8-3-2018 10:00 AM

Risk Perceptions of Smoking in China

Imran Syed
The University of Western Ontario

Supervisor
Dr. Samantha Wells
The University of Western Ontario Co-Supervisor
Dr. Tara Elton-Marshall
The University of Western Ontario

Graduate Program in Epidemiology and Biostatistics
A thesis submitted in partial fulfillment of the requirements for the degree in Master of Science

Abstract

Approximately one million smokers die in China every year. Risk perceptions of smoking have been theorized as being important in explaining behaviour change and have been found to be associated with initiating and quitting smoking. This study examined the extent to which smokers in China perceive risks associated with smoking (i.e., perceived likelihood of getting a smoking-related disease) and the roles of socio-demographic factors (i.e., gender, age, ethnicity, income and education) and knowledge of the consequences of smoking in explaining risk perceptions of smoking. Participants included 4861 smokers from six cities in China. The prevalence of perceived risk for smoking was very low: 19.9% (95% CI: 17.5%-22.7%). Multivariable logistic regression analyses revealed that those more likely to perceive risk were in the youngest age group, with medium education, and higher health knowledge. Interventions may be needed in China to improve knowledge and perceptions about the health harms of smoking.

Keywords

Risk Perceptions of Smoking, Health Belief Model, Perceived Likelihood, China, Smokers in China, Smokers, Smoking, Cigarettes, Tobacco Control, Sociodemographic Factors, Global Health, Knowledge of Health Risks

Dedication

For my nieces and nephew, may you grow up to have great futures, and for my family, who supported me through this part of the journey.

Acknowledgements

Above all, I would like to thank my supervisors, Drs. Tara Elton-Marshall, and Samantha Wells, for your patience, guidance, and collaboration. Undoubtedly you have both worked to shape my career the way you have my thesis. I have no doubt that my success here can be attributed to the time you have given me, enthusiasm for the project, and near omnipresence for the many times I needed help.

Thank you also to Dr. Neil Klar, my committee advisor, who often calmed my nerves to any statistical anxiety I was feeling throughout this project.

Thank you to the all the staff and fellow students at the Institute for Mental Health Policy Research at CAMH here in London for opening your doors to an obnoxious 21-year-old graduate student. The resources you have provided were instrumental in finishing this thesis. Rochelle, thank you for letting me use your office space throughout the year. Maryfrances, thank you for proofreading this thesis; I have no doubt that Chantal and yourself have bright futures ahead.

Thank you also to the staff at the International Tobacco Control (ITC) project, including the China team, in Waterloo and at the Chinese Center for Disease Control and Prevention for providing the data source used in this thesis, and for your warm receptivity when I needed help with the dataset. Thank you to the PIs Dr. Geoffrey Fong and Dr. Jiang Yuan for your leadership and expertise in coordinating this larger project. Steve and Gang, thank you for being readily available whenever I had questions that were ITC related.

Lastly, but not least, thank you to the faculty, staff, and fellow students at the Epidemiology and Biostatistics department, who often go unsung for the education they bestow, administrative support they provide, and emotional support they give. This includes three of my roommates, and even *arguably* two twins who lived down the hall. Lavanya and Patrick, thank you for your faith, support, and lasting memories. Rohin thank you for suggesting this program and reviewing my letter of intent when I was struggling to figure out my next steps; thank you also for forgiving me for almost getting us killed during the move-in process. Fellow SHET members, I hope to see you all in the coming years to reflect on our many moments in and out of class and catch up on the years to come. Jerome, thank you for housing me in the closing months of this thesis, while I had none in London, and for always being there when a round of Smash Bros. was needed.

Table of Contents

List of Tables

List of Figures

List of Appendices

1. Chapter 1

1 Introduction

1.1 Overview of Thesis

Cigarette smoking is one of the leading causes of preventable death in the world.[1] Despite numerous efforts to reduce cigarette use,[2] just over one fifth (20.7%) of the world's population smokes cigarettes.[1] This rate of cigarette use results in annual deaths of about six million people throughout the world.[1] The highest prevalence rates are observed in low- and middle-income countries,[3] where they are expected to rise.[4] China has one of the highest prevalence of cigarette use worldwide, with nearly a third of the population currently smoking, including the majority of men.[5] China is unique in that it has its own government-owned and operated tobacco monopoly.[6] This can be linked to many implications involving poor tobacco control policies that allow smoking rates to be as high as they are.

Risk perceptions of smoking have been found to be an important determinant of smoking behaviour.[7,8] According to the Health Belief Model,[9–11] risk perceptions of smoking are defined as one's "understanding of the probability of health consequences from smoking and [appreciation of] the severity of those consequences"[12] and can be further characterized into *perceived susceptibility* (i.e., the perceived likelihood that health harms will result from smoking) and *perceived seriousness* (i.e., the perceived severity of harms due to smoking).[9–11] This thesis focuses on perceived susceptibility. Risk perceptions of smoking have been shown to have important effects on smoking behaviours. Previous research has found that risk perceptions of smoking are associated with a decrease in the likelihood of smoking initiation, [13,14] and an increase in the likelihood of smoking cessation,[8,15–18] among other health outcomes. Thus, it is important to examine the prevalence of risk perceptions of smoking among daily smokers, and factors that associate with it, including those which have been found to associate with it in previous literature, being gender, [19–28] age, [19–28] ethnicity,[23,29,30] education,[23,31–33] income[23,31–33] and knowledge of the health consequences of smoking.[23,34,35] Moreover, given the high prevalence of smoking in China, it is important to investigate risk perceptions of smoking among China's smokers. High smoking prevalence may be indicative of generally lower risk perceptions of smoking among China's smoking population. For instance, a previous study found that the proportion of smokers in China to respond correctly to a risk perceptions of smoking measure was lower[36] compared to when the same measure was used for respondents in high-income Western countries.[37] Given the previously found health implications, and potential for population intervention, the risk perceptions of smoking are worth investigating in China.

The aim of this thesis is to investigate the risk perceptions of smoking in China among daily smokers. In particular, using a large database from China, we will investigate the extent to which smokers perceive risks of smoking, and factors (e.g. sociodemographic) associated with the risk perceptions of smoking. Data for this study were obtained from the 2011-2012 Wave 4 of the International Tobacco Control (ITC) project, including cross-sectional data from 4861 adult smokers. Weighted proportions were calculated for the perceived likelihood of smoking. Multivariable regression analyses were performed to examine the associations between explanatory variables, including sociodemographic factors (gender, age, ethnicity, income, and education) and health knowledge, and risk perceptions of smoking, as were previously investigated in other literature. This thesis focuses on the perceived likelihood of harms due to smoking. While a measure of perceived severity of harms due to smoking was available in the

ITC dataset, it had a high number of missing cases and therefore was not included in the thesis. The results of this study will be important for informing tobacco control efforts in China.

This first chapter provides an introduction to this thesis and describes its objectives. Chapter 2 provides an overview and critique of existing literature, including a more detailed description of smoking in China, how perceived likelihood is conceptualized by the Health Belief Model, and how certain factors may differently associate with perceived likelihood. Chapter 3 describes the methods of this study, including data collection, and analyses, while Chapter 4 presents the results. Finally, Chapter 5 provides a discussion of the study descriptive and analytic findings, and provides implications for future tobacco control and research. This final chapter also provides a conclusion to this study, as well as outlines its strengths and weaknesses.

1.2 Objectives and Rationale

The aim of this thesis is to describe the prevalence of risk perceptions (i.e. perceived likelihood of developing a negative smoking related health outcome) and examine factors associated with risk perceptions in a large sample of daily smokers in China.

The objectives of this thesis are twofold:

Objective 1: To estimate the extent to which smokers in China perceive risks associated with smoking.

Drawing on a measure of perceived likelihood that aligns with the Health Belief Model, we will estimate the prevalence of daily smokers in China that perceive the likelihood of health risks due to smoking. More specifically, we will identify the proportion of smokers in our sample who perceive they are “much more” likely to develop a smoking-related disease, compared to a non-smoker, if they continue to smoke as they do now, applying weights adjusted to China’s true population and a 95% confidence interval.

Objective 2: To examine which factors (sociodemographic and health knowledge) are associated with risk perceptions of smoking among smokers in China.

We will gain a better understanding of factors associated with risk perceptions of smoking, including the perceived likelihood of developing a smoking-related disease as described above. We will develop a model of risk perceptions assesses the relative roles of explanatory variables described in this literature review that exist in our dataset, including age, gender, ethnicity (Han vs. non-Han), highest achieved education, monthly household income and knowledge of the health consequences of smoking, while adjusting for the confounding of other explanatory variables and our covariates: current city of residence, cohort of recruitment and cigarettes consumed per day. This research is expected to address several gaps in the literature and improve our understanding of risk perceptions of smoking in China.

Chapter 2

2. Literature Review

2.1 Cigarette Smoking: A Persistent Global Health Issue

Cigarette smoking has been found to increase the risk of many severe negative health consequences including: adenocarcinoma (lung cancer), asthma, liver, breast and colorectal cancer, prostate cancer, chronic obstructive pulmonary disease (COPD), tuberculosis, stroke, and congenital malformations.[38] Despite the health risks associated with cigarette smoking, nearly one fifth of the world's population smokes,[2,5] with the highest prevalence of smoking found in low- and middle- income countries.[5] Worldwide, approximately six million deaths are attributed to smoking each year, with low- and middle-income nations disproportionately affected.[3] Smoking rates are projected to rise in many of these countries if current trends continue.[4] According to a 2017 World Health Organization (WHO) report, compared to low- and middle-income countries, a greater proportion of high-income countries currently have more stringent tobacco control policies and programs including warning labels on cigarette packaging, mass media campaigns targeting tobacco use, national television, radio and print media bans, and taxation of cigarettes exceeding 25% of the retail price.[2] Thus, research is needed to inform the development of tobacco control initiatives in low- and middle-income countries to gauge how current policies influence health outcomes, and to identify where improvements can be made.

2.2 Smoking in China

China is currently the largest consumer of tobacco in the world, comprising almost a third of the world's smokers. Over 300 million people in China are current smokers representing nearly one third of the population.[5,39] China is also unique in that it has a comprehensive government-owned monopoly on tobacco. The China National Tobacco Company (CNTC) and

State Tobacco Monopoly Administration (STMA) are responsible for over 90% of the cigarette market in China.[6] Through the CNTC, the STMA controls all aspects of the tobacco industry in China, including tobacco farming, processing manufacturing and distribution of tobacco in addition to use of materials and machinery.[41]

The 2015 Global Adult Tobacco Survey (GATS) conducted in China found that 52.1% of men, and 2.7% of women in China currently smoke,[2] thus indicating a notable gender divide. This gender gap may reflect how smoking is less socially desirable for women than men in China.[42] Previously, in most high-income countries the incidence of smoking initiation among women has lagged behind that of men; however, as a nation progresses through the stages of the tobacco epidemic, the smoking rates of young women rise just as they did decades earlier for men, in some cases to an equal prevalence.[43] This has often reflected previous success of feminist and women's suffrage movements in attaining greater equality, in both human rights and societal expectations, for women.[43] Similarly, in China it is known that acceptability of female smoking significantly increased between 2006 and 2009, and among women, tobacco use is currently most prevalent among younger cohorts.[42] Therefore, experts anticipate that overall rates of female smoking are likely to increase over time in China.[43,44]

An estimated 1 million people die from smoking related diseases in China annually; this figure is expected to nearly triple, from approximately 600,000 deaths in 1996 to approximately 1,500,000 per year by 2050.[45] In fact, 8.9% of all mortality in China in 2008 was attributable to smoking cigarettes, at a nation-wide health care cost of approximately $6.2 billion (USD).[6] The population-level impact of smoking on the health of China is therefore a clear public health priority.

2.3 The Health Belief Model and Risk Perceptions of Smoking

The Health Belief Model, a theory that describes how health behaviours (e.g. smoking) are influenced by certain belief patterns,[9–11] informs our conceptualization of risk perceptions in this thesis and factors that might explain risk perceptions of smoking. The model was developed in 1952 by Hochbaum, Kegels and Rosenstock to predict changes in health risk behaviours, and was initially oriented toward disease prevention.[9,11] Since its inception, this model has been revised a number of times to understand health behaviours[11] to inform treatment and policy.[9] This model has been applied to numerous public health concerns[9] and can be directly applied to smoking.[10]

A central component of this model are *risk perceptions* including perceived susceptibility to disease (or perceived likelihood of disease) and perceived seriousness of disease (or perceived severity of disease). Perceived susceptibility is defined as “the perception of the likelihood of experiencing a condition that would adversely affect one's health.”[11] Perceived seriousness is defined as “beliefs a person holds concerning the effects a given disease or condition would have on one's state of affairs.”[11] A frequently cited figure that illustrates this model is shown in Figure 1 below. As shown in this figure, in addition to these risk perceptions, the model includes “modifying” factors deemed to be important explanatory variables for both risk perceptions and the likelihood of behavioural change. Modifying factors refer to personal factors, and environmental cues in addition to the perceived threat of disease that ultimately influence one’s thought processes while contemplating a behaviour change, or when following through on one. Personal factors include gender, age, gender, ethnicity, socioeconomic status, and knowledge of the impact of a health behaviour,[9] many of which comprise associations with risk perceptions of smoking that we wish to test in this study.

While there are various conceptualizations of risk perceptions of smoking that influence the multiple ways they are operationalised,[46] Slovic (1998) considers the Health Belief Model when broadly defining risk perceptions as "understanding of the probability of health consequences from smoking and [appreciation of] the severity of those consequences."[12] Overall, this model highlights that in order to change one's behaviour to reduce negative health consequences, they must first consider their perceived threat of such consequences, which ultimately requires one to have individual risk perceptions (being perceived likelihood and severity). By applying this model to cigarette smoking, one can deduce that risk perceptions of smoking may be important in explaining behaviour change (such as initiating or quitting smoking). Although the Health Belief Model includes two different conceptualizations of risk perceptions, including perceived likelihood and perceived severity, this thesis will focus solely on the perceived likelihood component. Although both measures of risk perceptions are integral to the Health Belief Model,[9–11] a measure of perceived severity available in the ITC dataset could not be used due to a high rate of missingness (15.7%), likely due to poor measure interpretability.

Indeed, risk perceptions have been found to be negatively associated with smoking initiation,[13,14] positively associated with smoking cessation,[8,15–18] quitting attempts,[18,47] motivation or desire to quit,[48–50] intention to quit[36,51–54] and readiness to quit.[47,55] Longitudinal studies have also found that smokers who believed that they were at higher risk of developing future smoking related cancers at baseline were more likely to have quit by follow-up.[18,56,57] Given that risk perceptions have been shown to be important in explaining smoking behaviour, it is important to understand what factors explain risk perceptions, especially among daily smokers, who are particularly impacted by their health behaviour. Risk perceptions of smoking are known to differ among smoker and non-smoker groups, with smokers typically having higher perceived likelihood of various smoking-related health consequences than non-smokers.[58–67]

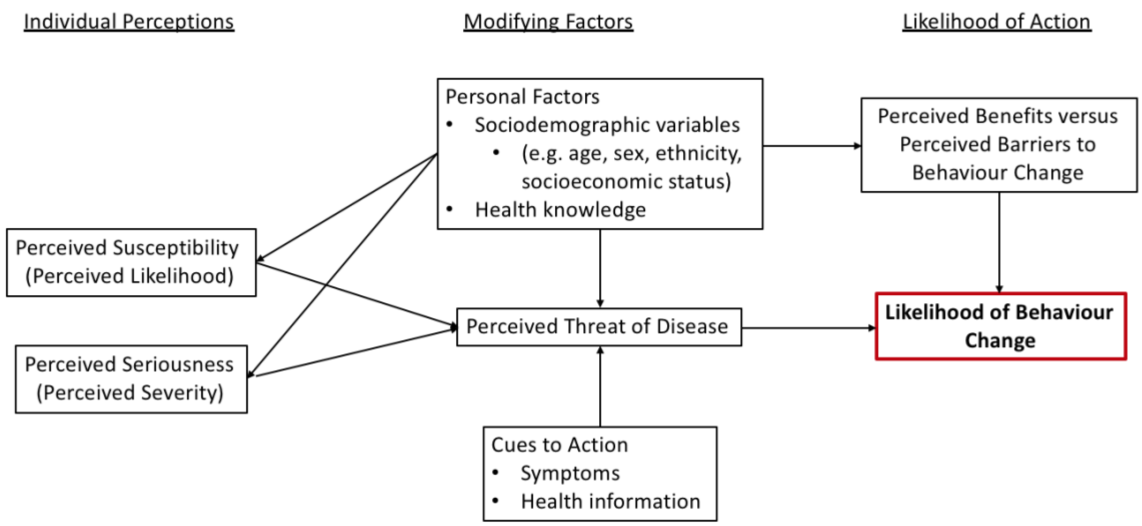

Figure 1. The Health Belief Model as outlined by Hochbaum, Kegels and Rosenstock (1952) and illustrated by Glanz, Rimer and Lewis (2008).[9]

2.4 Risk Perceptions of Cigarette Smoking in China

As noted above, the focus of the present thesis is on the risk perceptions of cigarette smoking in China. Studies conducted in China on the risk perceptions of smoking are generally consistent with the broader literature described above, with risk perceptions associated with decreased smoking behaviour. For example, a study conducted in China found that worrying about future damage caused by smoking, even only “a little,” compared to “not at all”, was associated with a 4.01 (95% CI: 3.02 to 5.33) greater odds of intending to quit among smokers.[36] Additionally, smokers who answered that they were “very much” worried about future damage caused by smoking had a 10.44 (95% CI: 7.59 to 14.38) greater odds of intending to quit compared to those who were “not at all” worried.[36] Therefore, given its theoretical impacts on health behaviour, and supporting empirical evidence, research is needed to improve our understanding of the risk perceptions of smoking in China. It should be noted, however, that China’s unique culture and history of tobacco use may impact risk perceptions of smoking among smokers in China. As such, findings relating to the prevalence of risk perceptions as well as factors associated with risk perceptions may not be consistent with findings obtained from other countries.

2.4.1 Prevalence of the Risk Perceptions of Smoking in China

Research to date suggests that risk perceptions of smoking are not exceptionally prevalent in China. Yang and colleagues (2010) found that over a third of smokers in China reported feeling “not at all” worried about future damage from smoking.[36] Findings from Wave 3 of the International Tobacco Control (ITC) China project found that 68% of smokers in China were “a little” or “very” worried about smoking damaging their health.[68] In contrast, 87.8% of ITC participants in Canada, USA, Australia and the UK had “moderate” to “high” worry of future damage to their health, when using a similar measure.[37]

While the prevalence of risk perceptions of smoking can vary depending on the type of measure that is used,[69] a number of studies conducted in China have shown similar results.[70] Persoskie and colleagues (2014) found that smokers had a mean rating of 2.41 (SD = 0.83) on a 5-point scale assessing their perceived likelihood of future cancer risk relative to similarly aged people of China’s general population, where 1 represented extremely unlikely, and 5 represented extremely likely.[70] Additionally, compared to the average non-smoker, smokers are significantly *less* likely to believe that they will personally develop cancer relative to the average person their age.[70] This is consistent with studies demonstrating that smokers tend to hold an optimistic bias, i.e. a smoker's tendency to underestimate their personal health risk, [71–74] usually relative to the that of the average smoker.[58,65–67] This study measured smokers' perceived likelihood of developing cancer in China, and further, using a sample of smokers and non-smokers, rather than a sample of daily smokers, as we have proposed. To our knowledge, it is the only study in China to measure perceived likelihood for any smoking-related consequence. Therefore, more research is needed, and this thesis provides that research.

2.5 Factors Associated With Risk Perceptions of Smoking

Returning to the Health Belief Model shown in Figure 1, a number of variables are deemed to be important explanatory variables for risk perceptions, including sociodemographic variables and knowledge of the health consequences of the behaviour.[9] Additionally, cigarette consumption has been shown to be an important variable associated with risk perceptions of smoking.[13,14] Below we describe existing knowledge regarding these associations. For each explanatory variable, the findings across all found studies are described, followed by results found specifically for data collected in China.

2.5.1 Gender

Among articles investigating the risk perceptions of smoking, females tended to have a greater perceived likelihood of developing smoking-related health consequences, compared to males,[19–28] although gender differences were not always statistically significant.[75–78] In the majority of studies, women were more likely than men to perceive the risks of smoking in terms of developing smoking-related health outcomes, within smoker-only samples,[20,23,27,79,80] but also within studies that included non-smokers in the sample.[19,22,25,26,81]

Men are theorized to be less likely than women to perceive risks due to gendered structures, such as traditional gender norms. As such, they engage in "riskier" and potentially more self-destructive behaviours that are associated with "masculine" social roles.[82] These roles are theorized to be reinforced by society, with men socialized to perceive risks in a different way than women.[82]

One study was found that evaluated the relationship of gender with perceived likelihood in China; null associations were found, in contradiction to much of the literature.[77] This study investigating the general population in China found that gender was unrelated to both one's personal perceived likelihood of developing cancer and to the perceived likelihood of developing cancer relative to the average person their age, adjusting for smoking-status.[77]

Therefore, it seems that findings in China contradict the bulk majority of literature explaining how gender associates with risk perceptions of smoking. Differences in study findings may be attributable to the fact that few women in China smoke[39] compared to Western countries that have produced the majority of the research in this area. [19,20,22,23,25–27,79,83,84] Therefore, where sample sizes permit, it will be important to examine whether gender is related to perceptions of the likelihood of developing smoking related consequences among China's smokers.

2.5.2 Age

The empirical research examining the association between age and risk perceptions of smoking has yielded mixed results. Many studies, including samples restricted to smokers and samples of both smokers and non-smokers have found that, generally, younger people are less likely to perceive the likelihood of risk, or have lower perceived likelihood scores on average, compared to older people.[53,85–88] However, other studies have found that older people are less likely than young people to perceive the likelihood of developing various smoking-related diseases.[23,78,79,86] For example, one study found a significant negative correlation between age and the perceived likelihood of developing smoking-induced cancer, oral disease, and reproductive mortality, among smokers smoking at least 10 cigarettes per day.[23]

These relationships between age and risk perceptions of smoking, particularly perceived likelihood of developing various smoking-related diseases, have also yielded non-significant results in both high-income Western countries, and in China, specifically.[77,89,90] For example, a study of smokers and non-smokers in China found no significant association between age and one's personal perceived likelihood of developing cancer, either in absolute terms, and relative to that of the average person of the same age category, adjusting for smoking status and other sociodemographic factors.[77]

Some tobacco experts have suggested that, compared with older smokers, younger smokers are more likely to believe that they will have little difficulty quitting and are unlikely to become addicted; thus they start smoking despite *knowing* the long-term risks.[91] Consequently, younger people may be less prone to perceive risk in response to measures assessing one's *personal* perceived likelihood. Further, researchers have argued that by underestimating the short-term risks exclusively, youth become addicted, and ultimately unable to quit as they initially planned,[12,92–94] while older people, having already smoked for an extended period of time, have been found to downplay the now impending long-term consequences of their behaviour.[23,79] Therefore, the effects of age on the risk perceptions of smoking are conflicting,[23,53,79,85–87,95,96] and may depend on how risk perceptions are assessed.[12,78,91–94] In China, the few studies that have been conducted have yielded non-significant differences in risk perceptions by age.[77]

2.5.3 Race and Ethnicity

Within the larger risk perceptions of smoking literature, the effects of one's racial or ethnic background have shown mixed associations with risk perceptions: one study found that non-White ethnic minorities (Asian Americans) rate themselves higher on a scale that includes a measure assessing perceived likelihood of developing a smoking-related disease,[97] whereas other literature suggests that Caucasians score higher, or are more likely to perceive likelihood for various smoking-related health consequences.[23,29,30] Additionally, many other studies found any association between race or ethnicity and perceived likelihood of developing various smoking-related consequences to be non-significant.[23,27,78,90,98] Much of the aforementioned research was also conducted in Western countries with predominantly Caucasian populations,[23,78,97,99] which is problematic when compared to China, where Han ethnicity comprises the majority of the population (94%).[100] When discussing a review of the literature, Winkleby and Cubbin (2004) argue that, while sociocultural differences are a factor, racial and ethnic differences in health behaviours are largely driven by differences in socioeconomic status (SES);[101] it is difficult to determine whether these phenomena apply to China, as, to the best of our knowledge, no previous study has researched differences in smoking-related risk perceptions by ethnicity in China.

2.5.4 Education

Studies assessing the effects of education on the risk perceptions of smoking have shown generally positive associations, with non-smokers with higher educational attainment having a greater likelihood of perceiving that smokers are at an increased likelihood of developing a smoking related disease,[23,31,33,78,88,102] and smokers with higher educational attainment also perceiving greater risks.[23,31–33] For example, in a sample of smokers and non-smokers in France, higher education was associated with a higher likelihood of reporting that at least 50% of smokers will die of a smoking-related disease.[32] However, numerous studies have found non-significant associations between educational attainment and risk perceptions of smoking.[23,30,33,76,79,103,104]

There are several potential theories that address how education can affect health behaviours,[105,106] and potentially risk perceptions; however, not all apply to the risk perceptions of smoking. One theory is that greater education leads to greater exposure to information relevant to the health risks of smoking. Cutler (2010) also argues that those of higher educational backgrounds are more likely to internalize information that they are exposed to, including information from universal programming.[106] Garrett and colleagues (2015) therefore recommend targeting future health warnings toward those of low socioeconomic status,[107] given that many current marketing campaigns are less effective among such people. Nevertheless, much of the theory here bases itself on high-income Western countries, and therefore discretion is needed when investigating how it may apply to China.[105,106,108–110]

Although there is substantial evidence demonstrating a positive association between higher levels of education and greater perceived likelihood of various adverse health outcomes,[23,31,33,78,88,99] one study demonstrated a negative association between education and risk perceptions.[67] McCoy and colleagues (1992) found a significant negative correlation between risk perceptions and education. However, other factors, including smoking status, were not adjusted for in the analysis.[67] Given that smoking status is a significant predictor of risk perceptions, this could cause confounding.[58–67]

Only one study to date has been conducted in China, and this study found no significant differences in risk perceptions of smoking by educational attainment.[70] However, given that this study was conducted in only two cities, and that the study included a sample of both smokers and non-smokers, further research is needed to examine whether education may be associated with risk perceptions among smokers in China.

2.5.5 Income

Previous studies have found that higher income is significantly associated with greater mean perceived likelihood scores for the development of various diseases.[23,77,111] One study found that higher income was associated with higher risk perceptions (unspecified) among a mixed (smoker and non-smoker) nationwide sample of Americans.[99] Some studies found non-significant associations.[32,79,81]

As noted for education, people of higher income may have greater access or exposure to information about the health risks of smoking compared with people of lower income.[105,106] Additionally, differences in risk perceptions by income may be explained by social networking and resource allocation.[105,106] Specifically, individuals with lower income are significantly more likely to have friends who are smokers,[37] and therefore smoking may be more socially acceptable among their social networks.[112]Also, individuals with lower socioeconomic status have less access to prevention and cessation-related resources, which may also impact their likelihood of smoking and risk perceptions of smoking. [105,106]

One study was found that investigated the relationships between risk perceptions and socio-economic variables in China. This study found a positive relationship between income and perceived likelihood of cancer risk relative to the average person of that age, adjusting for smoking status and other sociodemographic factors.[77] This finding is consistent with the broader literature; however, given that only one study was found examining this association in China, further research is needed.

2.5.6 Knowledge of the Consequences of Smoking

Weinstein (2001) argues that to assess the risks of smoking, individuals must first know about the health consequences of smoking.[46] However, health knowledge alone is not enough. Even those who are aware of the health consequences of smoking must also perceive themselves to be at risk if they smoke.[113] Health knowledge about the consequences of smoking has been found to be positively associated with risk perceptions.[23,34,35] For example, Oncken and colleagues (2005) found that among smokers, knowledge of the consequences of smoking was associated with greater perceived likelihood of developing cancer, pulmonary disease, cardiovascular diseases, reproductive difficulties, death, and disability.[23] However, to our knowledge, these relationships have not been investigated in China.

Health knowledge is also one of several "personal factors" in the Health Belief Model, which are said to directly influence or associate with risk perceptions.[9] For this study, we wish to test how such personal factors associate with risk perceptions.

2.5.7. Other Potentially Important Covariates

A few studies have found a positive association between number of cigarettes smoked per day and perceived likelihood of developing smoking-related negative health outcomes,[33,49,76,78,114,115] suggesting that heavier smokers may have greater risk perceptions of smoking than light smokers. All studies were conducted in high-income countries.[49,76,78,114,115] No studies to date have examined whether cigarette consumption is related to risk perceptions in China.

Although theories explaining the association between the number of cigarettes consumed, and risk perceptions of smoking are limited, one theory is that smokers tend to attribute smoking risks (e.g. of developing lung cancer) to consuming more cigarettes than their own level of consumption.[33] Peretti-Watel and colleagues (2007) examined what threshold of daily cigarette consumption could be attributed to increased perceived lung cancer risk and found that smokers, on average, attributed risk to daily rate that was higher relative to their own, which thus indicates risk denial.[33] They found that risk denial was less common among heavier smokers (those consuming more per day), while personal fear (a measure of personal perceived likelihood of developing lung cancer) was actually higher.[33] Therefore, while all smokers may adopt these thought processes, they are more common among those who smoke less, as heavier smokers are less able to deny the risks associated with smoking.

Another variable that may be related to risk perceptions is city of residence. Cities in China can be vastly different in terms of their population, location, tobacco industry presence and tobacco control policies. For example, certain regions of China have seen greater infrastructure investment than others, likely causing certain urban centers, such as Beijing and Shanghai, to modernize more rapidly than others.[116] Similarly, some cities, such as Beijing and Shanghai are more affluent than others. Others cities in China are also major tobacco producers[117] and or have greater cigarette brand availability.[118] While federal policies are consistent throughout China, certain regions and their municipalities have autonomy over certain laws concerning tobacco control, as well as how they are enforced.[68] We therefore anticipate that there could be differences in risk perceptions of cigarettes across the cities. Indeed, to date, one study conducted in China found differences in the risk perceptions of smoking between two cities (Beijing and Hefei) in China.[77] Specifically, they found differences between the urban areas of both cities, such that participants in urban Hefei were significantly less likely to perceive risks of smoking than those in urban Beijing.[77] Given that previous studies have found differences between Beijing and Hefei, [77] there may therefore be heterogeneity between participants from these city in terms of risk perceptions of smoking.[119]

2.6 Knowledge Gaps

Overall, research examining the risk perceptions of smoking in China has been limited. While several studies have included risk perceptions of smoking as a covariate or explanatory variable, relatively few have examined risk perceptions as the outcome variable.[36,70,120–123] Among the most relevant of these was a study by Yang and colleagues (2010)[36] which used data from Wave 1 of the International Tobacco Control (ITC) China study conducted in 2006. The Yang study measured risk perceptions of smoking, and examined a sample restricted to smokers only. However, the primary outcome of their study was health knowledge, rather than risk perceptions of smoking. [36] To our knowledge the most comprehensive study of risk perceptions in China was conducted by Persoskie and colleagues who examined associations of city, income, education, age, gender, smoking status and city of residence with one's own perceived likelihood of developing cancer using a sample of both smokers and non-smokers. However, the sample was restricted to two Chinese cities, Beijing and Hefei.[70]

Our study expands on this previous research by including samples from six Chinese cities[70] and by expanding the range variables to include cigarettes consumed per day and ethnicity. Additionally, to our knowledge this will be the first study to investigate whether ethnicity and health knowledge are associated with risk perceptions of smoking. Our study population differs slightly from the Persoskie et al.'s study, as we wish to investigate factors associated with risk perceptions of smoking among smokers in China specifically, rather than among the general population of China.[70]

As described above, some findings in previous research are mixed. Thus, it is important to clarify these associations. For example, the associations of age are mixed, with some positive associations, some negative associations[23,78,79,85–87] as well as some null findings. However, only a few studies, mostly conducted in high-income Western countries, found null effects.[89,90]

Our study will be one of the first to measure the prevalence of risk perceptions of smoking among smokers in six cities in China, and the first to do so using our measure of perceived likelihood informed by the Health Belief Model. While Yang and colleagues (2010) conducted similar research using data from previous waves of the ITC surveys they used a measure of risk perceptions that reflected worrying about health consequences rather than the likelihood of health consequences.[36] Additionally, they were not looking at risk perceptions of smoking as an outcome.

This study will be important for examining an under-researched concept (risk perceptions of smoking) in a country which has the highest prevalence of smoking internationally.[39,68] Further, this study contributes to the larger literature on risk perceptions of smoking, given that the majority of research to date has focused on risk perceptions among smokers in Western countries.

Chapter 3

3. Methods

This study used secondary cross-sectional data from Wave 4 of the International Tobacco Control (ITC) China Project. The goal of the ITC Project is to measure the impact of national level tobacco control policies of the World Health Organization's Framework Convention on Tobacco Control (FCTC),[124] in 29 countries to date.[68,125] The goal of the ITC-China project is to examine the patterns of smoking in six cities in mainland China, as well as the impact of tobacco control policies so that they could be compared to policies in other countries.[68] As part of the ITC-China project, surveys of the general population have been conducted in China, roughly biennially, since 2006. The study uses a longitudinal cohort design with a replenishment sample of smokers added at each survey wave to replace those lost due to attrition. The most recent survey was conducted between 2013 and 2015, but is not publicly available.[68] This thesis will therefore use Wave 4 data, which was collected in 2011-2012.

3.1 Participants

Participants included in ITC China Wave 4 were 5,082 adults (18 years of age or older) smokers, 472 quitters and 1840 non-smokers living in seven cities in China: Beijing, Changsha, Guangzhou, Kunming, Shanghai, Shenyang, and Yinchuan.[i] At each survey wave, participants from earlier waves were re-contacted, and a replenishment sample was also recruited to account for those lost to attrition. This included a replenishment of 1840 current smokers, recruited in wave 4 in addition to 3237 smokers who were recontacted.[126] Figure 2 provides a detailed illustration of how each wave contributed participants to the full sample in wave 4. Adults living

[i] 10 smokers and 3 non-smokers were excluded from any analyses due to various reasons that were undisclosed by the ITC China Wave 4 technical report.[126]

in jail, certain institutions (e.g. university residences, hospitals, or seniors' residences), private businesses, and mobile populations were also ineligible.

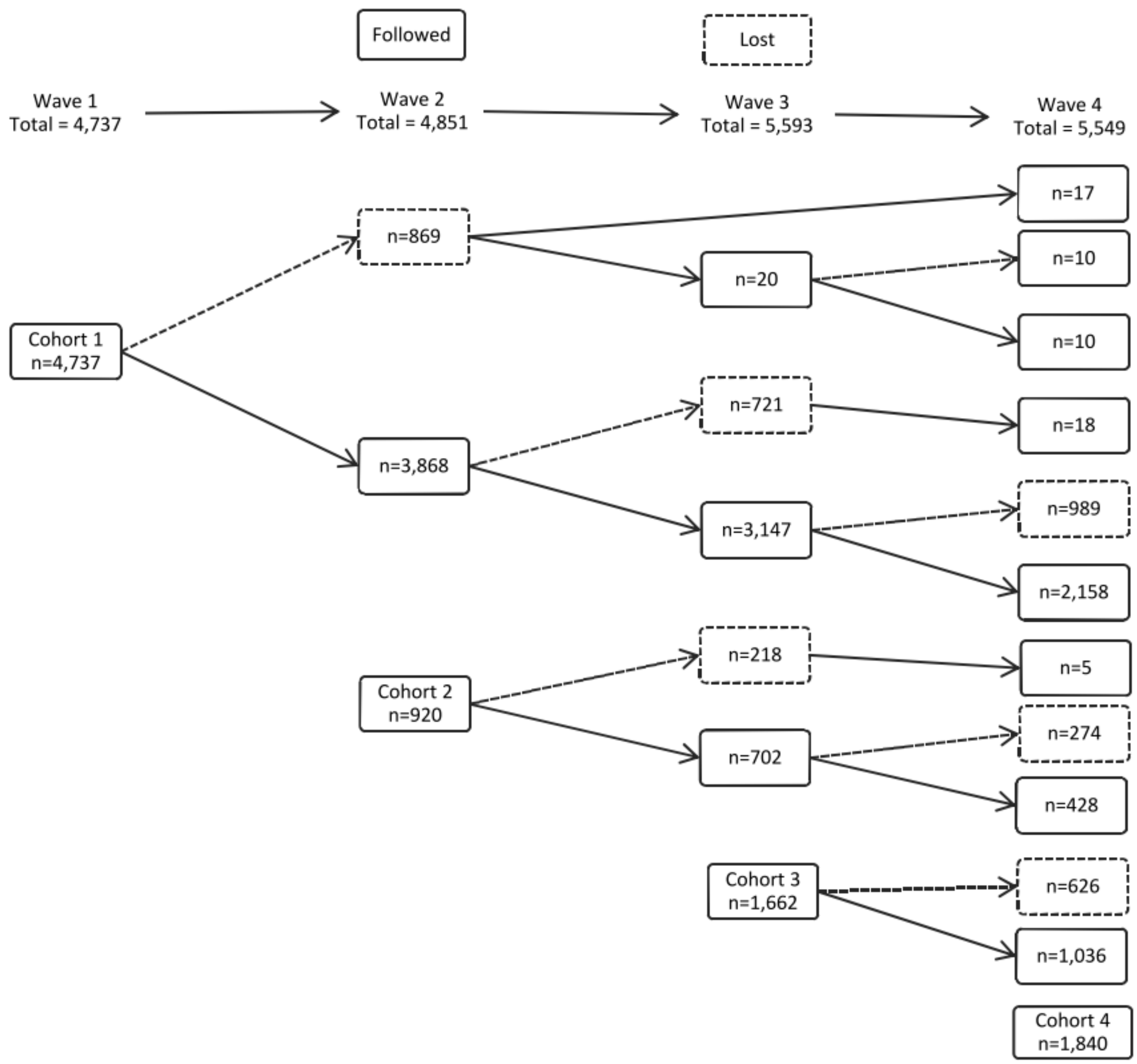

Figure 2. An illustration of the distribution of smokers who were followed-up or lost to follow-up between cohort waves, as originally provided by the ITC China Wave 4 technical report.[126]

3.1.1. Study Population

This thesis aims to investigate the risk perceptions of smoking among smokers. As such, for the purposes of the current study we only examined the adult smoker sample from the ITC China study. Although the ITC China survey included non-smokers and quitters, the outcome variables of interest were smoker's perception of their personal risk of developing a smoking related disease; therefore, it did not include relevant questions for non-smokers/quitters. ITC defined smokers as adults (18+ years) who have smoked at least 100 cigarettes in their lifetime and currently smoke at least once per week. With this definition, the sample was restricted to 5082 adult current smokers before implementing a complete case analysis, in which 4861 adult current smokers were included.

3.1.2. Sampling

ITC China used a multistage clustering quota-sampling design a target of 800 adult smokers and 200 non-smokers within each of the seven cities (regarded as strata in this sampling design) for a cumulative target of 5600 adult smokers, and 1400 non-smokers. Sampling design in Wave 4 was constructed so that randomly selected Jie Dao (street districts) acted as primary sampling units, with probability of selection being proportional to population size of said district in each city. Researchers then randomly selected Ju Wei Hui (residential blocks) within each district that acted as secondary sampling units; 300 randomly-sampled houses nested within these blocks were selected so that information on age, gender and smoking status could be collected from each adult living in the 300 houses.

These 300 houses were then randomly ordered so that adult smokers and non-smokers could be approached for an interview survey; one male smoker and one female smoker were interviewed per household when available, as well as one non-smoker of any gender. When there was more than one person per sampling category in a household, the next birthday method (i.e., selection of the person whose birthday is next) was used to select the participant.[126] At Wave 4 these same participants were re-contacted, while replenishment involved contacting more of the enumerated 300 houses in the same initial order used, or otherwise sampling, enumerating, and randomly ordering more houses within the same neighbourhood block. The city of Kunming differed in that it additionally re-contacted houses that were contacted in previous waves that initially provided no participants. This sampling design intended to sample 40 adult smokers and 10 adult non-smokers per secondary sampling unit (i.e. per sampled residential block). Full sampling details are available in the ITC China Wave 4 technical report.[126]

3.2 Procedure

3.2.1. Data collection procedures

The ITC China Wave 4 survey shares many common features with other ITC surveys, with modifications to match the China-specific context. Surveys were translated from English to both Chinese languages (i.e Mandarin and Cantonese). Face-to-face interviews were conducted. Interview-format for survey implementation is advantageous in that it facilitates the collection of more complex, accurate information, while also providing better response or completion rates.[127]

Interviewers initially contacted sampled eligible participants, including those sampled in previous waves, and new, replenishment participants recruited in Wave 4, and invited them to participate in the study. They also reiterated the confidentiality of the survey. Participants were given the survey and remunerated for their participation (20 yuan for smokers). Interviewers were trained on how to enumerate households and conduct the interviews.[126] Interviews were monitored with quality assurance checks of randomly selected interviews. MP3 recordings of interviews were collected by data manager along with forms and surveys to assure data quality, before sending data to China's Center for Disease Control and Prevention.[126] A detailed description of data collection procedures is available in the technical report.[126]

3.2.2 Survey Weights

ITC China Wave 4 unscaled and rescaled cross-sectional weights were applied to our analyses. Rescaled weights refer to those that are applied to accurately represent the actual population within China, and were applied to descriptive statistics in this sample, such that the true prevalence of perceived likelihood could be calculated. Weights were initially not scaled to represent actual population of smokers within cities. These unscaled weights rather treated cities equally, as they were in sampling design, such that a similar proportion of participants was collected from each city. Unscaled survey inflation weights adjusted the sample proportions to reduce any bias in results due to overrepresentation by a particular city (see: Chapter 3.1.2: Sampling, for details), and therefore were applied to any differential analyses (multivariable and analyses). Full details involving weighting are available in the technical report. [33] Unweighted analyses are also available in the appendix (see: Appendix Table A1), while weighted analyses are presented in the next chapter.

3.3. Measures

All measures used in analyses for this study are described below. A table listing the measures used in this study, including their original question stems and responses are provided in the appendix (see: Appendix - Table A4)

3.3.1. Outcome: Risk Perceptions of Smoking

There were two measures of risk perceptions of smoking as conceptualized by the Health Belief Model in the ITC China Wave 4 survey: the perceived likelihood of getting a smoking-related disease and perceived severity in terms of years of life lost such that one gets a smoking-related disease. As perceived likelihood is the focus of this thesis, only this measure was used.

3.3.1.1 Perceived Likelihood

To measure perceived likelihood of getting a smoking-related disease, participants were asked: “If you continue to smoke as much as you do now, compared to a non-smoker, what are the chances that you will get a smoking-related disease?” with the following response options: “much more likely,” “somewhat more likely,” “a little more likely,” “just as likely,” “less likely.” Participants were also permitted to respond with “don’t know” or refuse an answer. Refused answers (n=42) were treated as missing data. Response options were dichotomized such that “much more likely” was coded as 1, and all other responses (“somewhat more likely”, “a little more likely”, “just as likely”, “less likely”, “don’t know”) were coded as 0. When reporting this outcome, we refer to the “much more” response as the outcome variable of interest in our analyses, with all other levels of perceived likelihood reflecting the reference group.

While ordinal and nominal treatments of this variable were considered for analyses, we opted toward dichotomizing in order to produce a single, clinically interpretable odds ratio. Additionally, doing so avoids potential violation of ordinal assumptions, given that “somewhat more likely” and “a little more likely” are ambiguous in meaning, and difficult to order. Multinomial analyses also could be problematic, given potentially small cell sizes in analyses that cross-tabulate our outcome by explanatory variables. Lastly, those who endorse “much more likely” are considered to have an accurate assessment of personal risk from smoking given conclusive evidence that smoking causes many health harms. Interpreting how participants differently answer “somewhat more” or “a little more” to our measure is not as clinically useful. For similar reasons, our choice of coding is consistent with previous research.[77]

3.3.2. Explanatory Variables

Explanatory variables included in our analytic model were those that have been shown by previous studies to be linked to risk perceptions of smoking, and were available in our dataset.

They include: age, gender, ethnicity, socioeconomic status (education and income), city of residence, cigarettes smoked per day, and knowledge regarding the health consequences of smoking.

3.3.2.1. Gender

Gender was measured using the question "what is your gender?" with options to respond as either male or female. This dichotomous measure was coded so that male gender reflected the referent group.

3.3.2.2. Age

Age was measured with an open-ended question: "What is your date of birth?" Respondent`s age was subsequently calculated and categorized into age groups 18-39, 40-54, and 55+ years of age. A continuous age variable was considered for use in the analyses. However, preliminary analyses revealed violation of the assumption of linearity on the logit scale needed to satisfy the use of logistic regression,[119] as indicated by bivariate Hosmer-Lemeshow goodness of fit tests at an alpha = 0.1 significance level. Further, past studies have also categorized age groups (i.e. young adult or middle-aged adults versus older adults and the elderly) in their analyses so that they can deduce the distinct ways each age group differently perceives risk.[87,128,129] Therefore, doing so here would be consistent and would allow for comparisons with previous research. Ages 18-39 were collated into a single category to provide a single category with sufficient sample size. Otherwise, age 40 was chosen to signify middle age, while age 55 was chosen to signify older adulthood, as that is the average age of retirement in China.[130]

3.3.2.3. Ethnicity

Participants were asked: "what is your ethnic group?" with the options "Han," "Zhuang," "Man," "Hui," "Miao," "Uygur," "Yi," "Tujia," "Mongolian," "Tibetan," or "Other."

Participants were also allowed to refuse to answer (n=6); these responses were treated as missing data. Ethnicity was coded as a dichotomous variable with Han people, comprising 93.0% of our sample, and all other ethnicities combined into a single category due to small individual cell size. “Other ethnicity” was the referent group in our analyses.

3.3.2.4. Standardized Highest Level of Education

Highest level of education was provided as a standardized measure by the ITC Project. Participants were asked “what is your highest education?” Response options were “no education,” “elementary school,” “junior high school,” “high school or technical high school,” “college” and “university or higher.” These were categorized into three groups, the lowest comprising those who have an elementary school education or no education, an intermediate group which includes those who have high and middle-school education, and the highest education category of those with college education or higher. These categories were standardized by census data from China. Participants were also allowed to refuse or declare that they did not know their highest level of education; both answers were treated as missing data (n=34).

3.3.2.5. Monthly household income

Income was measured with the question, “in the last year, on average, how much was your total income per month of your household,” with the categorical responses “<1000 Yuan” “1000-2999 Yuan,” “3000-4999 Yuan,” “5000-6999 Yuan,” “7000-8999 Yuan,” “7000-8999 Yuan,” and “9000 Yuan or above.” Participants could also indicate that they did not know their income, or refuse to answer the question; these answers were collated into a single category that was included in our analyses. Consistent with other ITC studies examining self-reported income,[8] non-stated answers (refused and “don’t know”) were included as a separate category in our models. Income was therefore treated as categorical variable with the above categories, except that the lowest two categories were combined into a “<2999 Yuan” category, and the highest two income categories were combined into a “7000+ Yuan” category due to insufficient individual cell sizes.

3.3.2.6. Knowledge of the Health Consequences of Smoking

A composite scale measure of 7 questions assessing smokers’ knowledge about the health consequences of smoking was calculated and treated as a continuous explanatory variable in our models. These items began with the following statement: “I am going to read you a list of the health effects and diseases that may or may not be caused by smoking cigarettes. Do you think smoking causes…” with the following 7 health effects measured: stroke, lung cancer, emphysema, premature aging, coronary heart disease, oral cancer, and impotence in male smokers. Response options were “yes,” or “no,” with additional options for participants to declare that they “don’t know” or refuse to answer. Each item was coded as follows: “yes” (coded as 1) vs “no” and “don’t know” (coded as 0) while refused answers were treated as missing data (n= 88). A summary scale variable was created, reflecting a sum of the 7 items, with the range 0-7. Only subjects non-missing on all 7 items were included in analyses. This scale yielded a Cronbach`s alpha of 0.84.

3.3.3. Covariates

Along with explanatory variables, some additional variables were added to our multivariable analyses to account for any potential confounding they may introduce. These variables are not of particular interest to our objectives; nonetheless, results for their analyses are provided in this thesis.

3.3.3.1. Cigarettes Consumed Per Day

To gauge each smoker's cigarette consumption, all smokers were asked "on average, how many cigarettes do you smoke each day, including factory-made and hand-rolled cigarettes?" with participants giving open-ended responses. This number was then transformed, for these analyses, into four categories: 0-10 cigarettes (reference group), 11-20 cigarettes, 21-30 cigarettes, or 31+ cigarettes per day, as is consistent with previous ITC studies.[37] Categorizing this variable allows for interpretation of how heavier smokers, medium, and light smokers compare in terms of risk perceptions.[78] Notably, the relationship between number of cigarettes per day and perceived likelihood was found to be non-linear in a previous study.[78] This variable was therefore treated as categorical in our models, with 0-10 cigarette smokers as the referent group.

3.3.3.2. City

Within our dataset, city-level differences within China are the highest available geographical units measured, that modelled fixed-effects strata. A categorical variable for these six cities were added to the model as a covariate due to potential clustering differences in the sampling design, in addition to the potential differences in risk perceptions of smoking between cities. Prior to analyses, the city with the lowest prevalence of risk perceptions at a bivariate level (Beijing) was treated as the referent group.

3.3.3.3. Cohort

Given that the ITC China dataset consisted of four longitudinal waves, we added each participant's cohort of recruitment into our dataset as a covariate for our multivariable analyses. Doing so accounted for any potential clustering by recruitment wave, and for the test re-test effect, whereby participants who have participated in multiple survey waves are able to provide more knowledgeable answers (i.e. greater perceived likelihood of developing a smoking related disease), due to previous exposure to questions.[131]

3.4 Analyses

STATA 14 software was used for all analyses. Survey inflation weights were applied to both descriptive statistics and analytic analyses (see: Chapter 3.2.3 Survey Weights). Along with survey weights, design effects were also taken into account using STATA's "*SVY:*" commands: participants were sampled through six city strata and further divided into randomly sampled, primary and secondary clusters, which represented their city district, and city block respectively (see: Chapter 3.1.2. Sampling), all of which were imputed in STATA. City-strata were also adjusted for in the multivariable analysis. All analyses were restricted to complete cases (non-missing) between the explanatory variables and the outcome measures.

3.4.1. Sample Characteristics

Sample characteristics were measured for each of our explanatory variables, covariates, and the outcome variables. Descriptive analyses included frequency distributions for binary and categorical variables. An overall mean and standard deviation was reported for the health knowledge scale. Survey weights were applied to all descriptive analyses. All sample characteristics featured available-case data that was restricted to each measure's individual missingness.

3.4.2. Bivariate Associations

To address Objective 2, bivariate associations between each potential explanatory variable and risk perceptions were computed. For perceived likelihood of health risks (a dichotomous measure) we examined cross-tabulations for all dichotomous and categorical explanatory variables, applying appropriate survey weights as described above. Unweighted analyses were also conducted (shown in Appendix 2). A chi-square test was used to analyze statistically significant associations at a $p<0.05$ level in bivariate associations against the null hypothesis that variables are independent. A design-effect adjusted chi-square test statistic (presented as a survey-weight corrected F-test statistic) is a more robust inference test for a weighted survey, as STATA uses a default adjustment outlined by Rao and Scott (1984), to adjust for survey design-effect.[132]

Further, bivariate logistic regression analyses were conducted with two-tailed Wald testing at 95% level of confidence to analyze the unadjusted associations between the explanatory variables and perceived likelihood of risk. Logistic regression results were expressed as odds ratios representing the relative odds of responding "much more" to a question assessing the likelihood of developing a smoking-related disease, compared to a non-smoker, if one continues to smoke as they do currently, at a null hypothesis that OR = 1.0, representing no difference in relative odds.

3.4.3. Multivariable Weighted Logistic Regression

A multivariable weighted logistic regression model was conducted in STATA 14 using the "svy: logistic" function to analyze the association between explanatory variables, covariates and perceived likelihood measure. Survey weights were again applied to this model and a Wald test was used to determine significance with 95% confidence intervals used. The overall association between each categorical explanatory variable and this outcome was tested for adjusted significance using an F-Test.

Assumptions of binary outcome, independence, and sufficient sampling size were satisfied by the treatment of our outcome variable (see: Chapter 3.3. Measures), cross-sectional sample, and large sample size (see: Chapter 3.1.1. Study Population). A test for collinearity was conducted for each explanatory variable using variance inflation factors (VIF). VIFs below 5.0 (a conservative cut-off)[133] were considered to meet assumptions of non-collinearity. All presented multivariable analyses were weighted.

3.4.4. Confounding

Variables that were found to have no effect on our model at a bivariate level were still included in the multivariable model to reduce any potential confounding between significant explanatory variables and the risk perceptions of smoking, including all explanatory variables and our two covariates. This assured that confounding with the outcome did not occur by a third unaccounted variable, as all of our explanatory variables and covariates theoretically associate with our outcome for some reason or in some way. This is also consistent with the theory that bivariate relationships can be confounded by backdoor pathways, that are not always associated with an outcome at the bivariate level.[134]

3.4.5 Missingness

Prior to conducting statistical analyses, the extent of missing data for all variables was assessed. Missingness of data, including total missingness and item missingness (explanatory, covariate, and outcome) was assessed and presented in the next chapter.

3.5 Reporting Findings: Adherence to STROBE Statement

When reporting the findings of this study we will adhere to guidelines relevant to cross-sectional studies included in the STROBE statement. We present a STROBE flow-chart in the appendix.

Chapter 4

4. Results

4.1 Descriptive Statistics

4.1.1. Sample Characteristics

Sample characteristics based on a complete case analysis for all variables including weighted and unweighted percentages, are presented in Tables 1a and 1b, for outcome, explanatory variables, and covariates respectively.

Of the 4861 participants, women represented 3.6%, while 6.9% were non-Han. 17.7% were aged 18-39, 43.7% were 40-54 years old, and 38.6% were 55 years or older. Only 11.2% of the sample represented the lowest education category (those with an elementary school education or none at all) versus 64.7% of those in the intermediate (middle and high-school) and 24.1% of those in the highest education group (college and greater). 16.5% of our sample comprised those whose household earned 5000-6999 yuan per month while 14.2% earned 7000+ yuan per month, compared to 33.1% of those earning less than 2999 yuan per month, and 31.8% earning 3000-4999 yuan per month. On average, participants scored 4.23 (SD: 2.28) on the 7-point health knowledge scale.

4.1.2. Perceived Likelihood of Getting a Smoking Related Disease

Objective 1: To investigate the extent to which smokers in China perceive risks associated with smoking

20.0% of smokers in China (95% CI: 17.6% to 22.8%) in our complete sample answered that they were "much more likely" to get a smoking related disease compared to a non-smoker, such that they continue to smoke as they do currently.

Table 1a: Sample characteristics for explanatory variables based on complete-case analysis (n=4861)

	Frequency (n=4861)*	Unweighted Percentage (%) or Unweighted Mean (SD)	Weighted percentage (%) or Weighted Mean (SD)
Gender			
Male	4619	95.0	96.4
Female	242	5.0	3.6
Age			
18-39	932	19.2	17.7
40-54	2175	44.7	43.7
55+	1754	36.1	38.6
Ethnicity			
Non-Han	340	7.0	6.9
Han	4521	93.0	93.1
Education			
Elementary school or less	487	10.0	11.2
Junior high school, technical school, or high school	3131	64.4	64.7
College education or greater	1243	25.6	24.1
Household Income (yuan, per month)			
≤2999	1613	33.2	33.1
3000-4999	1519	31.3	31.8
5000-6999	822	16.9	16.5
≥7000	705	14.5	14.2
Refused or don't know	202	4.2	4.4
Health Knowledge scale (0-7 points)	--	4.33 (2.26)	4.23 (2.28)

Table 1b: Sample characteristics for covariates based on complete-case analysis (n=4861)

	Frequency (n=4861)*	Unweighted Percentage (%)	Weighted percentage (%)
Cigarettes smoked per day			
1-10	1909	39.3	37.2
11-20	2300	47.3	47.5
21-30	351	7.2	7.5
31-130	301	6.2	7.8
City			
Beijing	651	13.4	14.1
Changsha	697	14.3	14.7
Guangzhou	726	14.9	13.8
Kunming	713	14.7	14.6
Shanghai	684	14.1	15.0
Shenyang	725	14.9	14.2
Yinchuan	665	13.7	13.6
Cohort			
Wave 1 recruit	1850	38.1	30.9
Wave 2 recruit	355	7.3	6.4
Wave 3 recruit	896	18.4	19.0
Wave 4 recruit	1760	36.2	43.7

Objective 2: To examine which factors (sociodemographic or lifestyle) are associated with risk perceptions of smoking among smokers in China.

4.2. Bivariate Associations

4.2.1. Bivariate Associations involving Perceived Likelihood of Getting a Smoking-Related Disease

Table 2 presents complete case-weighted associations between the explanatory variables and the perceived likelihood measure (unweighted cross-tabulations are presented in appendix Table A1).

A greater proportion (31.5%) of younger smokers (18-39 years old) indicated that they believed they were “much more likely” to develop a smoking related disease compared to 22.0%

of older smokers (55+) and 18.6% of middle aged smokers (40-54 years old), an association that was significant ($p < 0.001$). There were also significant differences by ethnicity with a higher proportion of non-Han (30.9%) smokers believing that they are “much more likely” to develop a smoking related disease, compared to Han (21.6%) smokers ($p = 0.004$). Respondents who indicated that they were “much more likely” to get a smoking related disease also had a significantly higher mean health knowledge scale score of 5.42 (SD: 1.63) compared to those who reported they were a little more likely, just as likely or less likely to get a smoking related disease, who scored 3.89 (SD: 2.32) on the 7-point scale, on average ($p < 0.001$). None of the other associations between the explanatory variables and perceived likelihood were significant (see Table 2).

Among covariates, both city and cohort were significantly associated with perceived likelihood, with 28.3% of Yinchuan residents, and 26.2% of Shenyang residents believing that they were “much more likely” to develop a smoking-related disease compared to 9.6% of Guanghzou residents (p <0.001). In terms of cohort, 29.0% of those recruited in the third wave believed that they were “much more likely” to get a smoking related disease compared to 17.5% of those recruited in wave one (p = 0.001). Number of cigarettes per day was not significantly associated with this perceived likelihood measure (p = 0.21). Bivariate regression models were also calculated and are presented in appendix 2.

Table 2: Bivariate associations between perceived likelihood of getting a smoking related disease and explanatory variables.

	Much more likely to get a smoking related disease % or mean (sd)	Somewhat likely, just as likely, or less likely to get a smoking related disease % or mean (sd)
Gender	$F(1,79) = 1.570$ $p = 0.21$	
Male	22.0	78.0
Female	26.9	73.1
Age (years)	$F(2,128) = 8.989$ $p < 0.001$	
18-39	31.5	68.5
40-54	18.6	81.4
55+	22.0	78.0
Ethnicity	$F(1,79) = 8.929$ $p = 0.004$	
Han	21.6	78.4
Non-Han	30.9	69.1
Education	$F(2,135) = 2.126$ $p = 0.13$	
Elementary school or less	16.7	83.3
Junior high school, technical school, or high school	22.8	77.2
College education or greater	23.1	76.9
Household Income (yuan, per month)	$F(4,285) = 2.200$ $p = 0.08$	
<2999	20.5	79.5
3000-4999	22.1	77.9
5000-6999	26.0	74.0
>7000	24.8	75.2
Refused or don't know	13.3	86.7
Cigarettes smoked per day	$F(3,200) = 1.530$ $p = 0.21$	
0-10	22.2	77.8
11-20	23.7	76.3
21-30	15.2	84.8
31+	20.0	80.0
City	$F(4,290) = 7.290$ $p < 0.001$	
Beijing	15.6	84.4
Changsha	13.7	86.3
Guangzhou	9.6	90.4
Kunming	22.0	78.0
Shanghai	17.3	82.7
Shenyang	26.2	73.8
Yinchuan	28.3	71.7
	`	

Cohort	$F(2,175) = 6.440 \ p = 0.001$	
Recruited in Wave 1	17.5	82.5
Recruited in Wave 2	24.1	75.9
Recruited in Wave 3	29.0	71.0
Recruited in Wave 4	22.3	77.7
Health knowledge scale**	$F(1,79) = 171.38 \ p < 0.001$	
	5.42 (1.63)	3.89 (2.32)

*Percentage for a given variable is exclusive of missing observations.
**Mean (SD) health knowledge scale score

4.2.2. Bivariate Associations Among Explanatory Variables and Covariates

Further analyses were conducted to better understand associations among the explanatory variables and covariates. Such analyses may inform how interrelationships among the explanatory variables may affect the multivariable model. Significant bivariate associations were found for the following relationships among the explanatory variables: gender and income [$F(4, 279) = 3.69$, $p = 0.009$], gender and education [$F(2, 138) = 9.71$, $p < 0.001$], age and ethnicity [$F(2, 124) = 3.94$, $p = 0.03$], age and income [$F(5, 410) = 5.14$, $p < 0.001$], age and education [$F(2, 171) = 20.74$, $p < 0.001$], ethnicity and health knowledge [$F(1, 79) = 4.33$, $p = 0.041$], income and education [$F(4, 351) = 21.02$, $p < 0.001$], income and health knowledge [$F(3, 77) = 4.73$, $p = 0.004$], and education and health knowledge [$F(2, 78) = 5.26$, $p = 0.007$]. No other bivariate associations between explanatory variables were significant.

Associations among covariates, and between covariates and explanatory variables were also found, for instance there were significant associations between gender and cigarettes consumed per day [$F(3, 209) = 12.97$, $p < 0.001$], age and cigarettes consumed per day [$F(4, 318) = 4.88$, $p < 0.001$], age and city of residence [$F(7, 571) = 6.21$, $p < 0.001$], age and cohort [$F(5, 385) = 9.64$, $p < 0.001$], ethnicity and city [$F(4, 286) = 28.74$, $p < 0.001$], ethnicity and cohort of recruitment [$F(3, 186) = 4.88$, $p < 0.001$], income and city [$F(8, 629) = 3.76$, $p < 0.001$], education and cigarettes consumed per day [$F(3, 204) = 5.14$, $p < 0.003$], education and city [F(4,

332) = 4.88, p =0.005], education and cohort [F(4, 235) = 3.19, p = 0.025], education and city [F(5, 332) = 3.68, p = 0.005], health knowledge and cigarettes per day [F(3, 77) = 6.88, p <0.001], health knowledge and city [F(6, 74) = 5.93, p <0.001], and city and cigarettes consumed per day [F(5, 377) = 2.64, p =0.02], and city and cohort [F(7, 556) = 8.92, p <0.001]. No other bivariate associations between covariates, or between explanatory variables and covariates were significant.

4.3 Multivariable Associations

A weighted multivariable logistic regression model was conducted to estimate the odds of perceiving that one is "much more likely" to get a smoking related disease. Results of this regression are presented in Table 3 which includes associations for all explanatory variables, including gender, age, ethnicity, monthly household income, education, and health knowledge, adjusting for the effects of all other explanatory variables, and covariates.

Health knowledge was significantly associated with the perception that one is "much more likely" to get a smoking related disease, adjusting for all other explanatory variables and covariates. There was a 1.45 times greater odds (95% CI: 1.34 to 1.55) of smokers perceiving that they were "much more likely," to get a smoking related disease per unit increase in health knowledge (p<0.001). This indicates that those who were more knowledgeable about the health risks of smoking were significantly more likely to believe that they are "much more likely" to get a smoking related disease. Age was significantly associated with perceived likelihood (p = 0.003), with smokers aged 40-54 significantly less likely (OR = 0.55, 95% CI: 0.39 to 0.79) to perceive increased risk of health harms compared to those aged 18-39 (p =0.001). Education was found to be significant in this model (p = 0.005), but neither those of the middle (OR: 1.37, 95% CI: 0.90 to 2.08, p = 0.139) or highest education (OR: 0.95, 95% CI: 0.60 to 1.50), p = 0.

818) were significantly more or less likely than the lowest educated group (those with elementary schooling or less) to believe they were at greater likelihood of getting a smoking related disease. Lack of significance for group comparisons may reflect assignment of the reference group. Further analyses revealed that when the highest educated (those of college education or greater) was treated as the referent group in this regression model, those with a junior high school, technical school, or high school education were significantly more likely to perceive "much more" risk of getting a smoking-related disease (OR: 1.44, 95% CI: 1.15 to 1.82), $p = 0.002$). We found no significance in terms of gender or ethnicity.

City of residence was associated with perceived likelihood ($p < 0.001$). Relative to Beijing: Shenyang (OR: 1.86, 95% CI: 1.07 to 3.23, $p = 0.028$), Kunming (OR: 2.64, 95% CI: 1.63 to 4.29, $p < 0.001$) and Yinchuan (OR: 2.11 95% CI: 1.14 to 3.91 $p = 0.019$) had a greater likelihood of perceiving greater risk due to smoking.

Table 3: Logistic regressions models examining association between explanatory variables/covariates and perceived likelihood of getting a smoking-related disease.

	Odds of perceiving "much more" likelihood of getting a smoking related disease* Odds Ratio (95% confidence interval), p-value	Test statistic for explanatory variable (p-value)
Gender		
Male	*Reference*	F (1, 79) = 3.08
Female	1.49 (0.95-2.34), $p = 0.083$	$p = 0.083$
Age		
18-39	*Reference*	
40-54	0.55 (0.39-0.79), $p = 0.001$	F (2, 78) = 6.12
55+	0.74 (0.54-1.02), $p = 0.065$	$p = 0.003$
Ethnicity		
Non-Han	*Reference*	F (1, 79) = 1.46
Han	0.78 (0.51-1.18), $p = 0.230$	$p = 0.230$
Education		
Elementary school or less	*Reference*	
Junior high school, technical school, or high school	1.37 (0.90-2.08), $p = 0.139$	F (2, 78) = 5.80 $p = 0.005$
College education or greater	0.95 (0.60-1.50), $p = 0.818$	
Household Income (yuan, per month)		
<2999	*Reference*	
3000-4999	1.13 (0.89-1.45), $p = 0.315$	
5000-6999	1.36 (0.99-1.87), $p = 0.060$	
>7000	1.41 (1.02-1.94), $p = 0.035$	F (4, 76) = 1.69
Refused or don't know	0.76 (0.43-1.34), $p = 0.343$	$p = 0.160$
Health knowledge**	1.45 (1.34-1.55), $p < 0.001$	$p < 0.001$
Cigarettes smoked per day		
0-10	*Reference*	
11-20	1.27 (0.98-1.65), $p = 0.075$	F (3, 77) = 1.52
21-30	0.91 (0.57-1.45), $p = 0.676$	$p = 0.215$
31+	1.45 (0.97-2.16), $p = 0.072$	
City		
Beijing	*Reference*	
Changsha	1.64 (0.89-3.01), $p = 0.108$	
Guangzhou	1.08 (0.65-1.81), $p = 0.753$	
Kunming	2.64 (1.63-4.29), $p < 0.001$	
Shanghai	1.07 (0.60-1.83), $p = 0.798$	
Shenyang	1.86 (1.07-3.23), $p = 0.028$	F (6, 74) = 6.67
Yinchuan	2.11 (1.14-3.91), $p = 0.019$	$p < 0.001$

Cohort		
Wave 1	*Reference*	
Wave 2	1.50 (0.91-2.46), *p* = 0.110	
Wave 3	1.30 (1.01-1.68), *p* = 0.039	F (3, 79) = 2.52
Wave 4	1.29 (1.01-1.65), *p* = 0.041	*p* = 0.064

*Perceiving "much more" likelihood of "getting" a smoking-related disease, compared to a non-smoker, such that one continues as they do now.
**Infers that a change in odds or beta-value relative to each 1.0 integer increase on our 7-point health knowledge scale.

4.4 Missing Data

Item missingness for all variables are shown in Table 4. Missingness was not an issue for most variables. The only variables with 1.0% missingness or greater were perceived likelihood (1.0%) and the health knowledge scale (2.6%). For the regression model for the outcome variable, perceived likelihood of getting a smoking related disease, data were missing for 4.92% of the sample. The present findings of the logistic regression with the perceived likelihood outcome are restricted to observations for which complete data was provided, as per STROBE guidelines (see Figure 3). 4,861 observations were available for our logistic regression.

Table 4: Missing Data

Variable	# of missing observations	% missing
Perceived Likelihood	51	1.0
Health knowledge scale	130	2.6
Income	13	0.3
Education	47	0.9
Gender	1	<0.1
Ethnicity	7	0.1
Cigarettes per day	23	0.5
Age	5	0.1

Chapter 5

5. Discussion

China has one of the highest rates of cigarette use worldwide and is disproportionately affected by smoking related diseases.[5] Theory and evidence suggest that risk perceptions of smoking are a key factor linked to cigarette use.[8,13–18] Thus, the aim of this thesis is to better understand the presence of risk perceptions of smoking, as well as factors associated with these risk perceptions in a large population sample in China. This research is expected to inform policy and prevention related to cigarette use. This study contributes to previous research by being the first study to examine the perceived likelihood of getting a smoking-related disease among a smoker-only sample in China. This chapter discusses the study findings for both objectives, in addition to describing the study strengths, limitations, and implications.

5.1 Extent of Risk Perceptions of Smoking in China

The first objective of this thesis was to investigate the extent of risk perceptions among smokers in China. Only about 20.0% of smokers responded that they are "much more" at risk of developing a smoking-related disease compared to a non-smoker. This means that, compared to other countries, a relatively smaller proportion of smokers in China perceived that they were at risk for getting a smoking related disease. For instance, Costello and colleagues (2012) examined perceived likelihood of getting both heart disease and lung cancer using data from the ITC 4-country (4C) survey (Canada, USA, Australia and UK). They found that 35.5% and 32.7% of their sample had indicated that they were at "much more" risk of developing lung cancer and heart disease, respectively, compared to non-smokers.[8]

These results are consistent with previous research examining risk perceptions of smoking in China. Yang and colleagues (2010), for example, found that a much lower proportion smokers in China indicated that they were “very” worried about smoking-related damage to their health,[36] compared to a sample of smokers in Australia, Canada, United Kingdom, and United States.[37]

The relatively small proportion of smokers who perceived disease risk related to continued smoking among smokers in China is concerning in light of evidence that risk perceptions are associated with smoking and quitting behaviour. [8,15–18] Thus, this finding suggests that initiatives, such as graphic warning labels, or advertisement media bans may be needed in China to increase people’s perceptions of the health risks due to smoking.[2]

5.2 Factors Associated With Risk Perceptions of Smoking

This thesis draws on the Health Belief Model, which asserts that socio-economic and health-related knowledge are important factors influencing risk perceptions.[9–11] As such, the second and primary objective of this thesis was to identify factors associated with risk perceptions of smoking in China, including socio-economic factors (i.e., gender, age, ethnicity, education and income) and knowledge regarding the health effects of smoking.

5.2.1. Gender

Gender was not found to be significantly associated with perceived likelihood of smoking related disease at the bivariate or multivariable level. This finding is consistent with Persoskie and colleagues (2014) who also found a non-significant association between gender and perceived likelihood in a sample of the population of China which included both smokers and non-smokers.[77] However, these findings are inconsistent with research in Western countries where women were more likely than men to perceive the risks of developing smoking-related health outcomes.[20,23,27,79,80]

It is noteworthy that the number of female smokers who perceived risks associated with smoking in our sample was very low (n = 56). Some analyses for the association between gender and risk perceptions approached significance (see: Table 3, p<.08). Therefore, there may have been insufficient statistical power to detect differences between males and females. In Western countries, men are theorized to be less likely than women to perceive health risks due to traditional gender norms, as they are socialized to perceive fewer risks than women.[82] However, it is very unusual for women to smoke in China.[2,42] Thus, women who do smoke in China may be less conventional and less likely to conform to social norms than women who do not smoke. As such, their risk perceptions may be quite similar to those of male smokers.

However, because the sample size in the present study was small for women, more investigation is needed to better understand the relationship between gender and risk perceptions of smoking in China.

5.2.2. Age

Age was significantly associated with the perceived likelihood of developing a smoking related disease. The multivariable logistic regression model revealed that middle aged people (aged 40-54 years) were almost half as likely as younger people (aged 18-39 years) to perceive risk of getting a smoking-related disease. However, the difference between young adults (18-39 years) and older adults (aged 55+ years) was not significant.

Another study conducted in China found age to be non-significant when using a continuous measure of age and in a sample of both smokers and non-smokers.[77] However, use of a continuous measure may have obscured important differences between age groups, as were found here. Many other previous studies have used similar continuous measures of age with risk perceptions of smoking, some finding that older people have higher risk perceptions for various smoking-related consequences,[53,85–88] while others found that younger people have higher risk perceptions.[23,78,79,86]

Theories of how age may be associated with risk perceptions have suggested that younger people underestimate risks because they believe that they will be able to quit smoking before becoming addicted.[12,92–94] Therefore, they believe they will not smoke long enough to be at risk of smoking-related consequences.[12,92–94] While the present results may seem inconsistent with this theory, our measure of perceived likelihood questioned smokers whether they would *ever* develop a smoking-related disease if they *continue to smoke*. In contrast, many risk perceptions measures are not contingent on continuing to smoke. Hence, younger smokers may perceive greater risks of smoking if they consider a future where they continue to smoke.

5.2.3 Ethnicity

This is the first study, to our knowledge, to investigate whether ethnicity is associated with risk perceptions of smoking in China. In bivariate analyses, Han people were less likely than other races to perceive that they would get a smoking related disease. However, ethnicity was not associated with greater perceived likelihood of developing a smoking-related disease after adjusting for other explanatory variables and covariates in the multivariable model.

Among high-income Western countries with predominantly Caucasian populations,[23,78,97,99] the effects of ethnicity are mixed.[23,27,78,90,97–99] Some research in these countries indicates that visible minorities have lower levels of perceived risk compared with White people.[23,29,30] Thus, health risks could be driven by differences in health equity; particularly, differences in SES, which are theorized to be driving racial and ethnic differences in risk perceptions.[101] However, in middle-income countries like China, it is possible that differences in ethnicity are not so strongly tied to health equity. Indeed, we found no association between ethnicity and either income or education in our sample. However, we did find significant bivariate associations between ethnicity and both city of residence and cohort of recruitment. Therefore, an attenuation in the effect of ethnicity in the multivariable model may be explained by the inclusion of other variables, such as city and cohort.

Overall, given the mixed results in the literature, dearth of the literature in China, and non-significance of our findings when adjusting for other factors, we cannot confirm an association between ethnicity and risk perceptions of smoking.

5.2.4. Education

While the bivariate analyses revealed no association between education and perceived likelihood of getting a smoking related disease, the multivariable analyses indicated that education was associated with a perceived likelihood. Despite this, no differences were found between specific categories of education (e.g. elementary school or less vs. college education or greater) in the multivariable model. Further analyses revealed that the choice of reference group affected whether a difference was found. When the reference group was changed, we found that those with a junior high school, technical or high school education were significantly more likely to perceive likelihood of getting a smoking-related disease than those with a college education or greater.

These findings are therefore inconsistent with Persoskie and colleagues (2014), who found no significant differences in risk perceptions by educational level in a study conducted in China.[70] These findings are also inconsistent with much of the other literature, conducted in other countries, demonstrating that higher education is associated with higher risk perceptions,[23,31,33,78,88,102] as well as with the theory that those with higher education are more likely to have access to and to internalize health information.[106]

Although the assumption of multicollinearity was not violated, further analyses revealed significant associations between education and all other explanatory variables and covariates included in our multivariable analyses, with the exception of ethnicity. Therefore, the unexpected effect of education may be influenced by the inclusion of other variables in the final multivariable model.

5.2.5. Income

Monthly household income (in yuan per month) was non-significant, adjusting for other explanatory variables. These findings are inconsistent with other studies that have found significant positive associations between income and perceived likelihood.[23,77,111] They are particularly inconsistent with a study which found income to be positively associated with perceived likelihood of lifetime cancer development in a general population sample China.[77]

Findings from high-income countries for the link between income and risk perceptions may not apply to China. More specifically, in high-income countries, people of low SES are more likely to smoke, find smoking more acceptable,[105,106] and have less access to prevention, health information relevant to smoking, and cessation-related resources than higher SES people.[105,106] In contrast, in China, smoking is similarly prevalent among all income groups[39,135] and health information and other resources are generally insufficient.[2,68] Thus, income may not be associated with risk perceptions of smoking, as demonstrated here. This suggests that there may be not be income inequities in access to health information, but rather an overall lack of health information affecting all income groups.[36]

While many researchers argue that targeting interventions toward particular groups, such as those of low income, is a good way of alleviating disparities,[107–110,136] the lack of an association between income and risk perceptions of smoking in China indicate that previous public interventions that been successful in other countries[107–110,136] may be needed to target all income groups.[2,68]

5.2.6. Health Knowledge

Knowledge of the health risks of smoking was highly associated with greater perceived likelihood of getting a smoking-related disease. Those with greater perceived likelihood of getting a smoking related disease scored higher on the health knowledge scale on average, compared to those who perceived less risk. These results are consistent with other studies that found positive associations between health knowledge and perceptions of smoking risk.[23,34–36] Considering the magnitude of the effect size (i.e. a 1.45 greater odds per unit on the 7-point scale) even after adjusting for all other explanatory variables and covariates, health knowledge appeared to be the most important explanatory variable for risk perceptions. To our knowledge, this is the first study to investigate this association in China. This finding also supports the Health Belief Model which theorizes that health knowledge influences risk perceptions.[9,11]

Weinstein (2001) argues that, while perceptions of risk and knowledge of those health risks are conceptually distinct, a person must have knowledge regarding health risks to truly perceive potential risks for themselves; however, knowledge alone is insufficient to influence health behaviours.[46] Thus, to perceive potential risks of smoking, one must first be aware of the health harms related to smoking. It is therefore possible that health knowledge mediates relationships between SES variables, and other potentially important explanatory variables, and risk perceptions. However, we tested the association between health knowledge and risk perceptions consistent with the Health Belief Model, which conceptualizes health knowledge and sociodemographic factors as modifying factors that influence risk perceptions (Figure 1). This model does not suggest that health knowledge is a mediator. Future research could examine whether there is evidence for mediation using longitudinal analyses across survey waves to establish temporality.

Evidence suggests that health knowledge for smoking-related risks is relatively low among smokers in China compared with other countries. For instance, Yang and colleagues found that among smokers, health knowledge proportions were consistently lower than that of smokers from the 4-country survey: e.g. 68.1% of smokers in China acknowledge that smoking causes lung cancer[36] compared to 94.3% of smokers from the 4-country survey.[137] The prevalence of perceived likelihood of getting a smoking-related disease found in this study is low compared to that of a study that used a measure with much of the same wording in high-income Western countries.[8] Thus, the association between health knowledge and risk perceptions of smoking may explain the small proportion of smokers who perceive risk of getting a smoking-related disease in China, as theorized by the Health Belief Model.[9,11] Therefore, knowledge regarding smoking-related risks appears to be an important explanatory variable for risk perceptions of smoking and should be considered in the development of public-health interventions in China.

5.2.7. Cigarettes Per Day

The number of cigarettes that a smoker consumed per day was not associated with risk perceptions. This is inconsistent with other studies that have found generally positive associations between cigarettes consumed per day and perceived likelihood of various adverse health outcomes.[33,49,76,78,114,115] It has been theorized that lighter smokers tend to underestimate their risks of health harms due to smoking.[33] This theory is based on studies conducted in high-income Western countries[33] and therefore may not apply to China.

5.2.8. City Differences

Although not an explanatory variable of interest, city of residence was included as a covariate in our multivariable analysis to prevent bias by clustering.[119] Interestingly, however, city of residence was found to be significantly associated with perceived likelihood of getting a smoking related disease. Relative to smokers living in Beijing, those who lived in Shenyang, Kunming, or Yinchuan were significantly more likely to perceive that they were at greater risk of getting a smoking related disease. No other cities were significantly different from Beijing in their associations. This result is consistent with other literature.[77] Therefore, city differences may need to be considered in future studies involving risk perceptions of smoking in China. City specific differences, such as population size, urban density, cigarette brand availability and regional policy differences may be influencing differences in risk perceptions of smoking.[68,116,118] Future research is warranted to better understand how the each city's population and policy characteristics may influence differences in risk perceptions of smoking.

5.2.8. Cohort

Cohort of recruitment was included in our multivariable analysis to account for any effects of time in sample. This variable was non-significant in the final multivariable model, despite bivariate differential association with perceived likelihood of getting a smoking-disease. This finding was not expected, as previous research evidence suggests that individuals may become more knowledgeable over time after greater exposure to survey questions.[131]

5.3. Study Strengths

The present study used data from the ITC project, a representative sample of six cities in China, with a large sample size. This study improves upon previous research conducted in China which was restricted to two cities (i.e., Beijing and Hefei).[77]

To our knowledge, this is the first study to investigate factors associated with risk perceptions of smoking among smokers in China. Persoskie and colleagues (2014) investigated how risk perceptions are associated with several of the same factors that our study investigated, but did so using a sample of both smokers and non-smokers. Therefore, their findings apply to risk perceptions of smoking among China's general population, while ours focus exclusively on China's smokers.[77] Our study of smokers, whose health is of most concern, allowed for a more focused analysis without potential confounding by smoking status.[58–67] Our study also improved upon the measure used by Persoskie and colleagues (2014) who measured the perceived likelihood of developing cancer in the person's lifetime,[77] while our measure broadened this definition to examine perceived likelihood of getting any smoking related disease. Our measure also assessed participants beliefs given their continued smoking, with participants asked about the perceived health effects of smoking if they continue to smoke as they do now. Despite the many ways perceived likelihood is operationalized, it has been recommended that future research uses measures that attach perceived likelihood of disease directly to a particular health behaviour, or lack of health behaviour.[9,138] Such measures of perceived likelihood have been shown to better predict actual likelihood of person engaging in a health behaviour change.[9] The current measure of risk perceptions of smoking is similar to those used in other ITC studies, making it possible to compare prevalence of risk perceptions in our sample to representative samples of other countries from studies that used the same ITC survey measure, such as Costello et al. (2012).[8]

5.4. Study Limitations

This study also had several notable limitations. First of all, while we applied the Health Belief Model in our conceptualization of how factors may related to risk perceptions, we were unable to include another important part of the model, namely perceived severity.[11] An item of perceived severity was available in our dataset, but unfortunately, there was a high number of missing cases (15.7%). Thus, we decided to exclude this measure from the analyses. This measure asked people to estimate the number of years of life they believe a smoker would lose if that smoker developed a smoking-related disease. This may have been difficult to answer, perhaps resulting in many people choosing to leave it blank. In future research it will be important to study a combined measure of perceived risk and perceived severity as per the Health Belief Model.

The outcome measure, perceived likelihood of getting a smoking-related disease, also had potential issues. Most notably, there is a discrepancy between wording in the question stem and the response options which may have confused participants. While the question stem of the measure included the phrase "what are the *chances*," each response option contained the word "likely," (e.g. "much more likely," "somewhat more likely"). This measure might be improved by changing the question stem to "how likely do you think you are…" to be consistent with the response options. Moreover, this question is quite complex, as it includes both a probability component (i.e., what are the chances") and a conditional component (i.e., "if you continue to smoke"). Thus, it is possible that participants in lower education groups, who comprise a large proportion of the sample, may have had difficulty answering this question.

Another important limitation was the inability to establish temporal relationships between the explanatory and outcome variables due to our use of cross-sectional data. Notwithstanding, only a few studies investigating the risk perceptions of smoking have used longitudinal analyses;[7,18,56,57,94] therefore, it will be important for future research to examine these associations longitudinally. We used the ITC Wave 4 data set, collected in 2011 and 2012, which was the newest publicly available data pertaining to tobacco use in China. Therefore, any changes since this time will not be captured in our results. This dataset also can only generalize to China's urban population, as no rural sample was included in Wave 4 data collection. Wave 5 of ITC improves upon this,[126] as did Persoskie and colleagues (2014), who included population data from rural and urban areas of Beijing and Hefei.[77] Another limitation is a focus on main effects only. There may be important interaction effects among the explanatory variables of interest. For example, it will be important in future research to test for effect modification of gender by age, education, and income, to further understand risk perceptions of smoking in China.

5.5. Implications for Future Research

Given that most research on risk perceptions of smoking focus on perceived likelihood rather than perceived severity,[69] future research on risk perceptions should also consider perceived severity to better reflect the Health Belief Model.[122] Additionally, as recommended previously, it will be important in future research to include other measures in the Health Belief Model, including individual perceptions, self-efficacy, cues to action, perceived benefits, and perceived barriers.[9]

A large amount of research in this area was conducted in high-income Western countries. More research is therefore needed in low- and middle-income countries to establish what explanatory variables are associated with risk perceptions in these countries. Studies conducted in China can benefit from sampling in rural areas in addition to urban areas, and, like other risk perceptions research, can also benefit from longitudinal analyses to establish better evidence for causation.

5.6. Implications for Better Policy

A large majority of smokers in China do not believe that they are at health risk from smoking. China, like many other low- and middle-income countries, lacks the same extensive tobacco control policies as some high-income Western countries.[2] For instance, China lags behind many higher income countries in terms of monitoring health population trends, warning labels standards, media bans, and taxation.[2] Therefore, simple restrictions consistent with the Framework Convention on Tobacco Control (FCTC) should be considered in China, such as better implementation of graphic warning labels, implementing public service advertisements against smoking, and banning tobacco advertisements, are important for changing risk perceptions and ultimately smoking behaviour.

Such interventions align with theory from the Health Belief Model. For instance, knowledge of health risks is theorized to directly affect perceived likelihood and severity of health risks.[9,11] Some authors have advocated that further intervention in high-income Western countries be targeted to the highest risk groups, namely those in low income and low education groups.[107–110,136] Given the lack of association between most sociodemographic variables and perceived likelihood of getting a smoking-related disease as well as the low prevalence of risk perceptions overall, interventions may be needed that target *all smokers* in China, regardless of their background.

Further, laws banning tobacco advertisements may be another important prevention strategy in China, given their theorized link to risk perceptions.[139] More stringent tobacco control policies may indirectly affect the social acceptability of smoking as well as risk perceptions, which in turn may reduce smoking.[140,141] Previous research has shown that banning public smoking has lowered the acceptability of smoking which subsequently affected risk perceptions.[140,141]

5.7. Conclusion

In conclusion, the prevalence of perceived likelihood of getting a smoking related disease in China is relatively low compared to other countries,[8] as is consistent with previous literature.[36,77] Only three explanatory variables, health knowledge, education, and age were significantly associated with perceived likelihood of getting a smoking-related disease. The youngest adult smokers (aged 18-39 years) had significantly greater risk perceptions in our study than those aged 40-54 years old, as is consistent with certain theories[12,92–94] and some, but not all, research.[23,78,79,86] Education was associated with perceived likelihood of getting a smoking-related disease at a multivariable level but not at a bivariate level, and therefore be affected by other variables included in the multivariable model. The positive association between health knowledge and perceived likelihood was statistically significant and consistent with the Health Belief Model. A lack of health knowledge may be influencing low prevalence of perceived likelihood of getting a smoking disease among smokers in China.

Future research may be needed examining potential mediating effects of health knowledge and longitudinal data are needed to better illuminate the mechanisms by which explanatory variables are linked to risk perceptions. Future analyses may need to incorporate further study of city of residence, as it was found to be significantly associated with risk perceptions.

This research suggests that better public tobacco control policies and interventions may be needed in China to inform smokers of the dangers of smoking. Evidence has shown that graphic warning labels,[68,142] public service announcements,[143] smoking bans, [140,141] and advertisement bans,[139] are effective in changing perceptions and smoking behaviour, and thus these strategies are recommended. Given that we found few socio-demographic differences in risk perceptions, risk perceptions of smoking appear to be equally insufficient among all smokers in China. Thus, tobacco policy and prevention may be needed that target all sociodemographic groups.

Bibliography

1. Vidrine, J. I. *et al.* The role of tobacco in cancer health disparities. *Curr. Oncol. Rep.* **11,** 475 (2009).
2. World Health Organization & MPOWER. *WHO Report on the Global Tobacco Epidemic, 2017: Monitoring tobacco use and prevention policies*. (2017).
3. Mathers, C. *WHO global report : Mortality attributable to tobacco*. (World Health Organization, 2012).
4. Méndez, D., Alshanqeety, O. & Warner, K. E. The potential impact of smoking control policies on future global smoking trends. *Tob. Control* **22,** 46–51 (2013).
5. World Health Organization. *WHO global report on trends in prevalence of tobacco smoking 2015*. (2015).
6. Yang, L., Sung, H.-Y., Mao, Z., Hu, T. & Rao, K. Economic costs attributable to smoking in China: update and an 8-year comparison, 2000-2008. *Tob. Control* **20,** 266–72 (2011).
7. Song, A. V. *et al.* Perceptions of smoking-related risks and benefits as predictors of adolescent smoking initiation. *Am. J. Public Health* **99,** 487–492 (2009).
8. Costello, M. J., Logel, C., Fong, G. T., Zanna, M. P. & Mcdonald, P. W. Perceived risk and quitting behaviors: Results from the ITC 4-Country Survey. *Am. J. Health Behav.* **36,** 681–692 (2012).
9. Glanz, K., Rimer, B. K. & Viswanath, K. (Kasisomayajula). *Health behavior and health education : Theory, research, and practice*. (Jossey-Bass, 2008).
10. Taylor, S. E. & Sirois, F. M. *Health psychology*. (McGraw-Hill, 1999).
11. Hochbaum, G., Rosenstock, I. & Kegels, S. Health Belief Model. (1952).
12. Slovic, P. Do adolescent smokers know the risks? *Duke Law J.* 1133–1141 (1998).
13. Romer, D., Jamieson, P., Daniel, R. & Patrick, J. in *Smoking: Risk, perception, & policy* (ed. Paul, S.) 64–80, Chapter xiii, 378 Pages (Sage Publications, Inc, Thousand Oaks, CA, 2001). doi:http://dx.doi.org/10.4135/9781452232652.n4
14. Umeh, K. & Barnes, J. Cognitive appraisals and smoking intentions: The role of decision making competence. *J. Smok. Cessat.* **6,** 144–151 (2011).
15. Schnoll, R. A., Somasundaram, S., Elisa, M. & Engstrom, P. F. Correlates of continued tobacco use and intention to quit smoking among Russian cancer patients TL - 18. *Int. J. Behav. Med.* **18,** 325–332 (2011).
16. Savoy, E. *et al.* Risk perception and intention to quit among a tri-ethnic sample of nondaily, light daily, and moderate/heavy daily smokers. *Addict. Behav.* **39,** 1398–1403 (2014).
17. Lund, K. E., McNeill, A. & Scheffels, J. The use of snus for quitting smoking compared with medicinal products. *Nicotine Tob. Res.* **12,** 817–822 (2010).
18. Borland, R. *et al.* Do risk-minimizing beliefs about smoking inhibit quitting? Findings

from the International Tobacco Control (ITC) Four-Country Survey. *Prev. Med. (Baltim).* **49,** 219–223 (2009).

19. Clemmey, P., Brooner, R., Chutuape, M. A., Kidorf, M. & Stitzer, M. Smoking habits and attitudes in a methadone maintenance treatment population. *Drug Alcohol Depend.* **44,** 123–132 (1996).

20. Gould, G. S., Watt, K., West, R., Cadet-James, Y. & Clough, A. R. Can smoking initiation contexts predict how adult Aboriginal smokers assess their smoking risks? A cross-sectional study using the 'Smoking Risk Assessment Target'. *BMJ Open* **6,** e010722 (2016).

21. Cooper, T. V *et al.* A baseline assessment of attitudes toward tobacco free campus policies in a U.S./México border university. *Addict. Behav.* **60,** 223–227 (2016).

22. Kristiansen, C. M., Harding, C. M. & Richard Eiser, J. Beliefs about the relationship between smoking and causes of death. *Basic Appl. Soc. Psych.* **4,** 253–261 (1983).

23. Oncken, C., Mckee, S., Krishnan-Sarin, S., O 'malley, S. & Mazure, C. M. Knowledge and perceived risk of smoking-related conditions: A survey of cigarette smokers. *Prev. Med. An Int. J. Devoted to Pract. Theory* **40,** 779–784 (2005).

24. Gendre, P., Thelu, C. E., D'Ollonne, T., Trojani, C. & Gonzalez, J. F. Coracoid bone block fixation with cortical buttons: An alternative to screw fixation? *Orthop. Traumatol. Surg. Res.* **102,** 983–987 (2016).

25. Thornton, L. K., Baker, A. L., Johnson, M. P. & Lewin, T. Perceived risk associated with tobacco, alcohol and cannabis use among people with and without psychotic disorders. *Addict. Behav.* **38,** 2246–2251 (2013).

26. Bock, B. C., Becker, B. M., Robert, P. & Raymond, N. Are emergency chest pain patients ready to quit smoking? *Prev. Cardiol.* **10,** 76–82 (2007).

27. Waters, E. A. *et al.* The relationship between young adult smokers' beliefs About nicotine addiction and smoking-related affect and cognitions. *J. Cancer Educ.* **31,** 338–347 (2016).

28. Schluchter, M. D. Flexible approaches to computing mediated effects in generalized linear models: Generalized estimating equations and bootstrapping. *Multivariate Behav. Res.* **43,** 268–288 (2008).

29. Orom, H., Kiviniemi, M. T., Underwood Iii, W., Ross, L. & Shavers, V. L. Perceived Cancer Risk: Why Is It Lower Among Non-Whites than Whites? *Cancer Epidemiol Biomarkers Prev* **19,** 746–754 (2010).

30. Lyna, P., Mcbride, C., Samsa, G. & Pollak, K. I. Exploring the association between perceived risks of smoking and benefits to quitting Who does not see the link? *Addict. Behav.* **27,** 293–307 (2002).

31. Cummings, K. M. *et al.* Are smokers adequately informed about the health risks of smoking and medicinal nicotine? *Nicotine Tob. Res.* **6,** S333–S340 (2004).

32. Peretti-Watel, P., L'Haridon, O. & Seror, V. Time preferences, socioeconomic status and smokers' behaviour, attitudes and risk awareness. *Eur. J. Public Health* **23,** cks189

(2013).

33. Peretti-Watel, P. *et al.* Smoking too few cigarettes to be at risk? Smokers' perceptions of risk and risk denial, a French survey. *Tob. Control* **16,** 351–356 (2007).

34. Li, C., Fielding, R., Hedley, A. J. & To, C. Survey of knowledge, perceptions and behaviour related to smoking in young Asian women airline cabin crew. *Health Educ. J.* **55,** (1996).

35. Walker, J. Coping with the health threat of smoking: An analysis of the precontemplation stage of smoking cessation. *ProQuest Dissertations and Theses ProQuest Dissertations & Theses Global* (University of Maryland, 1998).

36. Yang, J., Hammond, D., Driezen, P., Fong, G. T. & Jiang, Y. Health knowledge and perception of risks among Chinese smokers and non-smokers: findings from the Wave 1 ITC China Survey. *Tob. Control* **19,** i18–i23 (2010).

37. Hitchman, S. C. *et al.* Socioeconomic status and smokers' number of smoking friends: Findings from the International Tobacco Control (ITC) Four Country Survey. *Drug Alcohol Depend* **143,** 158–166 (2014).

38. US Department of Health and Human Services. *The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General*. (2014). doi:NBK179276

39. Chinese Center for Disease Control and Prevention. *Global Adult Tobacco Survey (GATS) China 2010 Country Report*. (2010).

40. Ministry of Health People's Republic of Chin. *An analysis report of the national health service 2008*. (2008).

41. He, P., Takeuchi, T. & Yano, E. An overview of the China National Tobacco Corporation and State Tobacco Monopoly Administration. *Environ. Health Prev. Med.* **18,** 85–90 (2013).

42. Sansone, N., Yong, H.-H., Li, L., Jiang, Y. & Fong, G. T. Perceived Acceptability of Female Smoking in China: Findings from Waves 1 to 3 of the ITC China Survey. *Tob. Co* **24,** (2015).

43. A. D. Lopez, N. E. Collishaw, T. P. A descriptive modelof the cigarette epidemic. *Tobacco Control* **3,** 242–47 (1994).

44. Hitchman, S. C. & Fong, G. T. Gender empowerment and female-to-male smoking prevalence ratios. *Bull. World Health Organ.* **89,** 195–202 (2011).

45. Levy, D., Rodriguez-Buno, R. L., Hu, T.-W. & Moran, A. E. The potential effects of tobacco control in China: projections from the China SimSmoke simulation model. *Br. Med. J.* (2014). doi:10.1136/bmj.g1134

46. Weinstein, N. D. *Smokers ' Recognition of their Vulnerability to Harm in Smoking: Risk, Perception, & Policy Smokers*. (2001).

47. Emmons, K. M. *et al.* Smoking among participants in the childhood cancer survivors cohort: The partnership for health study. *J. Clin. Oncol.* **21,** 189–196 (2003).

48. Ranby, K. W., Lewis, M. A., Toll, B. A., Rohrbaugh, M. J. & Lipkus, I. M. Perceptions of smoking-related risk and worry among dual-smoker couples. *Nicotine Tob. Res.* **15,** (2013).

49. Butler, K. M., Kay, R. M., Mei, Z. & Hahn, E. J. Motivation to quit smoking among relatives of lung cancer patients. *Public Health Nurs.* **28,** 43–50 (2011).

50. Williams, R. J., Herzog, T. A. & Simmons, V. N. Risk perception and motivation to quit smoking: A partial test of the Health Action Process Approach. *Addict. Behav.* **36,** 789–791 (2011).

51. Klein, W. M. P., Zajac, L. E. & Monin, M. M. Worry as a moderator of the association between risk perceptions and quitting intentions in young adult and adult smokers. *Ann. Behav. Med.* **38,** 256–261 (2010).

52. Peretti-Watel, P. *et al.* Smoking motivations and quitting motivations among HIV-infected smokers. *Antivir. Ther.* **14,** 781–787 (2009).

53. Lazuras, L., Zlatev, M., Rodafinos, A. & Eiser, J. R. Smokers' compliance with smoke-free policies, and non-smokers' assertiveness for smoke-free air in the workplace: a study from the Balkans. *Int. J. Pu* **57,** 769–775 (2012).

54. Mayes, R. S. Smokers and smoking: A study of the impact of discount rates and risk perceptions on smoking and quitting. (Ohio State University, 2009).

55. Bock, B. C., Jennings, E., Becker, B. M., Partridge, R. & Niaura, R. S. Characteristics and predictors of readiness to quit among emergency medical patients presenting with respiratory symptoms. *Int. J. Emerg. Med.* **4,** 9 (2011).

56. Hay, J. L. *et al.* Changes in Cancer-Related Risk Perception and Smoking Across Time in Newly-Diagnosed Cancer Patients. *J. Behav. Med.* **30,** 131–142 (2007).

57. Schnoll, R. A. *et al.* Longitudinal predictors of continued tobacco use among patients diagnosed with cancer. *Annals of Behavioral Medicine* **25,** 214–221 (2003).

58. Mcmaster, C. & Lee, C. Brief Report: Cognitive dissonance in smokers. *Addict. Behav.* **16,** 349–353 (1991).

59. Frijling, B. D. *et al.* Perceptions of cardiovascular risk among patients with hypertension or diabetes. *Patient Educ. Couns.* **52,** 47–53 (2004).

60. Maxwell, A. E., Garcia, G. M. & Berman, B. A. Understanding tobacco use among Filipino American men. doi:10.1080/14622200701397890

61. White, L. J., Chin-Quee, A. L., Berg, C. J., Wise, J. C. & Hapner, E. R. Differences in head and neck cancer risk perception between smoking and nonsmoking NASCAR attendees. *Otolaryngol. Neck Surg.* **147,** 63–68 (2012).

62. Honda, K. & Neugut, A. I. Associations between perceived cancer risk and established risk factors in a national community sample. *Cancer Detect. Prev.* **28,** 1–7 (2004).

63. Messina, C. R., Kabat, G. C. & Lane, D. S. Perceptions of Risk Factors for Breast Cancer and Attitudes Toward Mammography Among Women Who Are Current, Ex-and Non-Smokers. *Women Health* **36,** (2002).

64. Finney Rutten, L. J., Blake, K. D., Hesse, B. W., Augustson, E. M. & Evans, S. Illness Representations of Lung Cancer, Lung Cancer Worry, and Perceptions of Risk by Smoking Status. (2011). doi:10.1007/s13187-011-0247-6

65. Zlatev, M., Pahl, S. & White, M. Perceived risk and benefit for self and others as predictors of smokers' attitudes towards smoking restrictions. *Psychol. Heal.* **25,** 167–182 (2010).

66. Weinstein, N. Accuracy of smokers' risk perceptions. *Nicotine Tob. Res.* **1,** 123–130 (1999).

67. McCoy, S. B. *et al.* Perceptions of smoking risk as a function of smoking status. *J. Behav. Med.* **15,** 469–488 (1992).

68. ITC Project, Office of Tobacco Control & CDC China. *ITC China Project Report. Findings from the Wave 1 to 3 Surveys (2006-2009).* (2012).

69. Kaufman, A. R., Persoskie, A., Twesten, J. & Bromberg, J. A review of risk perception measurement in tobacco control research. *Tob Control* **0,** 1–9 (2018).

70. Persoskie, A., O'Brien, E. K., Nguyen, A. B. & Tworek, C. Measuring youth beliefs about the harms of e-cigarettes and smokeless tobacco compared to cigarettes. *Addict. Behav.* **70,** 7–13 (2017).

71. Hahn, A. & Renner, B. Perception of health risks: How smoker status affects defensive optimism. *Anxiety, Stress Coping An Int. J.* **11,** 93–112 (1998).

72. Segerstrom, S. C., Mcarthy, W. J., Caskey, N. H., Gross, T. M. & Jarvik, M. E. Optimistic Bias Among Cigarette Smokers. *J. Appl. Soc. Psychol.* **23,** 1606–1618 (1993).

73. Weinstein, N. & Klein, W. Unrealistic optimism: Present and future. *J. Soc. Clin. Psychol.* (1996).

74. Weinstein, N. D. Unrealistic Optimism About Future Life Events. *J. Pers. Soc. Psychol.* **39,** 806–820 (1980).

75. Silagy, C. *et al.* Cardiovascular risk and attitudes To lifestyle: What do patients think? *Br. Med. J.* **306,** 1657–1660 (1993).

76. Floyd, A. H. L., Westmaas, J. L., Targhetta, V. & Moyer, A. Depressive symptoms and smokers' perceptions of lung cancer risk: Moderating effects of tobacco dependence. *Addict. Behav.* **34,** 154–163

77. Persoskie, A. *et al.* Absolute and comparative cancer risk perceptions among smokers in two cities in China. *Nicotine Tob. Res.* **16,** 899–903 (2014).

78. Ayanian, J. Z. & Cleary, P. D. Perceived risks of heart disease and ancer among cigarette smokers. *J. Am. Med. Assocation* **281,** 1019–1021 (1999).

79. Dillard, A. J., Mccaul, K. D. & Klein, W. M. P. Unrealistic Optimism in Smokers: Implications for Smoking Myth Endorsement and Self-Protective Motivation. *Journmal Heal. Commun.* **11,** 93–102 (2006).

80. Strecher, V. J. *et al.* Do cigarette smokers have unrealistic perceptions of their heart

attack, cancer, and stroke risks? *J. Behav. Med.* **18,** 45–54 (1995).

81. Kofahi, M. M. & Haddad, L. G. Perceptions of lung cancer and smoking among college students in Jordan. *J. Transcult. Nursing*, **16,** 245–254 (2005).

82. Gustafson, P. E. Gender differences in risk perception: theoretical and methodological perspectives. *Risk Anal.* **18,** 805–811 (1998).

83. Faseru, B., Barengo, N. C., Sandström, H. P. & Omokhodion, F. Smoking behavior and perception of risk among medical students in Ibadan, Nigeria. *Prev. Control* **2,** 103–109 (2006).

84. Ford, J. S., Puleo, E., Sprunck-Harrild, K., DeMoor, J. & Emmons, K. M. Perceptions of risk among childhood and young adult cancer survivors who smoke. *Support Care Cancer* **22,** 2207–2217 (2014).

85. Lee, C. Perceptions of Immunity to Disease in Adult Smokers. *J. Behav. Med.* **12,** (1989).

86. So, J., Cho, H. & Lee, J. Genre-specific media and perceptions of personal and social risk of smoking among South Korean college students. *J. Health Commun.* **16,** 533–549 (2011).

87. Muñ Oz Sastre, M. T., Mullet, E. & Sorum, P. C. Relationship between cigarette dose and perceived risk of lung cancer. *Prev. Med. (Baltim).* **28,** 566–571 (1999).

88. Power, B., Neilson, S. & Perry, I. J. Perception of the risks of smoking in the general population and among general practitioners in Ireland. *Ir. J. Med. Sci.* **173,** 141–144 (2004).

89. Helweg-Larsen, M. & Stancioff, L. M. Acculturation matters: Risk perceptions of smoking among Bosnian refugees living in the United States. *Journal of Immigrant and Minority Health* **10,** 423–428 (2008).

90. Kelly, D. L. *et al.* Perception of smoking risks and motivation to quit among nontreatment-seeking smokers with and without schizophrenia. *Schizophr. Bull.* **38,** 543–551 (2012).

91. Weinstein, N., Slovic, P. & Gibson, G. Accuracy and optimism in smokers' beliefs about quitting. *Nicotine Tob. Res.* **6,** 375–380 (2004).

92. Slovic, P. in *Smoking: Risk, perception, & policy* (ed. Paul, S.) 97–124, Chapter xiii, 378 Pages (Sage Publications, Inc, Thousand Oaks, CA, 2001). doi:http://dx.doi.org/10.4135/9781452232652.n6

93. Romer, D. & Jamieson, P. in *Smoking: Risk, perception, & policy* 64–80 (Sage Publications, Inc, 2001).

94. Jensen Arnett, J. Brief Report: Optimistic bias in adolescent and adult smokers and nonsmokers. *Addict. Behav.* **25,** 625–632 (2000).

95. Kaba, Z. & Khamisa, N. Age-group differences in risk perceptions of non-communicable diseases among adults in Diepsloot township, Johannesburg, South Africa: A cross-sectional study based on the health belief model. *South African Med. J.* **107,** 797–804 (2017).

96. Garrett, S., Martin, M. & Egelberg, J. Treatment of periodontal furcation defects. Coronally positioned flaps versus dura mater membranes in class II defects. *Journal of clinical periodontology* **17,** 179–185 (1990).

97. Romero, D. R. & Pulvers, K. Cigarette Smoking Among Asian American and Pacific Islander College Students. *Health Promot. Pract.* (2013). doi:10.1177/1524839913482923

98. Hayaki, J., Anderson, B. J. & Stein, M. D. Perceptions of Health Risk Susceptibility in Methadone Maintained Smokers. *J. Addict. Dis.* **24,** (2005).

99. Pacek, L. R., Mauro, P. M. & Martins, S. S. Perceived risk of regular cigarette smoking and marijuana use in the U.S. 2002-2012. *2014 Annual Meeting of the College on Problems of Drug Dependence. San Juan Puerto Rico. Conference Start: 20140614. Conference End: 20140619.* **146,** e59 (2015).

100. United Nations Statistics Division. UNdata | record view | Population by national and/or ethnic group, sex and urban/rural residence. (2010). Available at: http://data.un.org/Data.aspx?q=china+ethnic&d=POP&f=tableCode%3A26%3BcountryCode%3A156. (Accessed: 29th November 2017)

101. Winkleby, M. A. & Cubbin, C. in *Critical Perspectives on Racial and Ethnic Differences in Health in Late Life* (National Academies Press (US), 2004).

102. Hser, Y.-I., Longshore, D. & Anglin, M. D. The Life Course Perspective on Drug Use: A Conceptual Framework for Understanding Drug Use Trajectories. *Eval. Rev.* **31,** 515–547 (2007).

103. Martin, G. W., Wilkinson, D. A. & Poulos, C. X. The drug avoidance self-efficacy scale. *J. Subst. Abuse* **7,** 151–163 (1995).

104. Ma, G. X., Fang, C. Y., Tan, Y. & Feeley, R. M. Perceptions of risks of smoking among Asian Americans. *Prev. Med. (Baltim).* **37,** 349–355 (2003).

105. Jackman, M. R. & Muha, M. J. Education and Intergroup Attitudes: Moral Enlightenment, Superficial Democratic Commitment, or Ideological Refinement? *Source Am. Sociol. Rev.* **49,** 751–769 (1984).

106. Cutler, D. M. & Lleras-Muney, A. Understanding differences in health behaviors by education. *J. Health Econ.* **29,** 1–28 (2010).

107. Garrett, B. E., Dube, S. R., Babb, S. & McAfee, T. Addressing the social determinants of health to reduce tobacco-related disparities. *Nicotine Tob. Res.* **17,** 892–897 (2015).

108. Canadian Institute for Health Information. *Trends in Income-Related Health Inequalities in Canada*. (2015).

109. Kenneth, R. & Warner, E. Tobacco Policy in the United States.

110. *Health and Sport Committee Report on Health Inequalities*. (2015).

111. Chao, L.-W., Szrek, H., Leite, R., Peltzer, K. & Ramlagan Li-Wei Chao, S. Risks deter but pleasures allure: Is pleasure more important? HHS Public Access. *Judgm Decis Mak* **10,** 204–218 (2015).

112. Pulvers, K. *et al.* Classifying a Smoker Scale in adult daily and nondaily smokers. *Nicotine Tob. Res.* **16,** 591–599 (2014).

113. Weinstein, N. D., Slovic, P., Waters, E. & Gibson, G. Public understanding of the illnesses caused by cigarette smoking. *Nicotine Tob. Res.* **6,** 349–355 (2004).

114. Park, E. R. *et al.* Risk perceptions among participants undergoing lung cancer screening: Baseline results from the national lung screening trial. *Ann. Behav. Med.* **37,** 268–279 (2009).

115. Chen, L.-S., Kaphingst, K. A., Tseng, T.-S. & Zhao, S. How are lung cancer risk perceptions and cigarette smoking related?—testing an accuracy hypothesis. *Transl. Cancer Res.* **5,** S964–S971 (2016).

116. Song, Y. in *Infrastructure and Land Policies.* (2013).

117. Hu, T.-W. & Mao, Z. Economic analysis of tobacco and options for tobacco control: China case study. in (2002).

118. Li, Q., Hyland, A., Fong, G. T., Jiang, Y. & Elton-Marshall, T. Use of less expensive cigarettes in six cities in China: findings from the International Tobacco Control (ITC) China Survey. *Tob. Control* **19 Suppl 2,** i63-8 (2010).

119. Vittinghoff, E., Glidden, D. V., Shiboski, S. C. & McCulloch, C. E. *Regression Methods in Biostatistics*. (2012).

120. Lin, W. & Sloan, F. Risk perceptions and smoking decisions of adult Chinese men ც. *J. Health Econ.* **39,** 60–73 (2015).

121. Zhang, Y., Liu, Y., Wang, J. & Jia, C. Mediation of smoking consumption on the association of perception of smoking risks with successful spontaneous smoking cessation. **21,** 677–681 (2013).

122. Zhang, C. & Fan, J. A Study of the Perception of Health Risks among College Students in China. *Int. J. Environ. Res. Public Heal. Int. J. Environ. Res. Public Heal. (J.F.); Tel* **103390,** 2133–2149 (2013).

123. Cui, Y., Ying, M. & Fan, H. Cigarette smoking practice and attitudes, and proposed effective smoking cessation measures among college student smokers in China. *Health Educ.* **112,** 365–379 (2012).

124. World Health Organization. *WHO framework convention on tobacco control*. (2003).

125. ITC Project & Control, C. C. for D. *ITC China Executive Summary Report. Findings from the Wave 1 to 5 Surveys (2006-2015)*. (2017).

126. Hammond, D. *et al. ITC China Wave 4 Technical Report International Tobacco Control China Survey Wave 4 ITC China Technical Report*. (2015).

127. Groves, R. M. *et al. Survey methodology*. (Wiley, 2009).

128. Patrick, P.-W., Sandrine, H. & Isabelle, G. The ‘moral career’ of cigarette smokers: A French survey. *Health. Risk Soc.* **9,** 259–273 (2007).

129. MA, G. X. & Shive, S. A comparative analysis of perceived risks and substance abuse among ethnic groups. *Addict. Behav.* **25,** 361–371 (2000).

130. Tejada, C. In Charts: Why China's Low Retirement Age Won't Last - China Real Time Report - WSJ. *The Wall Street Journal* (2015).

131. Windle, C. Test-Retest Effect on Personality Questionnaires. *Educ. Psychol. Meas.* **14,** 617–633 (1954).

132. Rao, J. N. K. & Scott, A. J. The analysis of categorical data from complex sample surveys: Chi-squared tests for Goodness of Fit and independence in two-way tables. *Source J. Am. Stat. Assoc.* **76,** 221–230 (1981).

133. O'brien, R. M. A Caution Regarding Rules of Thumb for Variance Inflation Factors. *Qual. Quant.* **41,** 673–690 (2007).

134. Szklo, M. *Epidemiology: Beyond the basics*. (Jones & Bartlett Learning, 2014). doi:10.1016/j.ijmedinf.2010.04.003

135. Liu, S. *et al.* Prevalence and patterns of tobacco smoking among Chinese adult men and women: findings of the 2010 national smoking survey. *J. Epidemiol. Community Health* **71,** 154–161 (2017).

136. World Health Organization. *WHO | Health equity*. (2017).

137. Hammond, D. *et al.* Effectiveness of cigarette warning labels in informing smokers about the risks of smoking: findings from the International Tobacco Control (ITC) Four Country Survey. *Tob. Control* **15,** 19–25 (2006).

138. Ronis, D. L. Conditional health threats: Health beliefs, decisions, and behaviors among adults. *Heal. Psychol.* **11,** 127–134 (1992).

139. Slovic, P., Peters, E., Finucane, M. L. & MacGregor, D. G. Affect, risk, and decision making. *Heal. Psychol.* **24,** S35–S40 (2005).

140. Slovic, P. Perception of risk. *Science (New York, N.Y.)* **236,** 280–5 (1987).

141. Slovic, P. *et al.* Perceived Risk, Stigma, and Potential Economic-Impacts of a High-Level Nuclear Waste Repository in Nevada. *Risk Anal.* **11,** 683–696 (1991).

142. Fong, G. T. *et al.* Perceptions of tobacco health warnings in China compared with picture and text-only health warnings from other countries: an experimental study. *Tob. Control* **19,** i69–i77 (2010).

143. Wakefield, M. A., Loken, B. & Hornik, R. C. Centre for Behavioural Research in Cancer, Cancer Use of mass media campaigns to change health behaviour. *Lancet* **376,** 1261–71 (2010).

Appendices

Appendix 1: STROBE Protocol

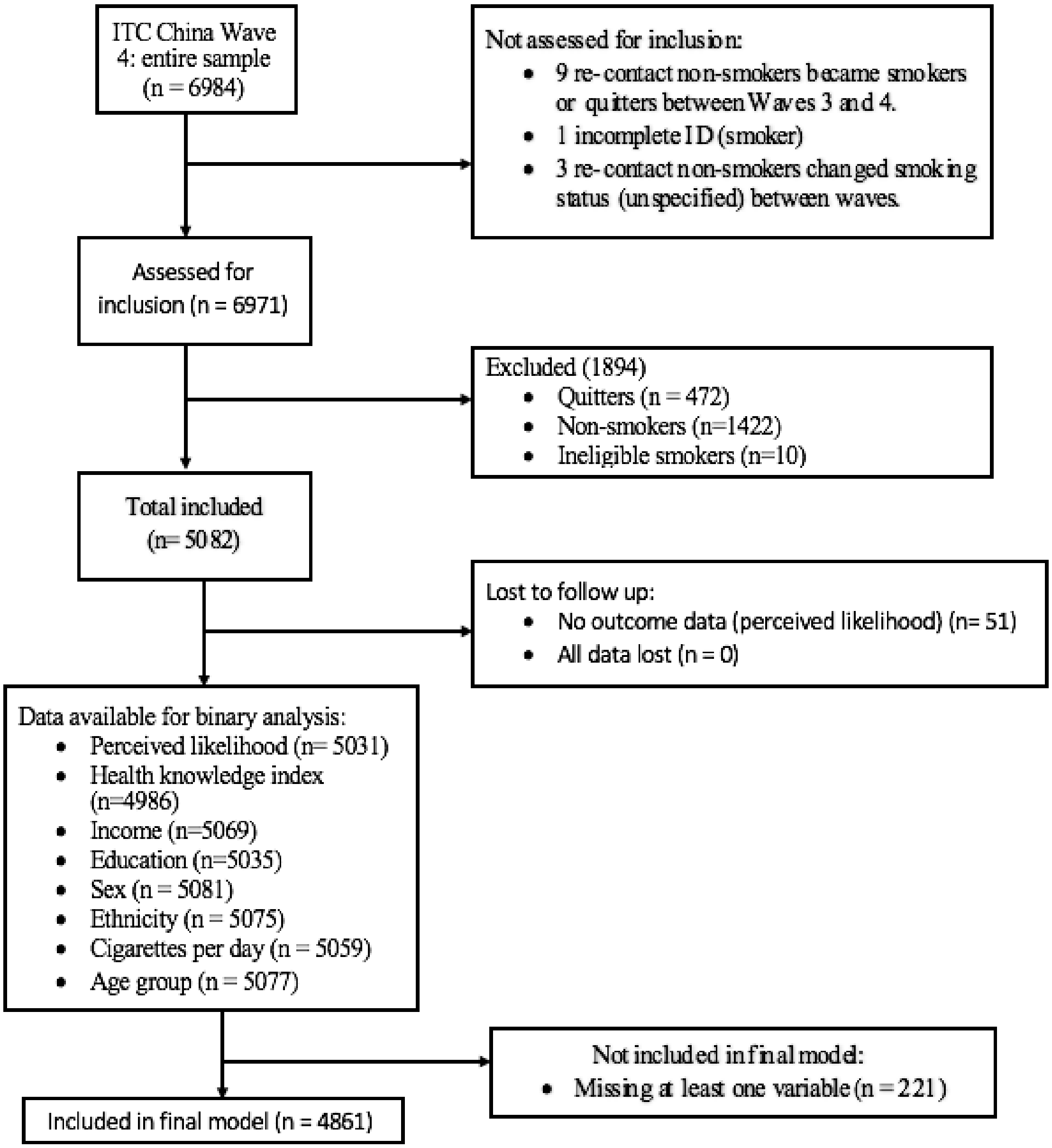

Figure 3. STROBE diagram for perceived likelihood

Appendix 2. Additional Tables

Table A1: Unweighted bivariate associations between perceived likelihood of getting a smoking related disease and explanatory variables.

	% participants who responded "much more" to perceived likelihood measure	% participants who did not respond "much more" to perceived likelihood measure
Gender	$X^2(1) = 0.543 \quad p = 0.461$	
Male	22.8	78.0
Female	24.8	73.1
Age (years)	$X^2(1) = 31.011 \quad p < 0.001$	
18-39	29.3	68.5
40-54	29.1	81.4
55+	22.8	78.0
Ethnicity	$X^2\ (1) = 13.359 \quad p = 0.478$	
Han	22.3	78.4
Non-Han	30.9	69.1
Standardized education	$X^2\ (2) = 4.283 \quad p = 0.117$	
Low	19.3	83.3
Medium	23.0	77.2
High	23.9	76.9
Household Income (yuan, per month)	$X^2(1) = 13.276\ p = 0.010$	
<2999	22.5	79.5
3000-4999	23.4	77.9
5000-6999	22.3	74.0
>7000	25.8	75.2
Refused or don't know	13.9	86.7
Cigarettes smoked per day	$X^2\ (3) = 2.683 \quad p = 0.443$	
0-10	22.5	77.8
11-20	23.4	76.3
21-30	22.3	84.8
31+	25.8	80.0
City	$X^2\ (6) = 99.179 \quad p < 0.001$	
Beijing	19.7	84.4
Changsha	18.7	86.3
Guangzhou	15.9	90.4
Kunming	33.2	78.0
Shanghai	18.2	82.7
Shenyang	25.1	73.8
Yinchuan	29.4	71.7
Cohort	$X^2\ (3) = 40.493 \quad p < 0.001$	

Recruited in Wave 1	18.5	82.5
Recruited in Wave 2	20.6	75.9
Recruited in Wave 3	28.0	71.0
Recruited in Wave 4	25.3	77.7
Health knowledge scale		
Weighted scale mean if (SD)	5.42 (1.63)	
Weighted Scale mean if perceived likelihood (SD)	3.89 (2.32)	
Weighted Test	$F(1, 79) = 171.38\ p < 0.001$	

Table A2: Bivariate logistic regressions models examining association between explanatory variables/covariates and perceived likelihood of getting a smoking-related disease.

	Odds of perceiving "much more" likelihood[1] Crude Odds Ratio (95% confidence interval), p-value	Test statistic for explanatory variable (p-value)
Gender		
Male	*Reference*	
Female	1.31 (0.854, 1.996), p = 0.215	$F(1, 79) = 1.56$ $p = 0.22$
Age		
18-39	*Reference*	
40-54	0.50 (0.337 ,0.737), p = 0.001	$F(2, 78) = 6.44$ $p = 0.003$
55+	0.613 (0.426, 0.882), p = 0.009	
Ethnicity		
Non-Han	*Reference*	$F(1, 79) = 8.78$ $p = 0.004$
Han	0.614 (0.442, 0.852), p = 0.004	
Standardized education		
Elementary school or less	*Reference*	$F(2, 78) = 1.75$ $p = 0.18$
Junior high school, technical school, or high school	1.47 (0.974, 2.227), p = 0.07	
University education or greater	1.49 (0.901, 2.468), p = 0.118	
Household Income (yuan, per month)		
<2999	*Reference*	
3000-4999	1.10 (0.868 ,1.396), p = 0.424	
5000-6999	1.36 (0.944,1.967), p = 0.096	
>7000	1.36 (0.944,1.967), p = 0.114	
Refused or don't know	0.60 (0.340 ,1.055), p = 0.075	$F(4, 76) = 2.18$ $p = 0.08$
Health knowledge[2]	1.42 (1.35 ,1.512), p < 0.001	p < 0.001
Cigarettes smoked per day		
0-10	*Reference*	
11-20	1.09 (0.832, 1.431), p = 0.075	F (3, 77) = 1.89 p = 0.139
21-30	0.67 (0.414, 0.949), p = 0.028	
31+	0.88 (0.499, 1.542), p = 0.646	
City		

Beijing	*Reference*	
Changsha	1.59 (0.770, 3.266), p = 0.207	
Guangzhou	1.12 (0.565, 2.232), p = 0.736	
Kunming	3.06 (1.604, 5.833), p = 0.001	
Shanghai	1.28 (0.643, 2.529), p = 0.482	
Shenyang	2.17 (1.110, 4.237), p = 0.024	F (6, 74) = 13.09
Yinchuan	2.41 (1.205, 34812), p = 0.013	p < 0.001
Cohort		
Wave 1	*Reference*	
Wave 2	1.50 (0.966, 2.333), p = 0.070	
Wave 3	1.93 (1.606, 2.317), p < 0.001	F (3, 77) = 17.41
Wave 4	1.36 (0.998, 1.843), p = 0.052	$p < 0.001$

1. Perceiving “much more” likelihood of “getting” a smoking-related disease, compared to a non-smoker, such that one continues as they do now.
2. Infers that a change in odds or beta-value relative to each 1.0 integer increase on our 7-point health knowledge scale.

Table A3: Collinearity Matrix

Variable	Variance Inflation Factor
City	1.06
Income	1.06
Education	1.18
Health knowledge	1.01
Gender	1.02
Ethnicity	1.03
Cigarettes per day	1.02
Age	1.10
Cohort	1.05

Table A4: ITC China Wave 4 Raw Measures Used in our Analyses

Question (Question Number)	Responses
"If a smoker got a smoking-related disease, such as lung cancer, heart disease, or emphysema, how much shorter, if at all, do you think his/her life would be? Estimate the number of years of life that the smoker would lose, or say 'zero' if you think his/her life would be no shorter." (186)	______ years
"If you continue to smoke as much as you do now, compared to a non-smoker, what are the chances that you will get a smoking-related disease?" (169)	(1) Much more likely (2) Somewhat more likely (3) A little more likely (4) Just as likely (5) Less likely (8) Refused (Don't read) (9) Don't know (Don't read)
"In the last year, on average, how much was the total income per month of your household?" (184)	(1) <1000 Yuan (2) 1000-2999 Yuan (3) 3000-4999 Yuan (4) 5000-6999 Yuan (5) 7000-8999 Yuan (6) 9000 Yuan or above (8) Refused (Don't read)
"What is your highest education? (185)	[Options were not read, but were coded as follows:] (1) No education (2) Elementary school (3) Junior high school (4) High school, technical high school (5) College (6) University or higher (8) Refused
"Just to wrap up, we have a few questions for statistical purposes. Please be assured that all your responses will be kept entirely confidential. What is your gender?" (181)	(1) Male (2) Female
'What is your date of birth?" (191)	________
"What is your ethnic group?" (187a; 187b)	(1) Han (2) Zhuang (3) Man

	(4) Hui (5) Miao (6) Uygur (7) Yi (8) Tujia (9) Mongolian (10) Tibetan (11) Others (98) Refused (Don't read) Other ethnicity? _______________
"I am going to read you a list of health effects and diseases that may or may not be caused by smoking cigarettes. Do you think smoking causes . . . " (074a;074b;…;074g)	(1) Yes (2) No (8) Refused (don't read) (9) Don't know (don' read)
"Stroke?"	
"Lung cancer in smokers?"	
"Emphysema"	
"Premature aging?	
"CHD?"	
"Oral cancer?"	
"Impotence in male smokers?"	

1. Indicates that question was asked at baseline or at Wave 4 as a replenishment observation.

Curriculum Vitae

Name:	Imran Syed
Post-secondary Education and Degrees:	University of Western Ontario London, Ontario, Canada 2016-2018 M.S.c. (anticipated) Wilfrid Laurier University Waterloo, Ontario, Canada 2016-2018 B.S.c.
Honours and Awards:	Dean's Honour Roll: Faculty of Science, Wilfrid Laurier University 2012-2013, 2013-2014, 2014-2015, 2015-2016

Publications:

Syed, I., Marcotte, AA, McKie, R. M., Wilson, C., Travers, R., & the ACBY team. (In Press). More Threatened Than Safe: What African, Caribbean, and Black Youth Living In Southern Ontario Say About Their Interactions with Law Enforcement. *Community Psychology in the Global Perspective.*

Krishnan, R.J., Crawford, E.J**, Syed, I.,** Kim, P., & Martin, J. (In Press). Staples versus Sutures for Skin Closure After Orthopedic Surgery: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Clinical Orthopaedics and Related Research.*

Conference Presentations:

Syed, I., Wells, S., Kim, P., Elton-Marshall, T. (2018) *Gender and the Risk Perceptions of Smoking: A Systematic Review.* Poster presented at London Health Research Day.

Krishnan, R.J., Crawford, E.J**, Syed, I.,** Kim, P., & Martin, J. (2018) *Staples versus Sutures for Skin Closure After Orthopedic Surgery: A Systematic Review and Meta-Analysis of Randomized Controlled Trials*. Presented at London Health Research Day.

Syed, I., Wells, S.., Kim, P., Elton-Marshall, T. (2017) *Socioeconomic Status and the Risk Perceptions of Smoking: Preliminary Results From A Systematic Review.* Poster presented at London Health Research Day. Presented at Biennial Conference for Canadian Society for Epidemiology and Biostatistics.