer, Changchun, and Dalian were 1.19 [95% CI (1.02, 1.38)], 1.93 [95% CI (1.47, 2.54)], and 1.70 [95% CI (1.26, 2.31)], respectively. After intervention, students in Bayannuoer, Changchun, and Dalian were 1.27, 2.35, and 1.56 times more likely not to smoke in the next 12 months [AOR=1.27, 95% CI (1.08, 1.48); AOR=2.35, 95% CI (1.76, 3.15); AOR=1.56, 95% CI (1.11, 2.19), respectively]. Students in Bayannuoer, Changchun, and Dalian were 1.33, 1.50, and 1.60 times more likely not to smoke in the next 5 years [AOR=1.33, 95% CI (0.69, 0.91); AOR=1.50, 95% CI (1.12, 2.01); AOR=1.60, 95% CI (1.20, 2.14), respectively]. According to the pooled data, students were 1.45 times more likely to refuse to smoke in the next 12 months and 1.38 times more likely to refuse to smoke in the next 5 years [AOR=1.45, 95% CI (1.28, 1.65); AOR=1.38, 95% CI (1.22, 1.55)]. (Table 3)

Table 5. Students' attitudes and knowledge level of smoking and passive smoking in Bayannuoer, Changchun, and Dalian.

Characteristics	Bayannuoer (N=9114)			Changchun (N=2645)			Dalian (N=4072)		
	Before intervention	After intervention	p value	Before intervention	After intervention	p value	Before intervention	After intervention	p value
Attitudes of smoking									
Best friend offered,%	4925*	4186*		1333*	1304*	<0.0001	2047*	2025*	<0.05
No	90.82	90.54		87.7	92.64		94.33	96.4	
Yes	9.18	9.46		12.3	7.36		5.67	3.6	
Smoke next 12 months,%	4927*	4187*		1337*	1306*	<0.0001	2047*	2025*	<0.05
No	92.04	92.21		88.33	94.1		95.65	96.99	
Yes	7.96	7.79		11.67	5.9		4.35	3.01	
Smoke 5 years from now,%	4927*	4187*		1337*	1306*		2047*	2025*	<0.05
No	90.44	91.19		90.88	92.73		93.89	95.75	
Yes	9.56	8.81		9.12	7.27		6.11	4.25	
Knowledge of smoking									
Smoking is harmful,%	4925*	4184*	<0.0005	1337*	1305*	<0.0001	2047*	2025*	
No	5.34	3.8		13.69	20.46		5.08	4.59	
Yes	94.66	96.2		86.31	79.54		94.92	95.41	
SHS is harmful,%	4915*	4181	<0.0001	1323	1306	<0.0001	2047	2025	
No	7.65	3.97		13.83	24.12		5.76	5.93	
Yes	92.35	96.03		86.17	75.88		94.24%	94.07	

*Total number of respondents under each variable.

Knowledge towards smoking

Students in general had an awareness of the harm of smoking and SHS. More specific, more students in Bayannuoer (94.66% vs.96.20%) and Dalian (94.92% vs.95.41%) realized that smoking was harmful after the intervention. The intervention also had a positive impact on students' knowledge of SHS in Bayannuoer, the awareness of harm of SHS significantly increased after the intervention (92.35% vs.96.03%, $p<0.0001$). However, fewer students in Changchun believed that smoking or SHS was harmful ($p<0.0001$). There was no significant difference between these two phases in Dalian (Table 5). In Bayannuoer, students were 33.70% less likely to think smoking is not harmful after intervention [AOR=0.66, 95% CI (0.53, 0.83)]. Also in Bayannuoer, students were 49.70% less likely to think secondhand smoke is not harmful after intervention [AOR=0.50, 95% CI (0.41, 0.61] (Table 3)

Attitudes and experience of quitting smoking

Attitudes towards quitting smoking

In general, more students in the three cities were in favor of banning smoking after the intervention (54.16% vs.75.31%, $p<0.0001$). The percentages of being in favor of banning smoking was 85.93% vs. 55.14% in Bayannuoer, 71.21% vs. 56.31% in Changchun, and 56.05% vs. 50.42% in Dalian. (Table 6). After intervention, students in Bayannuoer, Changchun, and Dalian were 5.17, 2.08, and 1.25 times more likely to be in favor of banning smoking [AOR=5.17, 95% CI (4.65, 5.75); AOR=2.08, 95% CI (1.75, 2.47); AOR=1.25, 95% CI (1.11, 1.42), respectively] (Table 3). Among those who were current smokers, most of them reported that they wanted to stop smoking (63.85% vs. 73.25%, $p<0.05$), however, there was no significant difference between before and after intervention in the analysis of each city (Table 6).

Table 6. Students' attitudes and experience of quitting smoking in Bayannuoer, Changchun, and Dalian.

Characteristics	Bayannuoer (N=9114)			Changchun (N=2645)			Dalian (N=4072)		
	Before intervention	After intervention	p value	Before intervention	After intervention	p value	Before intervention	After intervention	p value
Attitudes									
Favor of banning smoking,%	4900*	4172*	<0.0001	1316*	1285*	<0.0001	2047*	2025*	<0.05
Yes	55.14	85.93		56.31	71.21		50.42	56.05	
No	44.86	14.07		43.69	28.79		49.58	43.95	
Intention to stop smoking,%	373*	345*		30*	40*		70*	15*	<0.0001
Yes	75.6	75.65		66.67	62.5		0	46.67	
No	24.4	24.35		33.33	37.5		100	53.33	
Experience									
Ever tried to stop smoking last year,%	394*	394*	<0.05	41*	46*		71*	34*	<0.0001
Yes	66.75	73.6		46.34	63.04		5.63	61.76	
No	33.25	26.4		53.66	36.96		94.37	38.24	
Main reason of stopping smoking,%	615*	462*	<0.0001	48*	58*		7*	74*	
Improve health	37.89	70.78		43.75	39.66		14.29	44.59	
Save money	7.8	9.52		12.5	10.34		0	4.05	
Family/friends don't like	13.98	11.47		20.83	18.97		0	10.81	
Other	40.33	8.23		22.92	31.03		85.71	40.54	
Received help to stop,%	731*	656*	<0.0001	60*	75*		79*	80*	<0.0001
Yes	36.11	83.84		51.67	46.67		1.27	40	
No	63.89	16.16		48.33	53.33		98.73	60	

*Total number of respondents under each variable.

Table 7. Social environment of tobacco control in Bayannuoer, Changchun, and Dalian.

Characteristics	Bayannuoer (N=9114)			Changchun (N=2645)			Dalian (N=4072)		
	Before intervention	After intervention	p value	Before intervention	After intervention	p value	Before intervention	After intervention	p value
Family/peer factors									
Parents smoke,%	4864*	4160*	<0.0001	1313*	1290*	<0.0001	2009*	1992*	
No	34.77	39.52		53.77	64.65		44.95	46.08	
Yes	65.23	60.48		46.23	35.35		55.05	53.92	
Family discussion,%	4926*	4187*	<0.05	1338*	1305*		2047*	2025*	<0.05
No	34.49	30.71		34.08	34.71		27.45	23.01	
Yes	65.51	69.29		65.92	65.29		72.55	76.99	
Closest friends smoking,%	4921*	4183*	<0.0001	1334*	1305*	<0.0001	2047*	2025*	
Yes	49.56	41.6		53.82	66.21		68.98	68	
No	50.44	58.4		46.18	33.79		31.02	32	
Smoking rules inside home,%	4873*	4140*	<0.0001	1299*	1293*	<0.0001	2047*	2025*	<0.0001
Smoking is allowed	46.85	40.8		48.58	47.1		41.13	33.88	
Smoking is never allowed	19	13.48		24.63	31.86		26.28	30.07	
No rules	34.15	45.72		26.79	21.04		32.58	36.05	
Media message									
Anti-smoking media messages,%	4910*	4175*	<0.0001	1333*	1296*		2047*	2025*	<0.05
Yes	75.74	86.73		86.42	88.66		78.26	82.86	
No	24.26	13.27		13.58	11.34		21.74	17.14	
Anti-smoking messages in social events,%	3734*	3377*	<0.05	1036*	883*		1570*	1600*	<0.0001
Yes	83.13	86.11		90.64	89.24		79.94	89.31	
No	16.87	13.89		9.36	10.76		20.06	10.69	

*Total number of respondents under each variable.

The pooled data were that students were 2.58 times more likely to be in favor of banning smoking and 1.51 times more likely to have intention to stop smoking after the intervention [AOR=2.584, 95% CI (2.41, 2.77); AOR=1.51, 95% CI (1.12, 2.04)]. (Table 3)

Experience of quitting smoking

Over half of the respondents had tried to quit smoking during the past year after intervention. The pooled students demonstrated a significant increase in the rate of ever-tried to stop smoking after the intervention (56.52% vs.71.73%, $p<0.0001$). The corresponding proportions for Bayannuoer, Changchun, and Dalian were 73.60%, 63.04%, and 61.76%. In Bayannuoer and Dalian, these proportions were significantly changed before and after intervention ($p<0.05$) (Table 6). The overall students were 2.00 times more likely to have ever tried to quit smoking after the intervention [AOR=2.00, 95% CI (1.52, 2.64)]. Students in Bayannuoer and Dalian were 1.47 and 15.32 times more likely to have ever tried to quit smoking [AOR=1.47, 95% CI (1.07, 2.02); AOR=15.32, 95% CI (4.08, 57.46), respectively] (Table 3). The two most important reasons of quitting smoking were "improve health" and "family or friends did not like smoking" among participants in all cities.

Taking all students as a whole, there were a rising number of students reporting that they have received help to stop smoking after the intervention (34.02% vs.76.08%, $p<0.0001$). In Bayannuoer and Dalian, they all had a significant increasement in the proportion of students that have ever received help or advice to stop smoking ($p<0.0001$). Especially in Bayannuoer, this proportion has greatly increased from 36.11% in the baseline study to 83.84% in the evaluation study (Table 6). Students in Bayannuoer were 10.73 times more likely to received help to stop smoking after the intervention [AOR=10.73, 95% CI (8.18, 14.07)] (Table 3). In Changchun, there was no significant difference before and after the

intervention. In general, students were 6.85 times more likely to have received help to stop smoking after the intervention [AOR=6.85, 95% CI (5.48, 8.57)] (Table 6).

Social environment of tobacco control

Family factor

After the intervention, more students in all cities said their parents did not smoke (40.31% vs. 45.63%, p<0.0001). In Changchun, over half of the parents (64.65%) did not smoke after intervention and the change has a statistical significance (p<0.0001) (Table 7). Students in Bayannuoer were 1.34 times more likely to have no parents smoke after intervention [AOR=1.34, 95% CI (1.22, 1.46)] and students in Changchun were 1.57 times more likely to have no parents smoke [AOR=1.57, 95% CI (1.33, 1.85)]. Students generally reported that they were 1.32 times more likely to have no parent smoke after the intervention [AOR=1.32, 95% CI (1.24, 1.41)] (Table 3). However, there were still more than 50% of the parents in both Bayannuoer and Dalian smoked after the intervention (Table 7).

Additionally, after the intervention, more families discussed the harmful effects of smoking with students (67.31% vs.70.67%, p<0.0001). In Bayannuoer, the number was 65.51% vs.69.29% (p<0.05), and in Dalian, the number was 72.55% vs.76.99% (p<0.05) (Table 7). Families in Bayannuoer were 16.80% less likely to have no discussion about harm of smoking after intervention [AOR=0.83, 95% CI (0.76, 0.91)]; families in Dalian were 20.90% less likely to have no discussion about harm of smoking [AOR=0.79, 95% CI (0.69, 0.91)]. According to the pooled data, families were 14.20% less likely to have no family discussion about the harm of smoking after the intervention [AOR=0.86, 95% CI (0.80, 0.92)] (Table 3).

Furthermore, in all cities, fewer families allowed smoking inside home after the intervention (45.70% vs.40.01%, p<0.0001). The changes were all statistically significant in Bayannuoer (46.85% vs. 40.80%, p<0.0001), Changchun (48.58% vs. 47.10%, p<0.0001), and Dalian (41.13% vs.33.88%, p<0.0001) (Table 7).

Peer factor

More students claimed they have fewer closet friends smoking after the intervention (55.03% vs.52.99%, p<0.05). In Bayannuoer, the proportion of having closest friends smoke has significantly decreased from 49.56% to 41.60% after the intervention (p<0.0001). However, more students in Changchun reported they had closest friends smoke after intervention (p<0.0001) (Table 7). After adjusted by age, gender, grade, and ethnicity, students were 1.13 times more likely to have no friend smoke after the intervention [AOR=1.13, 95% CI (1.06, 1.21)]. Students in Changchun were 2.09 times more likely to have no closest friends smoke [AOR=2.09, 95% CI (1.76, 2.50)] (Table 3).

Media message exposure

There were more anti-smoking media messages in Bayannuoer (75.74% vs.86.73%, p<0.0001), Changchun (86.42% vs.88.66%), and Dalian (78.26% vs.82.86%, p<0.05) after the intervention. The pooled data was 78.08% vs. 86.02 (p<0.0001) (Table 7). Students in Bayannuoer, Changchun, and Dalian were 2.43, 1.44, and 1.34 times more likely to have seen anti-smoking media messages during the past 30 days [AOR=2.43, 95% CI (2.17, 2.72); AOR=1.44, 95% CI (1.12, 1.84); AOR=1.34, 95% CI (1.15, 1.57), respectively]. The pooled data was that students were 1.88 times more likely to have seen anti-smoking media messages after the intervention [AOR=1.88, 95% CI (1.73, 2.05)] (Table 3).

In addition, the number of anti-smoking messages in social events also increased (83.56% vs. 87.46%, $p<0.0001$). In Bayannuoer, the number was 83.13% vs.86.11% ($p<0.05$), and in Dalian, the umber was 79.94% vs.89.31% ($p<0.0001$) (Table 7). After the intervention, students were 1.44 times more likely to have seen anti-smoking messages in social events [AOR=1.44, 95% CI (1.30, 1.59)]. In Bayannuoer, students were 1.30 times more likely to have seen anti-smoking messages in social events after the intervention [AOR=1.30, 95% CI (1.14, 1.48)](Table 3).

Regional differences in students' attitudes, knowledge, and experience of smoking, SHS, and smoking cessation, as well as family, peer, media factors across three cities

Students' attitudes, knowledge, and experience of smoking, SHS, and smoking cessation, as well as the social environment of tobacco control including family, peer, and media factors varied across cities. Dalian served as the reference group and all the results listed below were compared to Dalian. Only significant data of these comparisons were reported (Table 8).

Table8. Regional differences in students' attitudes, knowledge, and experience of smoking, SHS, and smoking cessation, as well as family, peer, media factors across three cities.

Characteristics	Before intervention OR (95% CI)			After intervention OR (95% CI)		
	Bayannuoer	Changchun	Dalian	Bayannuoer	Changchun	Dalian
Smoking experience						
Ever smoked (Yes)	5.64(4.52,7.04)*	1.24(0.91,1.70)	Ref	2.47(2.06,2.96)*	2.12(1.69,2.64)*	Ref
Current smoker (No)	0.36(0.28,0.48)*	0.88(0.59,1.29)	Ref	0.15(0.10,0.22)*	0.29(0.18,0.45)*	Ref
Attitudes of smoking						
Best friends offer cigarettes (No)	0.59(0.48,0.73)*	0.43(0.33,0.55)*	Ref	0.36(0.28,0.46)*	0.47(0.34,0.64)*	Ref
Smoke next 12 months (No)	0.53(0.42,0.67)*	0.34(0.26,0.45)*	Ref	0.37(0.28,0.49)*	0.50(0.35,0.70)*	Ref
Smoke next 5 years (No)	0.62(0.50,0.76)*	0.65(0.50,0.84)**	Ref	0.46(0.36,0.58)*	.57(0.42,0.76)**	Ref
Knowledge of smoking						
Smoking is harmful (No)	1.05(0.84,1.33)	2.96(2.30,3.81)*	Ref	0.82(0.63,1.07)	5.34(4.17,6.85)*	Ref
SHS is harmful (No)	1.35(1.09,1.68)**	2.62(2.06,3.35)*	Ref	0.66(0.52,0.84)**	5.05(4.03,6.31)*	Ref
Secondhand smoke exposure						
Home SHS exposure within 7 days (No)	0.71(0.64,0.79)*	0.77(0.67,0.89)**	Ref	0.81(0.73,0.91)**	1.78(1.53,2.08)*	Ref
Other SHS exposure within 7 days (No)	0.74(0.67,0.83)*	0.75(0.65,0.87)*	Ref	0.72(0.64,0.80)*	.34(1.15,1.56)**	Ref
Attitude of quitting smoking						
Favor of banning smoking (Yes)	1.21(1.09,1.34)**	1.27(1.10,1.46)**	Ref	4.79(4.23,5.42)*	1.94(1.67,2.25)*	Ref
Quitting smoking						
Ever tried to stop smoking (Yes)	33.61(12.00,94.14)*	4.46(4.44,47.08)*	Ref	1.73(0.83,3.57)	1.06(0.42,2.64)	Ref
Received help to stop (Yes)	44.09(6.10,318.80)**	83.38(10.88,638.94)*	Ref	7.78(4.75,12.75)*	1.31(0.69,2.48)	Ref
Family/peer factors						
Parents smoke (No)	0.65(0.59,0.73)*	1.43(1.24,1.64)*	Ref	0.76(0.69,0.85)*	2.14(1.85,2.47)*	Ref
Family discussed harm of smoking (No)	1.39(1.24,1.56)*	1.37(1.18,1.59)*	Ref	1.48(1.31,1.68)*	1.78(1.53,2.08)*	Ref
Friends smoke (No)	0.44(0.40,0.49)*	0.52(0.46,0.61)*	Ref	0.34(0.30,0.38)*	0.92(0.80,1.07)	Ref
Media message exposure						
Anti-smoking media messages (Yes)	0.87(0.77,0.98)**	1.77(1.46,2.14)*	Ref	1.35(1.17,1.57)*	1.62(1.31,1.99)*	Ref

Anti-smoking messages in social events (Yes)	1.24(1.06,1.44)**	2.43(1.91,3.10)*	Ref	0.74(0.62,0.89)**	0.99(0.76,1.29)	Ref

*P<0.0001
**P<0.05
Dalian is the reference group.

Smoking experience

Relative to Dalian, students who were in Bayannuoer were 5.64 times more likely to have ever tried smoking before the intervention [OR=5.64, 95% CI (4.52, 7.04)] and the odds reduced to 2.47 after the intervention [OR=52.47, 95% CI (2.06, 2.96)]. The odds of ever smoked in Changchun were 2.12 after the intervention [OR=2.12, 95% CI (1.69, 2.64)]. In terms of non-smoker, students in Bayannuoer were 63.80% less likely to be non-smokers before the intervention [OR=0.36, 95% CI (0.28, 0.48)] and 85.4% less likely to be non-smokers after the intervention [OR=0.15, 95% CI (0.10, 0.22)]. In Changchun, students were 71.40% less likely to be non-smokers after the intervention [OR=0.29, 95% CI (0.18, 0.45)].

Attitudes of smoking

Compare to Dalian, students in Bayannuoer were 40.60% less likely to refuse to smoke if their best friends offered cigarettes before the intervention [OR=0.59, 95% CI (0.48, 0.73)] and 64.20% less likely to refuse to smoke after the intervention [OR=0.36, 95% CI (0.28, 0.46)]. In Changchun, students were 57.20% less likely to refuse to smoke before the intervention [OR=0.43, 95% CI (0.33, 0.55)] and 52.90% less likely to refuse to smoke after the intervention [OR=0.47, 95% CI (0.34, 0.64)]. Students in both Bayannuoer and Changchun were less likely to refuse cigarettes compared to students in Dalian in the next 12 months or next 5 years. The odds of refusing to smoke in the next 12 months for students in Bayannuoer were 0.53 before intervention [OR=0.53, 95% CI (0.42, 0.67)] and 0.37 after intervention [OR=0.37, 95% CI (0.28, 0.49)]. The odds of refusing smoking in the next 12 months for students in Changchun were 0.34 before intervention [OR=0.34, 95% CI (0.26, 0.45)] and 0.50 after intervention [OR=0.50, 95% CI (0.35, 0.70)]. When asked about whether or not students will refuse to smoke in the next 5 years, the odds ratios were relatively higher. In Bayannuoer, the odds were 0.62 before

intervention [OR=0.62, 95% CI (0.50, 0.76)] and 0.46 after intervention [OR=0.46, 95% CI (0.36, 0.59)]. In Changchun, the odds were 0.65 before intervention [OR=0.65, 95% CI (0.50, 0.84)] and 0.57 after intervention [OR=0.57, 95% CI (0.42, 0.76)].

Knowledge towards smoking

In Changchun, students were 2.96 times more likely to not understand smoking is harmful compared to Dalian before the intervention [OR=2.96, 95% CI (2.30, 3.81)], while the number was 5.34 times after the intervention [OR=5.34, 95% CI (4.17, 6.85)]. Similarly, students in Bayannuoer reported they were 1.35 times more likely to not know SHS is harmful compare to Dalian before the intervention [OR=1.35, 95% CI (1.09, 1.68)]. However, after the intervention, students in Bayannuoer were 34.40% less likely to not know the harm of SHS [OR=0.66, 95% CI (0.52, 0.84)]. Students in Changchun reported higher odds of not understanding the harm of SHS in both phases compared to students in Dalian. The odds for pre-intervention and post-intervention were 2.62 [95% CI (2.06, 3.35)] and 5.05[95% CI (4.03, 6.31)], respectively.

Secondhand smoke exposure

Compared to students in Dalian, students in Bayannuoer were 29.2% less likely to have no home SHS exposure before the intervention [OR=0.71, 95% CI (0.64, 0.79)] and 18.7% less likely to have no home SHS exposure after the intervention [OR=0.81, 95% CI (0.73, 0.91)]. In Changchun, students were less likely to have no home SHS exposure before the intervention [OR=0.77, 95% CI (0.67, 0.89)], while they reported they were more likely to have no home SHS exposure after the intervention [OR=1.78, 95% CI (1.53, 2.08)]. With regard to SHS exposure in other places within 7 days, students in Bayannuoer were 25.90% less likely to have no other SHS exposure before the intervention [OR=0.74,

95% CI (0.67, 0.83)] and 28.2% less likely to have no other SHS exposure after the intervention [OR=0.72, 95% CI (0.64, 0.80)]. The odds of no other SHS exposure within 7 days in Changchun increased from 0.75 before the intervention [OR=0.75, 95% CI (0.65, 0.87)] to 1.34 after the intervention [OR=1.34, 95% CI (1.15, 1.56)].

Attitudes towards quitting smoking

In two phases, students in both Bayannuoer and Changchun were all more willing to be in favor of banning smoking compared to students in Dalian. Before intervention, students in Bayannuoer were 1.21 times more likely to be in favor of banning smoking and the odds increased to 4.79 after the intervention [OR=1.21, 95% CI (1.09, 1.34) vs. OR=4.79, 95% CI (4.23, 5.42)]. In Changchun, the odds of favor of banning smoking were 1.27 before intervention and 1.94 after intervention [OR=1.27, 95% CI (1.10, 1.46) vs. OR=1.94, 95% CI (1.67, 2.25)]. In terms of intention to quit smoking, the odds ratio among students in Bayannuoer was 3.55 compared to Dalian [OR=3.55, 95% CI (1.25, 10.08)].

Quitting smoking

More students in Bayannuoer and Changchun have ever tried to stop smoking before the intervention compared with Dalian. The odds ratio was 33.61 for Bayannuoer [95%CI (12.00, 94.14)] and 14.46 for Changchun [95%CI (4.44, 47.08)]. In addition, the odds ratio of having received help to stop smoking was 44.09 for Bayannuoer [OR=44.09, 95% CI (6.10, 318.80)] and 83.38 for Changchun [OR=83.38, 95% CI (10.88, 638.94)] before the intervention, while the odds ratio was 7.78 for Bayannuoer after the intervention [OR=7.78, 95% CI (4.75, 12.75)].

Family factor

Before the intervention, students in Bayannuoer were 34.70% less likely to have no parents smoke compared with students in Dalian [OR=0.65, 95% CI (0.59, 0.73)]; however, students in Changchun were 1.43 more likely to have no parents smoke [OR=1.43, 95% CI (1.24, 1.64)]. After the intervention, students in Bayannuoer were 23.60% less likely to have no parents smoke compared with students in Dalian [OR=0.76, 95% CI (0.69, 0.85)], while students in Changchun were 2.14 more likely to have no parents smoke [OR=2.14, 95% CI (1.85, 2.47)]. The family discussion about harm of smoking was less common in Bayannuoer and Changchun compared to Dalian. In Bayannuoer, students were 1.39 times more likely to have no family discussion about harm of smoking before the intervention [OR=1.39, 95% CI (1.24, 1.56)]; and in Changchun, students were 1.37 times more likely to have no family discussion about harm of smoking before the intervention [OR=1.37, 95% CI (1.18, 1.59)]. After the intervention, the odds of no family discussion about harm of smoking were 1.48 among students in Bayannuoer and 1.78 among students in Changchun [OR=1.48, 95% CI (1.31, 1.68) vs. OR=1.78, 95% CI (1.53, 2.08)].

Peer factor

Exposure to friends smoke was higher in Bayannuoer and Changchun compare to Dalian in both phases. Before intervention, the odds ratio of no friends smoke exposure was 0.44 for Bayannuoer and 0.52 for Changchun [OR=0.44, 95% CI (0.40, 0.49) vs. OR=0.52, 95% CI (0.46, 0.61)]. Likewise, the odds ratio of no friends smoke exposure was 0.34 for Bayannuoer and 0.92 for Changchun after the intervention [OR=0.34, 95% CI (0.30, 0.38) vs. OR=0.92, 95% CI (0.80, 1.07)].

Media message exposure

Before intervention, students in Bayannuoer were 13.30% less likely to expose to anti-smoking media messages compared to students in Dalian [OR=0.87, 95% CI (0.77, 0.98)], while students in Changchun were 1.77 times more likely to expose to anti-smoking media messages [OR=1.77, 95% CI (1.46, 2.14)]. After intervention, students in Bauannuoer and Changchun were all more likely to have anti-smoking media messages exposure. The odds ratio was 1.35 for Bayannuoer and 1.62 for Changchun [OR=1.35, 95% CI (1.17, 1.57) vs. OR=1.62, 95% CI (1.31, 1.99)]. For the anti-smoking message exposure in social events, the odds ratio was 1.24 for Bayannuoer and 2.43 for Changchun before the intervention [OR=1.24, 95% CI (1.06, 1.44) vs. OR=2.43, 95% CI (1.91, 3.10)]. However, the odds ratio of anti-smoking message exposure in social events was 0.74 among students in Bayannuoer after the intervention, which means students in Baynnuoer were 25.80% less likely to expose to anti-smoking messages in social events [OR=0.74, 95% CI (0.62, 0.89)].

Factors associated with students' current smoking status

Attitudes of smoking

In Bayannuoer, students who had negative attitudes of smoking were 4.35 times more likely to be non-smokers compared to students who did not have negative attitude of smoking before the intervention [AOR=4.35, 95% CI (3.23, 5.84), $p<0.0001$]. After the intervention, students who were in Bayannuoer and had negative attitude of smoking were 4.81 times more likely to be non-smokers [AOR=4.81, 95% CI (3.47, 6.67), $p<0.0001$] (Table 9-1).

Table9-1. Associations between attitudes of smoking, media message exposure, and school curriculum and students' current smoking status, Bayannuoer (N=9114).

Indicators	Before intervention (N=4927)		After intervention (N=4187)
	Adjusted OR (95%CI)		Adjusted OR (95%CI)
Attitudes of smoking			
Negative attitudes of smoking	4.35(3.23,5.84)*	Negative attitude of smoking	4.81(3.47,6.67)*
Media Message Exposure			
Cigarettes brand /advertisements	0.49(0.38,0.64)*	Cigarettes brand /advertisements	1.49(0.95,2.32)
Actors smoking	1.15(0.86,1.54)	Actors smoking	1.59(1.16,2.18)**
School curriculum			
School curriculum	0.78(0.59,1.03)	School smoking education	0.87(0.61,1.22)
		Last discussed smoking	0.44(0.27,0.72)**

*P<0.0001

**P<0.05

***Adjusted for age, gender, grade, and ethnicity.

Table9-2. Associations between attitudes of smoking, media message exposure, and school curriculum and students' current smoking status, Changchun (N=2645).

Indicators	Before intervention (N=1339)		After intervention (N=1306)
	Adjusted OR (95%CI)		Adjusted OR (95%CI)
Attitudes of smoking			
Negative attitude of smoking	4.72(2.08,10.69)**	Negative attitude of smoking	5.42(2.41,12.19)*
Media Message Exposure			
Cigarettes brand /advertisements	1.22(0.60,2.48)	Media message1	0.33(0.17,0.65)**
Actors smoking	0.65(0.27,1.57)	Media message2	0.84(0.50,1.40)
School curriculum			
School curriculum	0.55(0.23,1.35)	School curriculum	1.10(0.46,2.63)

*P<0.0001

**P<0.05

***Adjusted for age, gender, grade, and ethnicity.

In Changchun, students who had negative attitude of smoking were 4.72 times more likely to be non-smokers compared to students who did not have negative attitude of smoking before the intervention [AOR=4.72, 95% CI (2.08, 10.69), p<0.05]; students who had negative attitude of smoking were 5.42 times more likely to be non-smokers after the intervention [AOR=5.42, 95% CI (2.41, 12.19), p<0.0001] (Table 9-2).

In Dalian, students who had negative attitude of smoking were 752.89 times more likely to be non-smokers compared to students who did not have negative attitude of smoking before the intervention [AOR=752.89, 95% CI (101.26, >999.999), p<0.0001]; students who were in Dalian and had negative attitude of smoking were 17.61 times more likely to be non-smokers after the intervention [AOR=17.61, 95% CI (5.86, 52.91), p<0.0001] (Table 9-3).

Table9-3. Associations between attitudes of smoking, media message exposure, and school curriculum and students' current smoking status, Dalian (N=4072).

Indicators	Before intervention (N=2047)		After intervention (N=2025)
	Adjusted OR (95%CI)		Adjusted OR (95%CI)
Attitudes of smoking			
Negative attitude of smoking	752.89(101.26, >1000 0.00)*	Negative attitude of smoking	17.61(5.86, 52.91)*
Media Message Exposure			
Media message on TV	0.61(0.31,1.20)	Cigarettes brand /advertisements	0.24(0.09,0.65)**
Other media message	0.41(0.22,0.76)**	Actors smoking	1.99(0.80,4.93)
School curriculum			
School curriculum	4.19(1.95,9.00)**	School curriculum	0.36(0.09,1.40)

*P<0.0001

**P<0.05

***Adjusted for age, gender, grade, and ethnicity.

In general, students who had negative attitude of smoking were 5.79 times more likely to be non-smokers compared to students who did not have negative attitude of smoking before the intervention [AOR=5.79, 95% CI (4.49, 7.46), p<0.0001]; students who had negative attitude of smoking were 4.98 times more likely to be non-smokers after the intervention [AOR=4.98, 95% CI (3.76, 6.59), p<0.0001] (Table 9-4).

Table9-4. Associations between attitudes of smoking, media message exposure, and school curriculum and students' current smoking status, Pooled analysis (N=15831).

Indicators	Before intervention (N=8313)		After intervention (N=7518)
	Adjusted OR (95%CI)		Adjusted OR (95%CI)
Attitudes of smoking			
Negative attitudes of smoking	5.79(4.40,7.46)*	Negative attitude of smoking	4.98(3.76,6.59)*
Media Message Exposure			
Cigarettes brand /advertisements	0.52(0.41,0.65)*	Cigarettes brand /advertisements	1.48(1.10,1.99)*
Actors smoking	0.99(0.77,1.27)	Actors smoking	1.64(1.23,2.17)*
School curriculum			
School curriculum	1.08(0.85,1.38)	School curriculum	0.74(0.55,0.99)*

*P<0.0001
**P<0.05
***Adjusted for age, gender, grade, and ethnicity.

Media messages exposure

Compared to students who had not seen cigarettes brand/advertisements, students who were in Bayannuoer and had seen cigarettes brand/advertisements were 50.80% less likely to be non-smokers before the intervention [AOR=0.49, 95% CI (0.38, 0.64), p<0.0001] (Table9-1).

After the intervention, students who were in Changchun and have own something with cigarettes logo, or have seen cigarettes advertisements on billboards or in newspapers and magazines were 67.2% less likely to be non-smokers [AOR=0.33, 95% CI (0.17, 0.65), p<0.05] (Table 9-2).

In Dalian, students who have seen smoking media messages other than on TV were 58.6% less likely to be non-smokers before the intervention [AOR=0.41, 95% CI (0.22, 0.76), p<0.05]. After the intervention, students who were in Dalian and have seen smoking media messages on TV were 75.9% less likely to be non-smokers [AOR=0.24, 95% CI (0.09, 0.65), p<0.05] (Table 9-3).

Generally, compared to students who had not seen cigarettes brand/advertisements, students who had seen cigarettes brand/advertisements were 48.20% less likely to be non-smokers before the intervention [AOR=0.52, 95% CI (0.41,0.65), p<0.0001]. However, students who had seen cigarettes bands/advertisements or actors smoking were more likely to be non-smokers after the intervention [AOR=1.48, 95% CI (1.10, 1.99), p<0.001; AOR=1.64, 95% CI (1.23, 2.17), p<0.001] (Table 9-4).

School curriculum

Before the intervention, students who were in Dalian and had school curriculum were 4.19 times more likely to be non-smokers compared to students who had no school curriculum [AOR=4.19, 95% CI (1.95, 9.00), p<0.05]. Interestingly, students in Bayannuoer that had school curriculum were 55.7% less likely to be non-smokers after the intervention [AOR=0.44, 95% CI (0.27, 0.72), p<0.05]. And the pooled data also indicated that students who had school curriculum were generally 26.40% less likely to be non-smokers (Table 9 1-4).

Chapter Five: Discussion

Our study has assessed the implementation of smoke-free interventions consisting of the school intervention, the social media intervention, and technical assistance from GHI-CTP in 54 schools in Bayannuoer, Changchun, and Dalian. The results reveal that the effectiveness of school smoke-free interventions varied in different cities. These interventions had a positive impact on different aspects of students' tobacco use attitudes and behaviors in each city, as will be discussed below.

Major Findings

1. Tobacco Use:

The tobacco use among students in the three cities reflected a regional difference in smoking prevalence, and a younger age of initial smoking. Additionally, cigarette access and the continuation of smoking among students on campus indicated poor enforcement of the smoke-free interventions and regulations.

- Regional difference did exist in smoking prevalence in our study. Bayannuoer experienced a higher smoking prevalence, while Changchun and Dalian had lower smoking prevalence both before and after the interventions.
- Of the smoking students in the three cities of China, the age of initial smoking for students was low. In our study, most students reported that they first tried a cigarette between the ages of 12 to 15, which is lower than that in the United States (U.S. Department of Health and Human Services, 2014).
- In our study, stores, shops, street vendors and vending machines were the most common places that students had access to cigarettes, both before and after the interventions, although it is illegal for businesses to sell cigarettes to juveniles. Although smoke-free interventions had been conducted on campus, most students in Bayannuoer and Changchun still reported that they usually smoked at

school. This suggested that the lack of impact of the interventions in the current study might be because of poor enforcement of the rules set during the interventions.

2. Attitudes, knowledge and personal experience towards active and passive smoking, and smoking cessation:

Although the majority of the students reported that they would refuse to smoke or quit smoking in the future; and, although they experienced a lower SHS exposure after the interventions, many still did not fully understand the dangers of both active and passive smoking. Additionally, for the students, a negative attitude toward smoking was positively associated with a non-smoking status of individuals. According to students' reports, those who believed that smoking would make them less comfortable or popular exhibited a higher likelihood of being non-smokers.

- In our study, the smoke-free interventions were effective to cultivate negative attitudes of smoking and enabled students to abstain from smoking. After the interventions, more students indicated that they would refuse to smoke if their friends offered them cigarettes; more students stated that they would not smoke in the next 12 months or 5years; and more students were in favor of banning smoking compared to prior to the interventions.
- According to the results of the Chinese youth tobacco survey, after the interventions, the prevalence of youth SHS exposure in the three cities was below the national estimate.
- Not all students were aware of the harm of smoking or secondhand smoking exposure. Our study reveals that only Bayannuoer had a significantly increased number of students that knew the harm of smoking or secondhand smoking exposure after the interventions (94.66% vs. 96.20% for smoking; 92.35% vs. 96.03% for SHS).

- In all the three cities, students who had negative attitudes toward smoking were more likely to be non-smokers, both before and after the interventions.

3. Risk and protective factors of students' smoking behaviors:

In previous research, families, media exposure, and school curriculum were three widely discussed factors associated with smoking behaviors. In our study, families, media, and school curriculum helped to establish a better smoke-free environment for students after the interventions compared to before the interventions by initiating more tobacco control discussions, reducing the number of cigarettes advertisements in the media, and increasing smoke-free education in schools.

- Families: After the intervention, fewer parents smoked, more families discussed the harmful effects of smoking, and more families had rules about tobacco use inside their home than before. Families made efforts to support this youth tobacco control program.
- Media: The smoke-free intervention proved to be effective to encourage more media coverage regarding anti-smoking. Specifically, media message coverage significantly associated with students' current smoking status: less exposure to cigarettes advertisements or brands was associated with lower smoking rates among students.
- School curriculum: After the inventions, more students reported that they were provided school curriculum regarding smoke-free and tobacco control during the past school year. But the association between school curriculum and students' current smoking status is still unclear.

Situation of Tobacco Use

In our study, most students in Bayannuoer, Changchun, and Dalian reported that they first tried a cigarette at ages 12 to 15. This finding is consistent both before and after the smoke-free interventions.

The average age of initial smoking for students in these three cities of China was low, which signals the urgent need for effective smoke-free interventions among school students, especially in lower grades.

After being adjusted for age, gender, grade, and ethnicity, we found students in Dalian were more likely to be non-smokers after the smoke-free interventions, while there were no significant differences between the two phases in Bayannuoer and Changchun. Before the intervention, the smoking prevalence in Bayannuoer, Changchun, and Dalian were 7.94%, 3.45%, and 3.03%, respectively. After the interventions, the smoking prevalence in Bayannuoer, Changchun, and Dalian were 8.45%, 4.52%, and 1.33%, respectively. However, a report from the United States CDC suggested that 6.7% of middle school and 23.3% of high school students in the U.S. in 2012 were current smokers (CDC, 2014). The Global Youth Tobacco Survey (GYTS) reported that the national smoking prevalence for Chinese teenagers was 6.9% (Chinese CDC, 2014). China has a relatively low rate of teenager smoking prevalence compared to the United States. However, regional difference does exist in smoking prevalence. Bayannuoer experienced a higher smoking prevalence, while Changchun and Dalian had lower smoking prevalence.

In our study, the most common places that students can purchase cigarettes were stores, shops, street vendors and vending machines (SSSV), although the law of Preventing Minors from Committing Crimes added a new item in 1999 that make it illegal for businesses to sell cigarettes to juveniles. Over half of the students in each city reported that they could have access to cigarettes from SSSV. Before the interventions, the percentage of cigarette access from SSSV was 71.61% in Bayannuoer, 63.04% in Changchun, and 74.6% in Dalian; while the percentage was 77.87% in Bayannuoer, 76.19% in Changchun, and 57.89% in Dalian after the intervention. In order to put an end to the source of

cigarettes for teenagers, enforcement and supervision should be strengthened and tobacco retail businesses should be strictly prohibited from selling cigarettes to people under 18, and cigarette products should not be found in vending machines. In addition, students can also obtain cigarettes from others, so it is important to gain support not only from schools but also from families and communities and involve everyone in the process of establishing a smoke-free environment for students.

A large number of students in Bayannuoer and Changchun still reported that they usually smoked at school even if the school smoke-free interventions had been conducted, which means more effective school interventions are needed. In Dalian, public places were the most common sites for students to smoke, while schools were the least common. It seems smoke-free interventions at schools were effective in Dalian, but a more comprehensive intervention strategy is critical in order to create a 100% smoke-free environment.

Attitudes and knowledge about smoking, passive smoking, and stopping smoking

In our study, smoke-free interventions proved to be effective to help students develop a better understanding of the importance of tobacco control and quitting smoking. After the interventions, students in Bayannuoer, Changchun, and Dalian were all more likely to refuse to smoke if one of their friends offered them a cigarette. And students in these three cities were more likely to be in favor of banning smoking and refused to smoke in the next 12 months or next 5 years. These changes were all statistically significant. Among current smokers, there was a significantly increasing number of students in Dalian stating that they wanted to stop smoking; yet there were no significant differences in Bayannuoer and Changchun. In addition, after the interventions, more students in these three cities reported that they had tried to stop smoking in the last year. Furthermore, the number of students that

had ever received help or advice to stop smoking increased in Bayannuoer and Dalian, while there was no significant change in Changchun. These facts, in general, reflect a positive trend of a developed better understanding of tobacco control and stopping smoking.

In all these three cities, students who had a negative attitude toward smoking were more likely to be non-smokers, both before and after the interventions. A negative attitude toward smoking was significantly associated with students' current smoking status. The majority of the students believed that smoking would lead to fewer friends, and made people fell less comfortable, and less attractive. Thus, these results demonstrate once again the importance of development of an appropriate attitude and of attainment of enough knowledge about tobacco control by students.

The level of knowledge about the harm of smoking and passive smoking can directly affect students' attitudes and behaviors toward smoking, so it is important to understand students' level of knowledge. Our study demonstrated that the main reason students in Bayannuoer, Changchun, and Dalian stopped smoking was to improve their health. This may be a result of the current school health education curriculum. Among students who were willing to stop smoking, most understood that smoking was bad for health. However, not all students were health-conscious. After the interventions, only Bayannuoer had a significantly increased number of students that knew the danger of smoking or secondhand smoking exposure. In contrast, fewer students in Changchun had awareness of the dangers of smoking and secondhand smoking exposure, and, there was no significant change in awareness in Dalian after the intervention. Thus, our study reveals that there were still large numbers of students in Changchun and Dalian who did not yet understand the dangers of smoking and passive smoking. Great efforts, such as education programs, should be developed to inform young students of the harms of smoking,

especially the dreadful consequences of taking up smoking as a habit. In addition, because Dalian was the only city that experienced a significant decrease in the number of current smokers among students, we can conclude that knowing the harm of smoking or secondhand smoking exposure has little impact on students' smoking behaviors and cessation. It is possible that, although students have appropriate attitudes and awareness of the health dangers of smoking and passive smoking, they still hold a positive attitude toward smoking behavior and believe it is easy to quit smoking even if they have started. The reason for this is that students lack a full understanding of tobacco use, especially the pains of the harms and the extent of the struggles that accompanies tobacco addiction. Thus their deficiency to grasp full or enough knowledge or wisdom warns us of the loopholes in smoke-free education.

Secondhand smoke exposure

In our study, only Changchun reported a significant decrease in home/other secondhand smoke (SHS) exposure after the intervention. After the smoke-free intervention, the prevalence of passive smoking at home during the past seven days in Bayannuoer, Changchun, and Dalian was 42.25%, 25.04%, and 37.28%, respectively. The values for passive smoking in other places during the past seven days in Bayannuoer, Changchun, and Dalian was 43.02%, 28.79%, and 35.16%, respectively. According to the results of the Chinese Youth Tobacco Survey, an estimated 44.4% of the respondents had experienced home SHS exposure within the past seven days and 58.3% of them had experienced SHS exposure in other places with the past seven days (Chinese CDC, 2014). The prevalence of youth SHS exposure in these three cities was all below the national estimate.

It is worth noting that most students in Bayannuoer and Changchun still reported that they usually smoked at school even if school smoke-free interventions had been conducted, which also means the

problem of school SHS exposure was serious in Bayannuoer and Changchun. In Dalian, fewer students reported that they smoked at school, but SHS exposure in home or public places was quite common. The proportions of SHS exposure were different in different places. It is necessary to examine the strength of existing smoke-free interventions and provide more effective strategies and recommendations for future smoke-free policy improvements.

Risk and protective factors of students' smoking behavior

Family:

In this study, besides students' own understanding of tobacco control, students' smoking behavior was also related to the knowledge and attitudes toward smoking of their families, friends, and teachers, as well as media messages and school curriculum. The universal smoke-free campaign to encourage more people to be involved in tobacco control and improve the health of the entire nation is needed. According to our study, the second most important reason students were willing to stop smoking was because their "family or friends don't like it." From this, we can see that family and friends play an important role in youth tobacco control. Our study indicates that parents in Bayannuoer and Changchun were more likely not to smoke after the smoke-free interventions. A significantly increasing number of families in Bayannuoer and Changchun had discussed the harmful effects of smoking. Also, more families in all of these three cities had rules that smoking was not allowed inside their home after the interventions. Thus, in general, family support is necessary to help to establish a better smoke-free environment for students. Parents serve as important role models in students' lives; their attitudes toward smoking shape their children's smoking behaviors.

Peers:

Only Changchun reported a significant decrease in current smokers among peers after the interventions. One possible reason was that these students' peers were from other schools that did not have any smoke-free intervention. Previous research has proved that peer influence was a notable risk factor of students' smoking behavior. Friends are always willing to have a "share attitude" and it is natural for friends to imitate each other's thoughts, mannerisms, and behaviors (Swadi, Harith, 1988). Students' attitudes and knowledge of smoking may be greatly affected by their peers. Thus, it is necessary to broaden the coverage of smoke-free interventions and educate more teenagers about the dangers of tobacco use. However, it is important to understand that students in these three cities have right attitudes toward smoking, and more students stated that they would not smoke even if their friends offered them cigarettes.

Media messages:

Different types of media messages serve as either risk factors or protective factors of students' smoking attitudes and behaviors. Following the smoke-free interventions, students in both Bayannuoer and Dalian reported they had seen or heard more anti-smoking media messages (e.g., radio, television, posters, billboards, magazines, newspapers, movies) and anti-smoking messages at social events (e.g., sports events, fairs, concerts, community events, or social gatherings). The change in Changchun was not statistically significant. Regardless, the smoke-free interventions proved to be effective to encourage more media coverage regarding anti-smoking.

In addition, our study has indicated that media messages were significantly associated with students' current smoking status. In Bayannuoer, students who had been exposed to cigarette

brands/advertisements were less likely to be non-smokers before the interventions. After the interventions, students who saw actors smoking were more likely to be non-smokers. It is possible that actors who smoked on screen were playing a negative and unattractive role, which likely left a bad impression of smoking to the students, and therefore, further encouraged them not to smoke. In Changchun, students who were not exposed to cigarette brands/cigarettes advertisements on billboards/cigarettes advertisements in newspapers or magazines were more likely to be non-smokers after the interventions. In Dalian, students who are not exposed to cigarette brand/cigarettes advertisements on TV/on billboards/in newspaper or magazines/in social events were more likely to be non-smokers after the interventions. In general, less exposure to cigarettes advertisements or brands prevented students from developing smoking behaviors.

School curriculum：

Our smoke-free school curriculum included teaching students about the dangers of smoking, discussing the reasons young people smoke, and educating them on the health effects of smoking during the previous school year. After the inventions, an increasing number of students in Bayannuoer, Changchun, and Dalian reported that they were provided school curriculum regarding smoke-free and tobacco control during the previous school year. However, only the baseline results in Dalian showed that school curriculum has a significant association with students' current smoking status. There are two important lessons that we can learn from this. One is that the one-year school smoke-free interventions period was too short and should be lengthened strengthened or improved in the future. The other lesson is that smoke-free interventions should be conducted as early as possible. Once smoking has already become a habit, it is really hard for students to quit. Also, there may be other confounding factors that may influence this association, such as the smoking behavior of teachers.

Challenges and barriers

Cigarette products make a great contribution to China's tax revenue and employment. In fact, the tobacco industry plays an important role in social economic development of China by applying around 7%-10% of government revenue through tobacco sales (Li, et al., 2012). For example, the tobacco system in Dalian has contributed 1.019 billion yuan in revenue in 2010, which accounts for a large portion of Dalian's total revenue. In addition, the cigarette factories and/or companies provide many employment opportunities for local residents. The Hongta Group Changchun Cigarette Factory is a local tobacco manufacturer with more than 1,200 employees. All of these reasons lead to the slow progress in tobacco control. However, although the tobacco industry generates a great deal of money in revenues and profits, the growing medical expenditures of smoking-related illness treatment is also a huge burden for individuals and for the country.

China has an enormous number of smokers. Based on the results of the 2010 Global Adult Tobacco Survey (GATS), about 28.1% of residents in China aged 15 or older were current smokers (Yang, et al., 2010). It is possible to educate everyone in this country about the harms of smoking, but it is not easy to stop everyone from smoking in a short time. In addition, in China today, many people still think smoking can help to create social community and reduce stress, and that it is also fashionable. Some business owners often disagree with smoking bans in their restaurants, café or hotels, because they are worried about losing customers who smoke. There is still a long way to go to make people change their smoking behaviors on a national level.

People lack of recognition of the seriousness of secondhand smoke (SHS) exposure. According to our results, only students in Bayannuoer had a significant increase in awareness of the harm of smoking or

SHS exposure after the interventions. Only Changchun experienced less home/other SHS exposure during the previous seven days. People are not aware of the dreadful consequences of SHS exposure or of taking up the habit of smoking because there is no immediate visible and taxing bodily reaction to SHS exposure or smoking. However, SHS exposure can result in a high risk of bronchitis, pneumonia, asthma, heart disease, and cancer, and tobacco addiction is considered a serious chronic disease (CDC, 2010).

There is a lack of tobacco control enforcement and support from leaders. Although China is facing a serious problem in controlling tobacco use, it still lacks a national law or regulation that can completely ban smoking in public places. Under current provisions, there is no effective punishment for those who smoke in public places. Likewise, no adequately trained staff supervises the smoke-free environment in public places or identifies those who sell cigarette products to teenagers under 18. Tobacco control in China generally depends on people's self-discipline. However, placing laws or regulations with strong enforcement seems to be essential at this point. In addition, many local leaders still encourage and promote the development of tobacco-planting and cigarettes production; therefore China should find a balance between tobacco-related economic development and public health.

Limitations

Although our study covered 54 schools in three cities of China and provided an important example of an evaluation of youth smoke-free interventions for future research, it cannot reflect the entire tobacco use issue or examine the smoke-free interventions on a national or global level. An even larger sample size is needed for future studies in order to improve the sample representativeness.

For this study, we should also consider the possible bias brought out by self-reported assessment. Since the responses regarding tobacco use and smoke-free interventions were all self-reported and some participants may have been reluctant to report honestly about their tobacco use or their thoughts about tobacco control, the accuracy and credibility of results may be reduced. Also, the researchers did not follow a group before and after the interventions. Developing clear measurable indicators can ensure the objectivity of results. For example, field observation is encouraged to monitor students' smoking status.

Another limitation is that, the one-year smoke-free intervention period may be too short to see any significant results. Establishing a good habit of refusing smoking and gaining enough knowledge of the harm of tobacco use among students requires time. Creating a 100% smoke-free environment for students needs even more time. These smoke-free interventions should be further improved to be more generally useful in future studies and a longer observation period should be implemented to advance the assessment of the change of students' smoking attitudes, knowledge, and behaviors.

Furthermore, our study lacks a control group, and only used a self-control method to evaluate changes before and after interventions. To some extent, these results are not convincing enough. For future studies, researchers should randomly select the same number of schools in one city, which have similar students, school quality, teaching conditions, and learning environments, and divide them into two groups with the principle of randomization: a control group and an intervention group. The smoke-free interventions should be conducted among schools in the intervention group, while schools in the control group run as usual.

Lastly, other factors that may influence participants' attitudes, knowledge, and behaviors towards smoking such as socioeconomic status, parental occupation and education level, native place, monthly expenditure, psychological health status, and teachers' smoking status should be taken into account in future studies. Although the three cities we covered have different conditions in socioeconomic status, education level, health level, smoke-free policy, and tobacco industries, the associations between these city-level risk factors and students' attitudes, knowledge, and current smoking status still needs to be confirmed. From our study, we also found different levels of students' attitudes, knowledge, and smoking risk in different cities, which suggested that the regional component is worth considering when making smoke-free interventions and prevention strategies in the future. Future longitudinal research should also examine the barriers and facilitators of youth tobacco control, as well as the possible impact of regional disparity on the establishment of smoke-free schools in order to understand the real needs of the target population and effectively decrease their smoking prevalence.

Strengths

Our study has a number of strengths. First, it was conducted across three cities in China and covered 8,313 students in the baseline study and 7,518 students in the evaluation study. We had a relatively large sample size, and our results are much more representative than previous studies. The regional difference displayed in our study suggested that future research should consider covering more cities in order to obtain a representative conclusion. Secondly, most of the former studies conducted in China only addressed the smoking attitudes, knowledge, and behaviors among the target population in one phase, either before the smoke-free interventions or after the smoke-free interventions. Little was known about the effectiveness of smoke-free intervention implementation during a certain period of time by doing a two phase study that incorporates results from surveys done both before are after

interventions, especially in a school environment. To close this knowledge gap, our study conducted the evaluation survey among a large target population after one-year smoke-free interventions, which can better explain the effectiveness of certain smoke-free interventions by comparing smoking-related changes before and after the interventions. Thirdly, our study not only discussed target students' prior and current attitudes, knowledge, and personal experience regarding tobacco use, and examined the changes between two phases, but also highlighted the risk and protective factors of students' smoking behaviors. These findings will provide important information and reference for future youth tobacco control education as well as smoke-free intervention planning. Fourth, we conducted a tetrachoric Principal Component Analysis (PCA) to create three principal components: attitudes toward smoking, media message exposure, and school curriculum. This method allowed us to reduce the number of variables and enabled us to demonstrate our results in a simple way.

Recommendations

Tobacco use is an important public health issue and teenagers are one of the most vulnerable populations. Our study indicated a regional difference in tobacco use across three target cities in Mainland China. A survey that covers more cities with a larger sample size is necessary in order to obtain a more representative result. Also, since tobacco use is a global issue, we need more studies in overseas Chinese communities as well as in other countries. A comparison across different regions would have a great significance. Moreover, it would be much easier for researchers to examine the similarities across different places as well as the regional differences in tobacco use among students by using the same procedure and study methods. A standard protocol is useful for future studies.

To address the tobacco use issue among young students and improve their health condition, education programs including peer to peer education aimed at raising students' awareness of the harms of tobacco use and aimed at boosting positive attitudes and behaviors regarding tobacco control are in urgent need. Since peers' attitudes and behaviors toward smoking can have an impact on students' smoking status, and peers may study in different schools, coverage of smoke-free interventions should be expanded to as many schools as possible to avoid negative influence by students in one school on students at another school.

In terms of school curriculum, although all of these three cities have reported an increase in providing smoke-free school curriculum after the interventions, the association between school curriculum and students' current smoking status is still unclear. Several improvements are therefore needed for future studies and interventions: First, one-year smoke-free interventions may be too short to see any significant results. The period of intervention should be lengthened and the enforcement should be strengthened. Likewise, more long-term follow-up studies may be necessary to understand the changes in smoking behaviors among students. Secondly, the earlier the intervention is conducted, the better, because it could be more difficult for students to change their smoking behaviors once smoking has already become a habit. Thirdly, other factors, such as teachers' smoking behaviors, should be considered to include in future survey design to examine the effectiveness of school smoke-free interventions. Lastly, it is recommended that students participate in the planning of school smoke-free intervention programs; in this way, students will be more willing to comply with the rules and regulations they made.

Our study also indicates that media messages are significantly associated with students' current smoking status, thus suggesting cigarettes advertisements and promotions should be prohibited while anti-smoking media presence are welcome. In addition, families and communities should all be involved in this smoke-free campaign to build a 100% smoke-free environment for students.

Furthermore, we should strengthen the supervision and control of access to cigarettes for students. Although China has already passed a law to prohibit selling tobacco products to juveniles, juveniles still can purchase cigarettes from businesses due to lack of penalties. The Chinese government should consider effective strategies and more punitive actions to address this issue. Shops, stores, and vending machines should not sell cigarette products to teenagers under 18. The enforcement of tobacco control regulations should be strengthened at the same time. Lastly, more financial support should be given to conduct longitudinal research and smoke-free intervention programs.

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Appendix: List of Acronyms

AOR: Adjusted Odds Ratio

CATC: Chinese Association on Tobacco Control

CDC: Centers for Disease Control

CHPI: China Healthy Provinces Index

EIU: Economist Intelligence Unit

FCTC: WHO Framework Convention on Tobacco Control

GATS: Global Adult Tobacco Survey

GDP: Gross domestic product

GHI-CTP: Emory University Global Health Institute China Tobacco Control Partnership

GYTS: Global Youth Tobacco Survey

NCSC: National Children's Study of China

NOYTS: Northwest Ohio Youth Tobacco Survey

NYTS: National Youth Tobacco Survey

OECD: Organization for Economic Cooperation and Development

PCA: Principal Component Analysis

SHS: Secondhand Smoke

STMA: State Tobacco Monopoly Administration

TFC: Tobacco-Free Cities

ITC: International Tobacco Survey / Framework Convention on Tobacco Control Surveillance Adult Smoker's Questionnaire

WHO: World Health Organization