Predictors of Smoking Susceptibility among Adolescents

Findings from a Peri-Urban Nepalese Community

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A doctoral thesis at a university in Sweden is produced either as a monograph or as a collection of papers. In the latter case, the introductory part constitutes the formal thesis, which summarizes the accompanying papers. These have either been published or are manuscripts at various stages (in press, submitted, or in manuscript).

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ABSTRACT

Background: Susceptibility to smoking in adolescence is an important indicator of future smoking. Identifying smoking susceptibility and its associated psychosocial factors helps reduce smoking initiation.

Objectives: This thesis aimed to establish a health demographic surveillance site and examine psychosocial factors among non-smoking adolescents who demonstrated susceptibility to smoking initiation.

Methods: To establish the health demographic surveillance site, a baseline survey was conducted in Jhaukhel and Duwakot villages, a peri-urban area in the Bhaktapur district of Nepal. Next, a community-based cross-sectional study was conducted among 352 randomly selected non-smoking adolescents. Further, eight focus group discussions included 71 adolescent students.

Results: A baseline survey revealed there were 2,712 households with 13,669 individuals. Among individuals older than 18 years of age, nearly 15% were current smokers. Multivariable logistic regression demonstrated that personal and environmental factors strongly predict smoking susceptibility. The content analysis showed that participants were unaware about short-term health consequences of smoking. Smoking initiation related to socio-environmental factors and participants expressed confidence that they would be able to resist peer pressure and refuse to smoke. They agreed that both government and schools should have strict rules about smoking.

Conclusion: This thesis demonstrates that it is possible to collect accurate and reliable data in a peri-urban area to establish a demographic surveillance site in Nepal, and reveals several psychosocial factors that influence smoking-susceptible adolescents. Thus, effective smoking prevention programs must incorporate psychosocial factors that prevent smoking initiation in adolescents.

Keywords: *Adolescents, smoking susceptibility, psychosocial factors, Nepal*

LIST OF THESIS PAPERS

This Thesis is based on the following papers, which are referred to in the text by their Roman numerals:

Paper I

Aryal UR[#], Vaidya A[#], Vaidya-Shakya S Petzold M, Krettek A. Establishing a health demographic surveillance site in Bhaktapur district, Nepal: initial experiences and findings. (# equally contributed)

BMC Research Notes 2012; 5 (1): 489.

Paper II

Aryal UR, Petzold M, Krettek A. Perceived risks and benefits of cigarette smoking among Nepalese adolescents: a population-based cross-sectional study.

BMC Public Health 2013;13:187.

Paper III

Aryal UR, Petzold M, Bondjers G, Krettek A. Cognitive correlates of smoking susceptibility among adolescents in a peri-urban area of Nepal: A population-based cross-sectional study in the Jhaukhel-Duwakot health demographic surveillance site.

Submitted

Paper IV

Aryal UR, Petzold M, Krettek A.

Adolescents' opinions about cigarette smoking: a qualitative study of adolescent students in the Jhaukhel-Duwakot health demographic surveillance site, Bhaktapur district, Nepal.

Submitted

ABBREVIATIONS

AOR   adjusted odds ratio

CI   confidence interval

DBS   Decision Balance Scale

FCTC   Framework Convention on Tobacco Control

FGD   focus group discussion

GYTS   Global Youth Tobacco Survey

HBM   Health Belief Model

HDSS   health demographic surveillance site

HIC   high-income country

IQR   interquartile range

JD-HDSS   Jhaukhel-Duwakot Health Demographic Surveillance Site

LMIC   low- and middle-income country

NCD   noncommunicable disease

NPR   Nepalese rupees

OR   odds ratio (unadjusted)

PCA   Principal Component Analysis

SCT   Social Cognitive Theory

TPA   Theory of Planned Behavior

TRA   Theory of Reasoned Action

TSQ   Teen Smoking Questionnaire

TTM   Trans-Theoretical Model

VDC   village development committee

WHO   World Health Organization

PREFACE

My father left his home when he was five years old and came to Kathmandu, where he struggled a lot. I cannot express his struggles in a few words. Later, my father served as Operation Theater In-Charge for more than 35 years at private nursing home in Nepal. During his service period, I met many medical doctors but I never dreamed that I might become a medical doctor and teach at a medical school.

After completing my Bachelor of Science degree, I joined Nepal Medical College, Kathmandu, as an administrative staff member in 1997. I worked there for four years. During this time, I interacted with professors, senior colleagues, and other professional experts from Nepal, India, and abroad. When I realized that a bachelor's degree would no longer be sufficient in my career, I enrolled in a Master of Science program in statistics at Tribhuwan University. I joined the Department of Community Medicine as a statistics tutor immediately after completing my M.Sc. degree in 2001 and worked there until March 2004. I began hunting for a PhD degree in public health in 2001, but luck did not favor me till 2008.

Luck favored me in 2008, when I joined Kathmandu Medical College and met Dr. Abhinav Vaidya, who introduced me to the Swedish Team in Nepal. I expressed my interest in pursuing a master of public health degree with my supervisor, Alexandra Krettek, but she encouraged me to seek a doctoral degree because I had already completed a Master of Science degree in statistics. When I stated that I was interested in doing research on tobacco smoking in adolescents, a neglected public health problem in Nepal, I answered her queries. She gave a positive signal for further process and introduced me to co-supervisor Max Petzold, who supported me in developing a research proposal. My proposal underwent several rounds of discussion and revision. In 2010, I became a Doctoral Fellow in Public Health at Nordic School of Public Health NHV,

Gothenburg, Sweden. In 2013, I transferred to the Institute of Medicine, Sahlgrenska Academy at Gothenburg University because NHV will be history after 2014. Besides smoking studies, I was also given responsibilities for establishing the Health Demographic Surveillance Site in Jhaukhel and Duwakot Villages in the Bhaktapur district, which challenged me.

I am happy to be a doctoral student in Sweden because research training in Sweden not only increased my research knowledge but also aroused my interest and enthusiasm for public health research in Nepal. Whatever I did in this thesis is just the beginning of my research career and my tobacco research. I need to do to a lot to reduce smoking in Nepal.

TABLE OF CONTENTS

BACKGROUND

Tobacco use: a major public health challenge

Evidence suggests that non-communicable diseases (NCDs) will rise globally, particularly in low- and middle-income countries (LMICs), and become the leading cause of death worldwide [1]. Already a major contributing risk factor for NCDs, tobacco use also increases the risk of death from lung and other cancers, heart disease, stroke, and chronic respiratory disease. Smoking is becoming more prevalent in many LMICs but decreasing in high-income countries (HICs), largely due to affordability [1, 2].

Among one billion smokers worldwide, 50% are young people who consume 6 trillion cigarettes per year [1]. Smoking kills nearly 6 million people each year, resulting in global economic losses totaling $100 billion [3]. More than 80% of premature deaths occur in LMICs, and the NCD mortality gap between LMICs and HICs continues to rise [4]. By 2020, 7 in 10 deaths from smoking will occur in LMICs. If current trends continue, tobacco will kill more than 8 million people worldwide annually by 2030. Indeed, half of all current smokers will die from tobacco-related diseases [3].

Every day more than 80,000 young people initiate smoking [5], 14,000–15,000 in HICs and 68,000–84,000 in LMICs [5]. Nearly 80% of all adult smokers began smoking before their 18th birthday [6]. In HICs, 8 in 10 smokers had their first cigarette during adolescence, and almost all smokers in LMICs have their first cigarette before their 20th birthday. This pattern is now shifting toward early adolescence [5, 6]. Thus, tobacco use is a major, but preventable, public health challenge that can be attenuated by reducing tobacco use.

Egocentrism and tobacco use during adolescence

Adolescence is a transition period between childhood and adulthood [7]. According to the World Health Organization (WHO), an adolescent is between 10–19 years of age, whereas youth encompasses ages 15–24 years. These overlapping age groups are combined in the group "young people" and cover the age range of 10–24 years [8, 9]. Adolescence can be divided into three distinct periods: early (10–14 years), middle (15–17 years), and late (18–19 years) [8, 9].

During the physiological metamorphosis of adolescence, teenagers are primarily concerned with themselves and fail to differentiate between what others are thinking and their own preoccupations. They assume that other people are as obsessed with their own behavior and appearance as they are themselves [10].

Elkind describes two components of adolescent egocentrism: (i) the imaginary audience, wherein adolescents believe they are "on stage" and all eyes are watching them, and (ii) the personal fable, wherein adolescents believe that their thoughts or experiences are completely novel and unique compared to the thoughts and experiences of others [11]. Belief in this personal fable is thought to be the origin of adolescents' tendencies to view themselves as invulnerable to harm, leading to poor decision-making skills and poor ability to judge risks [12]. The personal fable leads adolescents to engage in high-risk behavior (e.g., unsafe sexual activities, violence, and drug and tobacco use) [12]. Therefore, adolescents frequently initiate cigarette smoking and also use other tobacco products [6].

Behavioral stages of smoking

Smoking behavior in adolescence progresses through a sequence of developmental stages [13], and multiple sociopsychological and biological factors play significant roles for different people at different points in this progression. The six stages of smoking initiation among adolescents [13] include

- *pre-contemplation*, when non-smoking adolescents have not yet thought about initiating smoking. They are unaware of positive reasons to start smoking and ignore the pressure to smoke.

- *contemplation*, when several psychosocial factors influence non-smoking adolescents to thinking about smoking. Pre-contemplation and contemplation are also known as the preparation and susceptibility stages (Papers II and III).

- *initiation/tried*, when adolescents try their first cigarettes. During this stage, peer influence is stronger than family influences and adolescents' self-image associates with smoking initiation.

- *experimenter*, when adolescents gradually increase their smoking frequency and smoke in a variety of situations. Although they emphasize the positive aspects and recognize a few negative aspects of smoking, they have not yet committed to future smoking. They also learn how to handle cigarettes and how to inhale correctly.

- *regular*, when adolescents progress from sporadic to regular smoking. During this stage, adolescents smoke at least monthly but not as frequently as daily. They smoke especially at social gatherings (e.g., parties) or with their best friends. In the early stages of regular smoking, adolescents experience physiological reactions such as increased heart rate and stimulation of the nervous system.

- *established smokers*, when adolescents smoke on a daily basis and become addicted to nicotine.
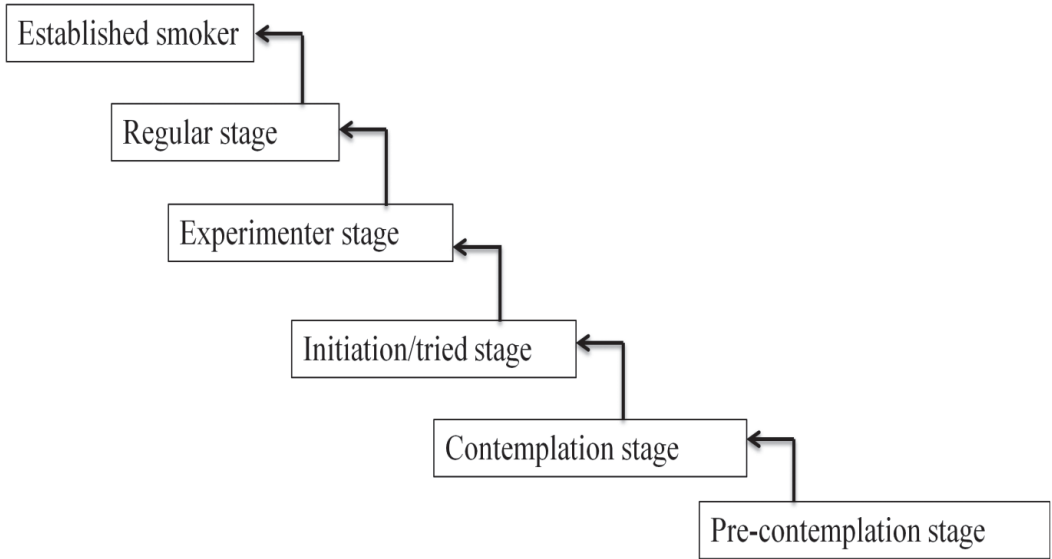
Established smoker ← Regular stage ← Experimenter stage ← Initiation/tried stage ← Contemplation stage ← Pre-contemplation stage

Figure 1. Stages in the development of adolescent smoking [13].

Predictors of smoking behavior in adolescence

Several psychosocial factors (i.e., sociodemographic, environmental, personal, and behavioral) contribute importantly to smoking initiation during adolescence [6].

Sociodemographic factors

Sociodemographic factors in adolescents include age; sex; ethnicity; parents' education level, occupation, and economic status; types of family; and pocket expenditures. Smoking prevalence among adolescents rises with increasing age and school grade [14]. Most adolescents begin smoking before their 18th birthday, thus becoming regular smokers who are less likely to quit [6]. Historically, smoking prevalence is higher among males but recent data suggest a similar rate of smoking initiation and prevalence in females. Interestingly, the

rate of smoking initiation varies among ethnic groups [6]. For example, smoking prevalence among adolescents in California is higher for Hispanics and blacks than whites, and lowest for Asians [6]. Higher levels of socioeconomic variables (e.g., parents' education level and social class) relate inversely with smoking behavior in adolescents [6]. Living in a nuclear family protects against smoking, an association that is consistent in all countries [14]. Adolescents with more pocket expenditures are more susceptible to smoking initiation [15].

Environmental factors

Environmental factors include those that potentially influence smoking initiation and maintenance (e.g., parental, sibling, or peer smoking and availability of cigarettes, etc.). Further, environmental factors can be classified as interpersonal and perceived as well as tobacco acceptability and availability [6].

Pro-tobacco advertisements and other promotional activities by the tobacco industry influence the acceptability and availability of tobacco. Acceptability may be achieved through persuasive, multiple, and attractive role models (e.g., movie actors) and further reinforced by community norms and governmental policies that make tobacco products easily accessible for adolescents [6]. Likewise, increased acceptability and availability support a social milieu in which smoking cigarettes may seem socially functional.

Interpersonal factors (i.e., social learning variables for smoking initiation) involve opportunities for adolescents to perceive the apparent advantages of smoking modeled by parents, siblings, friends, and peers who smoke [6, 14]. Role models provide situations (e.g., parties, picnics) where adolescents can try their first cigarettes and learn the meaning of smoking in a social context [6]. Perceived environmental factors include smoking-related social norms, social support, expectations, reactions, and barriers that adolescents sense in their environment.

Social norms are defined as an individual's perceptions about what he/she ought to do and what is acceptable behavior for a given age group [6]. Adolescents' overestimation of the proportion of peers, classmates, and adults who smoke generally motivates their decision to initiate smoking [6]. Social support includes perceived approval or disapproval of cigarette smoking by parents, siblings, peers, and teachers [6]. Usually, disapproval of cigarette smoking by other adolescents helps prevent smoking initiation. Likewise, parents' reaction to smoking and adolescents' perception of parental strictness associate with smoking initiation [6].

Most tobacco control policies aim to discourage tobacco use among adolescents and youths. Such policies include tax increases on tobacco; restrictions on smoking in public places; prohibition of advertisements and sponsorships; punishment and penalties; and limiting availability [17]. However, tobacco control policies frequently lack strict implementation [17, 18].

Personal Risk Factors

Cognitive processes, personality constructs, and psychological well-being are inherent. Personal risk factors include knowledge about the meaning and consequences of cigarette smoking, subjective expected utility (i.e., positive and negative expectation of overall consequences), self-esteem, self-image, and self-efficacy in refusing offers to smoke [6]. Such factors vary from person to person even when individuals are exposed to the same environments.

Knowledge of the short-term health risks of smoking is a better predictor of smoking behavior than knowledge of long-term risks [6]. Adolescent smokers express several reasons for smoking initiation, most commonly including acting mature, acceptance by peer groups, curiosity, coping with personal problems, and boredom [6].

Subjective expected utility associates with internal locus of control. In other words, adolescent smokers believe they can control what happens to them.

Therefore, internal locus of control motivates adolescents to become regular smokers [6].

Self-esteem (i.e., belief in one's own ability to successfully perform a behavior) is the most important prerequisite for behavior changes [19]. Adolescents with low self-esteem are less able to refuse cigarettes [6]. Further, physical changes that occur during adolescence can affect self-image. Physical changes combine with psychological and emotional changes to affect self-image and behavior, evoking different behavior from parents, peers, and others [19].

Self-efficacy (i.e., an individual's confidence in performing specified behaviors) is the most important precondition of peer influence on smoking. Self-efficacy affects not only the amount of effort an adolescent puts into a behavior but also the outcome of that behavior [19]. For example, low self-efficacy associates with drug use, including smoking [6].

Behavioral factors

Behavioral patterns related to adolescent smoking include academic performance and aspiration, risk behavior, and lifestyle [14]. Smoking status consistently associates with academic performance at school [14]. Students who smoke cigarettes perform poorly [6], whereas students who perform well have high academic aspirations, are committed to school, and are less likely to smoke [14]. Generally, risk taking and deviance include unconventional and antisocial behaviors [6]. Proneness to risk-taking behavior (e.g., alcohol use) significantly predicts smoking initiation among adolescent students. Conversely, adolescents who engage in health-enhancing behavior (e.g., participation in sports) are less likely to initiate smoking [6].

Nicotine dependency, genetic factors, and implementation of tobacco control policies also play significant roles in smoking initiation among adolescents [13]. Nicotine is a poisonous substance in cigarettes, but most adolescents do not understand that nicotine is addictive [20, 21]. Tobacco

addiction may occur rapidly and, once established, is difficult to stop [21]. Nicotine dependence can be measured using a scale in the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders* (*DSM IV*) [22]. The scale includes seven-item questions relating to depressed mood, insomnia, irritability, anxiety, difficulty concentrating, restlessness, decreased heart rate, and increased appetite or weight gain. An adolescent is defined as nicotine-dependent when he/she fulfills at least four criteria [22]. A twin study conducted in Australia shows that genes may influence variation in smoking behaviors [23].

Figure 2 shows a model of the importance of determinants for smoking initiation, cessation, and maintenance [6, 18].
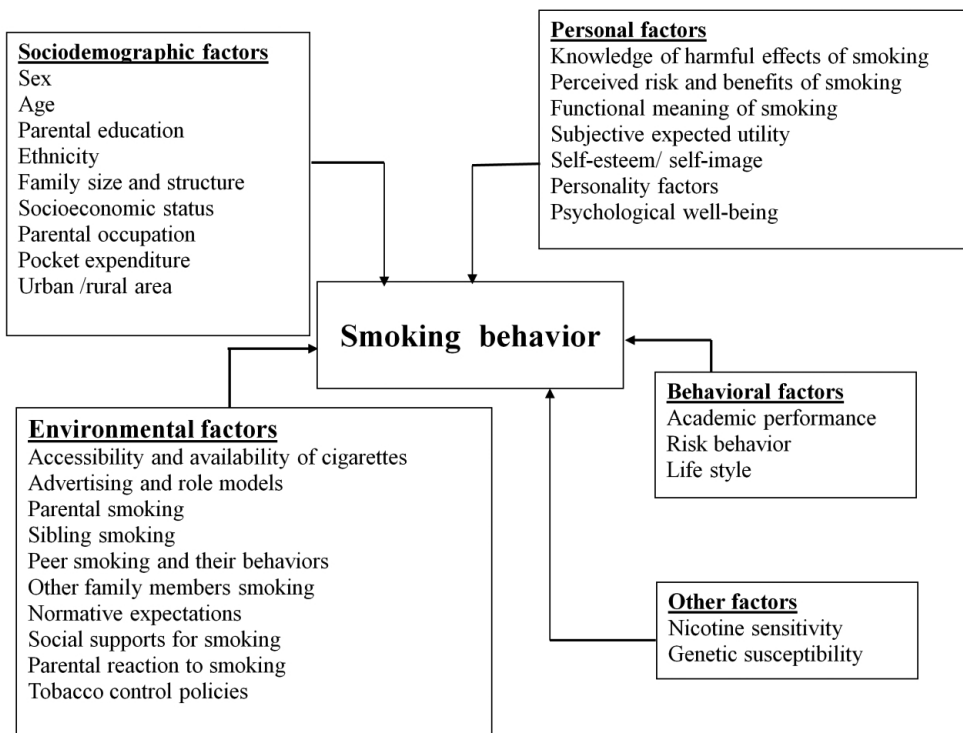

Sociodemographic factors
Sex
Age
Parental education
Ethnicity
Family size and structure
Socioeconomic status
Parental occupation
Pocket expenditure
Urban /rural area

Personal factors
Knowledge of harmful effects of smoking
Perceived risk and benefits of smoking
Functional meaning of smoking
Subjective expected utility
Self-esteem/ self-image
Personality factors
Psychological well-being

Smoking behavior

Environmental factors
Accessibility and availability of cigarettes
Advertising and role models
Parental smoking
Sibling smoking
Peer smoking and their behaviors
Other family members smoking
Normative expectations
Social supports for smoking
Parental reaction to smoking
Tobacco control policies

Behavioral factors
Academic performance
Risk behavior
Life style

Other factors
Nicotine sensitivity
Genetic susceptibility

Figure 2. Predictors of smoking behavior among adolescents [5, 18].

Nepal: a brief introduction

Located in South Asia, Nepal became a republic in 2008 [24]. It is a landlocked country with an area of 147,181 km^2, surrounded to the north by the Tibetan region of China and to the south, east, and west by India. Nepal is divided into five development regions, 14 zones, and 75 districts. Districts are further divided into 3,754 village development committees (VDC) and 99 municipalities. Each VDC contains 9 wards; the number of municipalities varies from 9 to 35. Kathmandu, the capital city of Nepal, is situated in the Central Region.

The total population of Nepal is 26.6 million and the annual population growth rate is 1.4 % [25]. Adolescents comprise nearly 24% of the total population [9]. More than 83% of Nepalis live in rural areas [26]. The sex ratio (i.e., number of males per 100 females) is 94.41, and the average household size is 4.70 [26]. The crude birth and crude death rates are 22.17 and 6.81 per 1,000 population, respectively. Life expectancy at birth is 64.1 years (64.5 years for females and 63.6 years for males) [27].

Nepal has 125 ethnic/caste groups, each with their own distinct language and culture. The major groups are Chhetri, Brahmin, Magar, Tharu, Tamang, and Newar [25].

Burden of tobacco use in Nepal

According to the most recent national survey, 30% of men and 9% of women aged 15–49 years smoke cigarettes [26], and 38% of men and 6% of women use smokeless products. The rate of smoking prevalence varies across the country for men (ranging from 23.4% in the Western Region to 34.8% in the Mid-Western Region) and women (from 5% in the Eastern Region to 15.6% in the Mid-Western Region). In rural Nepal, 31% of men and 10% of women smoke cigarettes [26]. The World Health Organization (WHO) reports that smoking prevalence in South Asia is highest for Nepalese women (28%) and mid-range for Nepalese men (36%) [28]. Prevalence is higher among people who are

illiterate, less exposed to information, and under social pressure. Annually, Nepal spends more than Nepalese rupees (NPR) 28 billion (approximately $3.5 million) on cigarettes and NPR 16 billion (approximately $2 million) to treat tobacco-related diseases [17]. Tobacco is a major cause of NCDs in Nepal, accounting for 50% of all deaths [1]. Cigarette smoking and other tobacco products kill 15,000 people each year; 60% are men [29].

Prevalence and determinants of tobacco use in Nepalese adolescents and youths

Findings from national surveys

The most recent Global Youth Tobacco Survey (GYTS) shows that 10.4% of adolescent students are ever smokers, 3.4% are current smokers (boys = 5.5%; girls = 0.8%), and 9.5% have smoked any tobacco products [30]. In 2012, the Nepal Adolescent and Youth Survey (NAYS) reported that nearly 20% of respondents >20 years of age had used cigarette or tobacco products [31]. Among boys, the prevalence of tobacco use was 24% compared to only 2.22% in girls. Smoking prevalence varied among caste/ethnicities, ranging from 10.86% in disadvantaged non-dalit terai caste groups to 16.62% in relatively advantaged janajatis [31]. In urban and rural areas, the prevalence rate was 17.60% and 11.43%, respectively. Additionally, tobacco use increased with education level: 7%, 12%, and 22.07% at the primary, secondary, and secondary level, respectively [31]. Nepal's Health Education and Tobacco Intervention Program (HETIP) reported that smoking prevalence in schools varies 2%–49%. Additionally, smoking prevalence is 10%–30% higher among boys compared to girls [17]. Importantly, these studies reported smoking prevalence rates only among adolescents. Scientific evidence regarding the prevalence and predictors of tobacco use among adolescents and young adults is sparse.

Findings of epidemiological studies

In a cross-sectional study from Dharan municipality in eastern Nepal, Pradhan et al. explored tobacco use in 1,312 adolescents (14–19 years old); 52.9% were male from grades 9–12 [32]. Ever smokers accounted for 17.9%, of which 98.7% had smoked cigarettes. The median number of cigarettes smoked per day was two (interquartile range [IQR] 1–3). The median age of smoking initiation was 14 years (IQR 13–15 years). In this study, 1 in 10 adolescents initiated smoking due to curiosity and 1 in 3 smoked to relieve tension. Likewise, one quarter of adolescents initiated smoking due to peer pressure. Predispositions for tobacco use included age (i.e., 16–19 years old), being male, studying in a government school, belonging to a relatively advantaged/disadvantaged family, and having more pocket expenditures (<NPR 500 [$5.55] vs.≥ NPR 500/month). Pradhan et al. concluded that tobacco intervention programs should focus on the above-mentioned variables [32].

Kabir et al. analyzed secondary data from a nationally representative sample of adolescents in the GYTS 2007 survey [33], which included 1,444 adolescents aged 13–15 years; 54% were female. The prevalence of ever smokers was 7.9% (5.7% boys and 1.9% girls), and 3.9% were current smokers. Members of the study sample smoked an average of 1.3 cigarettes per day and the average age of tobacco initiation was 10.2 years. Nearly 50% reported having at least one parent who smokes. Kabir et al. demonstrated that being male, having friends who smoke, exposure to secondhand smoking at home and in public places, and being offered free tobacco products by vendors predict students' smoking behavior [33]. The study concluded that Nepal should prioritize tobacco intervention programs and strongly implement existing prevention programs to reduce the prevalence rate of tobacco use [33].

In 2011, Aryal et al. [34] performed a cross sectional study among 340 young adults aged 18–24 years who were public health students from Kathmandu and the Lalitpur district. The prevalence of ever and current smokers

was 33.3% and 16%, respectively. Among smokers, 60 % had already smoked more than 100 cigarettes (median number of cigarettes per day = 3). About 50% of smokers always inhaled compared to 12% who never inhaled. One in 10 smokers also used smokeless tobacco products. Young adults understood that smoking entails risk (i.e., smoking 1–5 cigarettes a day is harmful) and that nicotine associates positively with smoking habits. Young adults believed that smoking a few days per week is not harmful to their health and that smoking during a weekend party or gathering does not qualify them as regular smokers. Aryal et al. concluded that tobacco intervention programs should focus on each cigarette is harmful to health [34].

In 2010, Aryal et al. [35] performed a cross-sectional study among 304 college students (18–24 years old) from the Kathmandu Valley. Most (66.4%) were older than 20 years and 75% were male, 72% were current smokers, and 16% were susceptible to smoking. The mean±standard deviation of age at smoking initiation was 14.2±2.6 years, and the mean±standard deviation of cigarettes smoked per day was 5.03±3.72. Factors that associate with smoking behavior in young adults included being male, not living with family members, having friends who smoke, and having a father who is non-service holder. The study recommends that aforesaid factors should be included while designing effective smoking interventions [35].

Also in 2010, Binu VS et al. [36] conducted a cross-sectional study among 816 college students in Pokhara, the capital city of Western Nepal; 54% were male. Nearly 42% were daily smokers, 23% smoked their first cigarette within one hour of waking up, and 72% smoked with friends. The mean±standard deviation of age of smoking initiation was 16.8±2.8 years. Binu VS et al. also reported that 72.7% of the students introduced smoking by friends, 20.9% introduced smoking on their own initiative, and relatives introduced 6.4% of the students to smoking. Reasons for smoking initiation included feeling relaxed after smoking (23.7%), restlessness when not smoking (13.7%),

boredom (20%), and feeling comfortable smoking with friends during social gatherings (23%). Some students said that smoking helps them feel mature. Nearly 65% of the smokers reported trying to quit smoking, and 43% said they are addicted to smoking. The study reveals that being male, having several friends who smoke, ever having used smokeless tobacco products, and ever having used alcohol associates with smoking behavior in adolescents. The study concluded that its findings would help formulate tobacco control measures and planning for cessation efforts [36].

In 2008, a cross-sectional study by Sreeramareddy et al. [37] investigated smoking behavior in two urban areas of Nepal's Kaski district. Study participants included 1,590 college students (14–32 years of age; median age = 17 years); 62.9% were male. The prevalence of ever smokers was 13.9% (boys = 20.5%; girls = 2.9%), and 10.2% of the students were current users of any tobacco products. Additionally, 9.4% of participants were current smokers and 5.7% students used both cigarettes and smokeless products. The median age of smoking initiation was 16 years (IQR 12–18 years), and 30% of participants initiated smoking before their 15th birthday. The median number of cigarettes smoked per day was two. Eighty-two percent of students had been exposed to pro-tobacco advertisements. More than 55% of participants who smoked wanted to quit. This study demonstrated that age; sex; high household asset score; teachers, friends, and family members who smoke; and low knowledge about the harmful effects of smoking associate with smoking [37].

In 2003, Paudel et al. [38] conducted a cross-sectional study among 2,032 students in grades 8–10 in Pokhara Municipality; 51.5% of study participants were male. The prevalence of ever using any tobacco products was 47.1%, and the prevalence of ever smokers was 22.9% and 5.9% for boys and girls, respectively. The mean age of smoking initiation was 12.64 ±0.2 years (12.76 years in boys vs. 12.40 years in girls). Nearly 32% of participants had been exposed to tobacco advertisements. The proportion of current users was higher

in students from nongovernment schools (18.2%) compared to students in government schools (10%). More students from the Gurung and Magar ethnic groups were current users (17%) compared to Brahmin/Chhettri (10.7%) and Newar (11.9%). Three in 10 students had poor knowledge about the hazards of smoking. Additionally, 4 in 10 students had never been exposed to environmental tobacco smoke at home, and only 2 in 10 had been exposed in public places. The study demonstrated that ethnicity (i.e., Gurung/Magar), parents' attitude, smoking habits of friends and family members, exposure to tobacco advertisements, environmental tobacco smoke, and being male associate with tobacco use.

In 1987, Pandey et al. [39] conducted a community-based cross-sectional study in Bhadrabas and Alapot, two villages located about 20 km northeast of the Kathmandu district. Participants included 1,112 adolescents aged 8–19 years, including 620 males. Nearly 30% of boys and 50% of girls did not attend school. Overall prevalence of smoking was 12.6% (17.3% male vs. 6.7% female). The highest prevalence of smoking (1.7%) occurred in the 16–19 year age group, and the lowest prevalence (1.2%) occurred in students younger than 11 years of age. Adolescents smoked 1–38 cigarettes per week. Among smokers, 37% of males and 36% of females reported they would definitely not smoke after their 20th birthday. More than 50% of all participants knew that smoking is harmful to health, and 75% agreed that (i) teachers should not smoke and (ii) tobacco advertisements should be prohibited. Some participants agreed that smoking makes them appear grown-up. More boys than girls favor public action against smoking. The study concluded that peer pressure deters smoking and that appropriate mass media techniques could influence such pressure [39].

Challenges for tobacco control policies in Nepal

The Nepal House of Representatives ratified the WHO-Framework Convention on Tobacco Control (WHO-FCTC) on 7 November 2006 [40]. In 2011, the Parliament of Nepal endorsed the Tobacco Control and Regulatory Act [41], which included most provisions of WHO-FCTC [16]. Nevertheless, there are numerous challenges to its implementation, including (i) a low level of awareness regarding tobacco control policies, (ii) a lack of commitment by political leaders and parties, (iii) most government programs prioritize the Millennium Development Goals and primary health care and provide less support for tobacco control and prevention [42], (iv) limited multi-sector collaboration, and (v) the Tobacco Control and Regulatory Act does not clearly define efforts regarding monitoring mechanisms and the roles of responsible institutions [43]. Finally, geographical infrastructure makes it difficult to launch awareness programs in rural Nepal [43].

Importance of a health demographic surveillance site for tobacco studies

Health data in Nepal derives mainly from (i) routinely kept records from healthcare centers and (ii) cross-sectional studies [44]. The GYTS regularly provides data about smoking prevalence among adolescent students. However, only limited information is available regarding risk factors for tobacco use, and available data fail to establish causal inference. Although sparse, data regarding the behavioral stages of tobacco use or smoking trajectories among adolescents can be obtained through follow-up population studies. To a certain extent, a health demographic surveillance system (HDSS) offers a good platform for population-based tobacco research, providing information for health planning and policy development [45].

An HDSS is a longitudinal, population-based health and vital registration system that is useful for monitoring demographic and health events in a geographically defined population [46]. HDSS also provides a platform for a

wide range of health, social, economic, and behavioral studies and interventions [45]. Further, there are several advantages to conducting research in an HDSS [47]. First, background variables are readily available in advance. Second, HDSS provides a sampling frame for probability sampling techniques. Third, the ability to conduct population-based longitudinal studies and show the cause-effect relationship of different parameters is significantly advantageous. Finally, HDSS provides facility of triangulation for both quantitative and qualitative studies. Thus, HDSSs are particularly important in low-income countries like Nepal, which lack vital registration systems. HDSSs can also provide a setting for community-based studies on smoking trajectories.

AIMS

The overall aim of this thesis was to explore and analyze psychosocial predictors of smoking susceptibility among non-smoking 14- to 16-year-old adolescents in a peri-urban area of Nepal. Specifically, I wanted to

- initiate and establish an HDSS in Nepal and assess smoking-related diseases in the community (Paper I),

- examine the perceived risks and benefits of smoking among adolescents who demonstrate susceptibility or non-susceptibility to smoking initiation (Paper II),

- correlate sociodemographic and environmental factors with susceptibility to smoking (Paper III), and

- explore factors that might influence adolescents' initiation of cigarette smoking and their views on prevention strategies (Paper IV).

THEORETICAL FRAMEWORK

This thesis mainly aims to explore predictors of adolescent smoking behavior in JD-HDSS. To explain and predict such behavior, I incorporated the following health behavior models/theories in the questionnaire design. Combining several theories into a single study helps identify factors that will aid the design of effective smoking intervention programs. Finally, despite the inherent difficulty of covering every aspect of behavioral models, the questionnaire in this thesis covered some important aspects of the models (Figure 3).
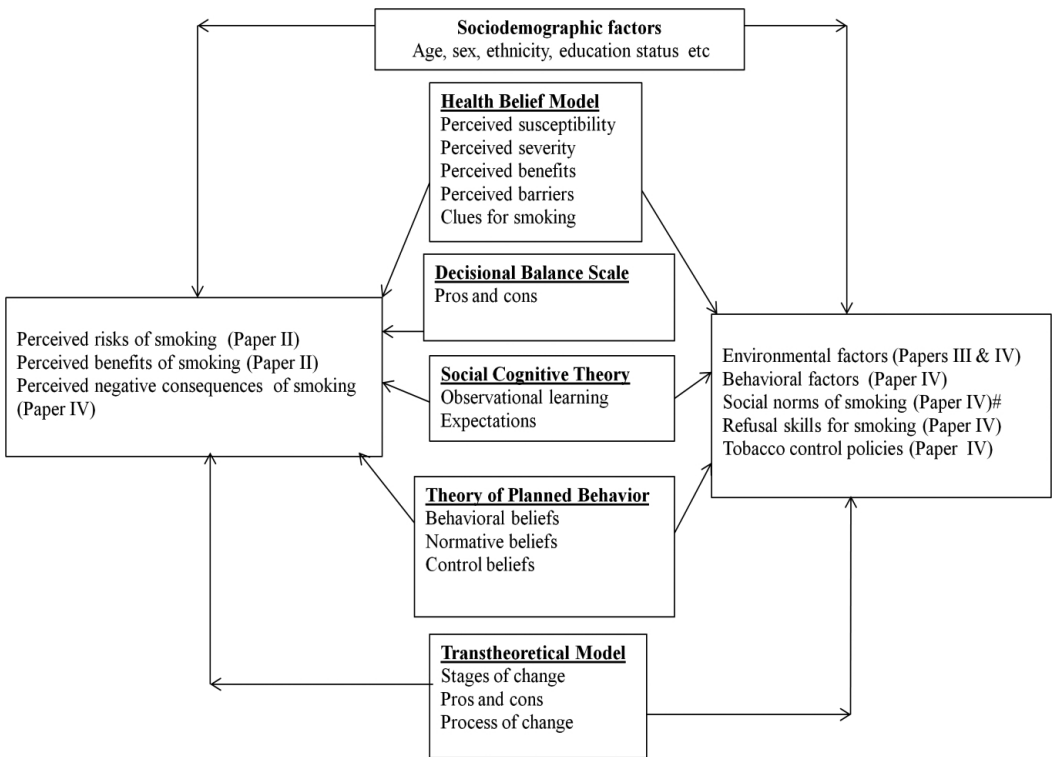
 Figure 3. *Constructs of health behavior models in the Thesis and how there were incorporated in the Questionnaires Used in Papers II-IV.* [#] **Perceived prevalence of smoking among adolescents.**

Health Belief Model

The basic principle of the Health Belief Model (HBM) is that the individual has choices and is capable of making good health decisions based on the interaction between four different beliefs [19, 48]. HBM predicts that the individual will act to protect or promote health if he/she believes (i) he/she is susceptible to a condition, (ii) the condition would have serious consequences, (iii) an available course of action will help him/her avoid the condition, and (iv) the benefits of acting outweigh the costs or barriers. In the case of smoking, HBM would predict that the individual will not smoke if his/her first choice is to avoid smoking-related risks when he/she may be susceptible to diseases (at risk) and he/she also believes that not smoking will help avoid health risks [49].

Social Cognitive Theory

Social Cognitive Theory (SCT) provides a framework for understanding the relationship between behavior and environment [48]. The theory explains how an individual and his/her environment and behavior continuously interact and influence each other. SCT describes three important cognitions that govern individual behavior: observational learning, expectations, and self-efficacy.

Observational learning represents an individual's capacity to learn by observing others' behavior and recognize the reward received for different behaviors. Expectations involve the capacity to anticipate and place a value on the outcomes of different behavior patterns. Finally, self-efficacy describes an individual's ability for desirable behavior [19]. When adolescents observe that smoking cigarettes has many benefits, they begin to smoke during social events within the adolescent society. When adolescents are taught how to act in such situations, they have the capacity to reject smoking [50].

Theory of Planned Behavior

The Theory of Planned Behavior (TPB) is an extension of the Theory of Reasoned Action (TRA) [51]. Both models illustrate an individual's intent to perform a behavior like smoking and predict the occurrence of that behavior (i.e., to smoke or not to smoke). TPB and TRA explain how an individual's attitudes toward behaviors, subjective norms, and perceived behavior control influence behavioral intentions. Attitudes are determined by positive or negative evaluation of a particular behavior (e.g., smoking). Subjective norms explain peer pressure (i.e., what other people think he/she should do). Thus, perceived behavior control is an individual's perceived ease or difficulty in performing a particular behavior (e.g., smoking). These theories are widely applied in the development of programs to reduce smoking prevalence among youth.

Decisional Balance Scale

The Decisional Balance Scale (DBS) represents both cognitive and motivational aspects of human decision-making [52]. The assumption of DBS involves decision-making as a gain model rather than a loss model. The theory, which emphasizes comparative models (gain vs. loss) rather than an absolute mode, has identified four main categories: (i) utilitarian gains and losses for self; (ii) utilitarian gains and losses for others; (iii) self-approval or -disapproval; and iv) approval or disapproval by significant others [52]. The first two categories address how the decision will affect the decision maker and others associated with him/her. Categories (iii) and (iv) explain how the decision will affect the decision maker's moral standards and self-image and the approval or disapproval of others who may be evaluating the decision maker. In the context of smoking, perceived benefits of smoking represent a gain, and perceived risks represent a loss, during research that explores beliefs about smoking-related risks and benefits [52].

Transtheoretical Model

The Transtheoretical Model (TTM) describes and explains how behavior change occurs over time and through a series of stages [53, 54]. The five basic stages of change include

- *precontemplation*, wherein the individual has no intention of performing the behavioral change within the next six months;
- *contemplation*, when the individual intends to perform the change within the next six months and he/she is aware of both pros and cons of change;
- *preparation*, when the individual makes a serious commitment to change and has a plan for action or has shown desire to change;
- *action*, which involves initiation of behavior change in the individual (smoking initiation); and
- *maintenance*, which demands sustaining change and achievement of predictable gains (social benefits of smoking).

Importantly, individuals are less likely to relapse when they feel change is beneficial. TTM is a construction of decisional balance (measuring pros and cons), self-efficacy and temptations (confidence in oneself), and processes of change (activities used to progress through the five stages).

METHODOLOGICAL CONSIDERATIONS

Study setting

The studies in this thesis were conducted in Jhaukhel and Duwakot Village Development Committee (VDC), located in the Bhaktapur district of Nepal (Figure 4). Both VDCs lie in the Mid Hills Region, 13 km east of Kathmandu, the capital city.

Figure 4. Map of Nepal showing the Bhaktapur district and the location of the health demographic surveillance site (HDSS) in Duwakot and Jhaukhel villages (insert).

The Jhaukhel-Duwakot Health Demographic Surveillance Site (JD-HDSS) was established in 2010 as a collaboration between University of Gothenburg and Nordic School of Public Health NHV, Sweden, and Kathmandu Medical College and Nepal Medical College, Nepal. JD-HDSS aimed to monitor demographic and health data in close proximity to community hospitals operated by the collaborative partners. The site symbolizes an urbanizing area that is rapidly becoming peri-urban, with all modern facilities.

After its establishment, JD-HDSS became a setting for different studies including community-based tobacco research. Other ongoing research in the JD-HDSS includes studies on cardiovascular health literacy, uterine prolapse, and

neonatal health. The objective of JD-HDSS was to (i) create and maintain a population and household register for planning health and other programs at local level; (ii) conduct continuous registration of vital events (birth, marriage, deaths, migration, and sickness); and (iii) provide an infrastructure for research and intervention.

Study design

This thesis employed both quantitative (Papers I - III) and qualitative (Paper IV) methods to identify factors associated with smoking initiation among adolescents.

First, a baseline survey was conducted to generate background variables and prepare a sampling frame for further studies (Paper I). A cross-sectional study helped identify the prevalence of smoking behavior in adolescents and examined risk factors associated with such behavior (Papers II and III).

In the qualitative study, Focus Group Discussions (FGDs) collected information from adolescents regarding their opinion on cigarette smoking (Paper IV). Importantly, FGDs facilitate group interaction, allow participants to talk freely in a non-threatening environment, and encourage different viewpoints [55].

Study population

The baseline survey included all household members living in JD-HDSS (Paper I). In the cross-sectional study, the study population comprised all 14- to 16-year-old adolescents living in JD-HDSS (Papers II and III). This age group constitutes the most vulnerable period and higher percentages of premature deaths occur among adults that are attributed to behavior patterns like smoking and sexual behavior that emerge in the middle adolescence period [6].

Sampling techniques and sample size

A census survey collected household information from JD-HDSS (Paper I). A proportionate stratified sampling technique was applied to select adolescents from each village (Papers II and III). The stratified sampling improved the representation of particular minority groups (groups having less number of units in population sex and age wise) within the population, prevent from oversampling of the respondents as well as make valid inferences from the sample to the population. The sampling frame, which included 909 adolescents, was obtained from the baseline census survey 2010 (Paper II). Out of 909 adolescents, 500 were randomly selected for this thesis. Using a sampling frame, 500 adolescents were selected in following three steps: (i) total adolescents population was divided into two groups according to area (Duwakot and Jhaukhel); (ii) further, area wise adolescents population were grouped by sex; (iii) sex of the adolescents was further classified into three age groups (14-, 15-, and 16-year-olds). Using a sampling fraction, the required number of adolescents was selected in each step (Paper II). Systematic sampling was used as it was assumed that the population units do not follow any pattern (say only smokers) to select the adolescents from each age group, for what the sampling interval was different for each group. For example, the sampling interval for each stratum was found to approximately 2. This method gives more precise result than simple random sampling and the sample is spread more evenly over the population.

During analysis, all missing cases and "I do not know" answers were excluded and final analysis was conducted for 352 respondents (Papers II and III).

Participant selection

In FGDs, participants were selected from schools due to ease of obtaining the cooperation of school authorities and accessing adolescents (Paper IV). At first, a list of secondary schools in the JD-HDSS was prepared. There were nine secondary schools of which seven were private and two were governmental schools. One private school was randomly selected from each village of JD-HDSS, while there was no need for random selection of a governmental school because there is only one school in each village. Two schools were selected from each VDC of which one was governmental. In total four schools were selected from JD-HDSS of which two were governmental. The moderators then visited the selected schools several times to establish contact with the school principals and concerned class-teachers.

The moderators randomly selected six students (three male and three female) of each grade using a lottery method and with the help of the teachers. This resulted in 9 participants in each FGD, which is within the recommended number of participants [55]. Nine participants for eight FGDs were selected for the study, i.e. a total of 72. One boy from a governmental school later refused to participate (Table 1). Participants were between 13 and 16 years old; 36 were females. Eight different castes were represented (Paper IV).

Table 1. The participants in the focus group discussions.

Age (Years)	Government School		Private School		Total
	Male	Female	Male	Female	
13	5	7	6	2	20
14	5	2	6	8	21
15	6	7	6	6	25
16	1	2	0	2	5
Total	17	18	18	18	71

Data collection

Supervised by a field coordinator and PhD students, trained enumerators conducted quantitative data collection via paper-and-pencil interviewing (Papers I–III). The baseline survey questionnaire (Paper I) was developed using the FilaBavi and DodaLab HDSS model applied in Viet Nam [56]. Socioeconomic status was defined by Kuppuswamy's socioeconomic status scale, modified to the Nepalese context [57] (Paper I). For the smoking study (Papers II and III), I developed a semi-structured questionnaire using GYTS 2007, The Teen Smoking Questionnaire, perceived risk and benefit items from Song et al. and Halpern-Felsher et al., and previous publications regarding tobacco use in Nepal [37, 38, 58-61]. The questionnaire was adapted to the Nepalese context and pre-tested in Changunarayan, a neighboring VDC; feedback was incorporated into the final study questionnaire prior to data collection. Before data collection, all enumerators received five days of training per study (Papers I–III). For the qualitative study, FGDs asked open-ended questions from a guide that was developed using relevant literature [6, 62].

Eight FGDs were conducted, asking open-ended questions from a FGD guide (Paper IV). The guide comprised questions concerning the adolescents' knowledge and norms of tobacco and smoking; potential health consequences; and strategies to prevent smoking. The guide was developed using relevant literature, health behavior theories [48, 51-54] and by consulting public health experts with experience in qualitative research. Prior to data-collection, the FGD guide was pre-tested with nine male students from grades 8-10 in a private school in an area quite similar to the study site. After pre-testing, some minor changes to the initial guide were made (Paper IV).

Two moderators conducted the FGDs. First author URA who had previously conducted community-based studies on smoking was the main moderator, while a public health graduate with previous experiences in qualitative studies primarily ensured that the FGD progressed smoothly. A note-

taker was responsible for tape-recording the discussions and taking notes (Paper IV).

At the beginning of each FGD, the note-taker gave each student a unique code to ensure anonymity. The note-taker then collected information on grade, age, and ethnicity of each student using the unique codes. Next, the moderators introduced ourselves and explained the purpose and procedures of the FGDs. Participants were especially encouraged to explain their views openly and in their own words. All students were furthermore asked to contribute to the discussions and to make room for each other [55] .

Separate FGDs were conducted for boys and girls to create an environment where the participants would feel comfortable with each other and feel free to express their opinions and experiences (Paper IV) [55]. The moderators asked probing questions whenever required to elicit responses from participants. The moderators also noted non-verbal communication and gestures during the FGD which could help deepen the understanding of the participants' views. Each FGD concluded with a "debriefing" in which the moderators summarized the most important information from the FGDs and the participants' reactions to the discussions (Paper IV).

The FGDs were conducted in the Nepali language and lasted about 90 minutes. Each FGD was conducted within school hours and in a separate classroom to maintain privacy. No teachers were present during the discussions. Lunch packs were provided to the participants after each FGD as well as stationary items at a value of NPR 200 ($2.22).

Study variables

Paper I gathered statistical information about household structure, family composition, socioeconomic status, types of family, fertility, mortality, morbidity, deaths, marriage, migration, smoking habits, and health service utilization.

Caste/ethnicity was defined according to the Government of Nepal [31]. JD-HDSS includes Brahmin, Chhetri, Thakuri, Magar, Tamang and Dalits (Paper I). These castes were further classified as upper caste groups (Brahmin, Chhetri, and Thakuri); relatively advantaged group (Newar); indigenous disadvantaged group (Magar and Tamang); and socioeconomically disadvantaged group (Dalit) (Papers II and III) [31].

Paper II used variables related to perceived risks and perceived benefits of smoking. We presented respondents with the following hypothetical scenario: "Imagine that you just began smoking. Sometimes you smoke alone and, if you smoke 2–3 cigarettes each day, sometimes you smoke with friends" [63]. Next, we asked respondents to estimate (0%–100%) the chances of experiencing smoking-related physical risks (lung cancer, heart disease, facial wrinkles, bad colds, bad cough, bad breath, trouble breathing); social risk (getting into trouble, smelling like an ashtray); social benefits (looking cool, feeling relaxed, becoming popular, feeling grown-up); and addiction risks (you can quit smoking cigarettes if you want to, and you will become addicted to cigarettes).Perception items were treated as explanatory variables.

Papers II and III explored susceptibility to smoking. Susceptibility to smoking was assessed using the algorithm of Pierce et al. [64]. First, I discuss the concept of smoking susceptibility: Most young children have never thought to smoke. However, during adolescence, they begin to think that they may try to smoke sometime in future. When they have the opportunity to smoke, they will not refuse as they rethink about acceptability of cigarettes and their consequences.

This leads adolescents to become more vulnerable to pro-tobacco influences. Thus, there is a cognitive shift from resistance to ambivalence which defines smoking susceptibility and strongly predicts experimentation with smoking. Therefore, susceptibility is an important construct in smoking research among adolescent as it is an early stage of cognitive change that ultimately results in experimentation with smoking and becoming an established smoker [64].

In Papers II and III, the adolescents who had not smoked cigarettes (even a few puffs) were defined as non-smoking adolescents. Further, non-smoking adolescents were categorized as susceptible to smoking if they failed to state a firm commitment not to smoke in the future or if offered a cigarette by a friend. Therefore, adolescents who responded with a negative response (definitely will not; never; and not at all) to questions including, "Will you try a cigarette (taking even just one puff) sometime in the next 6 months?", "If one of your best friends offers you a cigarette, do you smoke?", and "Do you think you will smoke cigarettes 5 years from now?" were identified as non-smoking and not susceptible to smoking. I treated susceptibility to smoking as the outcome variable.

Sociodemographic characteristics included age (14–15 years), sex, caste/ethnicity, education status, father's occupation, mother's occupation, literacy status of father/mother, household asset score, types of family, and pocket expenditures [31,37, 61, 65, 66]. The questionnaire also included academic performance in previous grades. I treated these characteristics as explanatory variables (Papers II and III).

To determine the household assets score (Paper III), enumerators asked eight questions related to household availability of a radio, bicycle, television, refrigerator, motorbike, washing machine, computer, and car at household as a proxy to measure respondents' economic status [26,37]. The score was lowest for radio (5) and highest for car (40). The total score was computed for each

respondent and then further divided into three categories: low (0–60), middle (61–120), and high (121–180) [37].

Environmental variables included parental smoking, sibling smoking, smoking habits of other family members (uncle, aunts, grandfather, grandmother, etc.); actor smoking; asked to bring cigarettes from shop; asked to light cigarettes; exposure to secondhand smoking; involvement in extracurricular activities (quiz, debate, etc.); going to concerts/picnics with friends; exposure to pro-tobacco advertisements; exposure to anti-smoking messages; and whether respondents had discussed harmful effects of tobacco smoking with family members [6, 67]. These items were also treated as explanatory variables.

Data management and analysis

Data was entered in EpiData version 3.1 and analyzed using SPSS version 17 and STATA Standard version 10 (Papers I-III). Both descriptive and inferential statistics were applied in data analyses. In descriptive statistics, number, percentage, mean, median, and IQR were computed and presented to describe characteristics of the data. In inferential statistics, simple and multivariable regression models were used to study the statistical association between the explanatory variables and outcome variables. Then, both unadjusted odds ratios (OR) and adjusted odds ratios (AOR) were reported with a 95% confidence interval (CI). Chi-square test was applied to compare the proportion between different categories. Significance was set at $\alpha = 0.05$ for all tests (Papers I–III).

Factor analysis using principal component analysis with varimax rotation was performed to summarize data set dimension (perceived risks and perceived benefits items) into a few meaningful factors or categories [68, 69] (Paper II). Next, the factor scores for each individual were computed by summing raw scores (chance estimate: 0%–100%) corresponding to all items loading on a factor [68]. Next, the average scores were computed and converted into quartile

scores (coded as 0 for first quartile and 3 for fourth quartile) for ease of interpretation and discussion [68, 69]. Quartile scores were treated as independent variables and smoking susceptibility was treated as a dependent variable (Paper II).

A cumulative risk score (Paper III) was computed to explain the relationship between exposure to number risk factors and smoking susceptibility [70]. The greater the number of risk factors, the more likely an individual will be susceptible to smoking [71]. A cumulative risk score was computed for each respondent by totaling the number of dichotomized risk factors obtained from the multivariable logistic regression. After assigning each risk factor a 0 (absence of risk) or a 1 (presence of risk), I created a risk index by aggregating the risks [71]. A cumulative risk score ranged between 0 and 4; only a few respondents scored 0 (Paper III). A cumulative risk score was used to predict the outcome of interest (smoking susceptibility). Thus, univariate logistic regression was applied to measure association between a cumulative risk index and smoking susceptibility (Paper III).

An experienced translator transcribed data verbatim and subsequently translated them into English (Paper IV). The audio tapes, the notes and the transcriptions were reviewed and discussed several times among the moderators and the note-taker. All translated data were imported into OpenCode 3.6.2.0 software to facilitate the coding procedure [72].

Manifest qualitative content analysis (Paper IV) as described by Graneheim and Lundman [73] was applied and included the following steps: i) The text was read several times to gain an overall view of the content; ii) Words and sentences describing a central meaning (meaning unit) were identified; iii) The meaning units were condensed without changing the original meaning; iv) The condensed meaning units were labeled with a code stating their contents; v) Categories including a number of sub-categories consisting of groups of codes with a similar content were created. An example of the analysis process is given

in Table 2. The results were regularly discussed during the analysis. Quotations from the FGDs are likewise shown to facilitate the evaluation of the credibility of the findings (Paper IV).

Table 2. An example of the data analysis process using qualitative content analysis.

Meaning unit	Condensed meaning unit	Code	Subcategory	Category
I heard those people who smoke cigarettes have risk of getting heart disease	Smokers can have heart disease	Heart disease	Consequences of smoking	Knowledge about smoking

Ethical considerations

The plan for establishing an HDSS (Paper I) and conducting a smoking study (Papers II and III) was discussed with local authorities, health workers, the district public health office (Paper I), and political leaders. Enumerators explained the objectives of the study to each respondent and told them their participation was voluntary. Enumerators obtained verbal consent from the respondents before collecting data (Papers I - III). Informed verbal consent was obtained from the parents of participating adolescents because they were under 18 years of age (Papers II and III). Before obtaining parental approval, enumerators explained the importance of tobacco research in the community and confidentiality of the data. Permission was also sought from the principals of the schools before students were approached for FGDs (Paper IV). Additionally, permission was obtained from participants for recording the interview by audiotape and notes (Paper IV). During the interview, the respondents/participants could terminate the study at any time and skip any question they did not want to answer (Papers I–IV). Each interview/FGD was conducted in a separate setting and without witnesses (Papers I–IV). At the end of the study, each participant received a leaflet containing anti-smoking messages (Papers II and III). Negative consequences of smoking were discussed

with the participants at the end of each FGD (Paper IV). Participants' information was encrypted and accessible only by the research team. During the study period, participants who required medical care received discounted hospital services at either Kathmandu Medical College or Nepal Medical College. The Nepal Health Research Council and the Institutional Review Board of Kathmandu Medical College granted ethical approval to conduct these studies.

DESCRIPTION OF THE PAPERS

Table 3 shows an overview of four papers, including study design, sample size, data source, study population, main outcome, and analysis.

Table 3.Overview of the designs of the four papers included in the thesis.

Paper	Study design	Participants/ data source	Study population	Study year	Main outcome measure	Analyses
I	Quantitative study (census)	2,717/ household surveys	All individuals living in JD-HDSS	2010	Demographic characteristics, health status, smoking behavior of adult population	Percentage, mean, standard deviation, unadjusted and adjusted odds ratio
II	Quantitative study (cross-sectional survey)	352/face-to-face interview	Adolescents (14-16 years) living in JD-HDSS	2011	Perceived risks and benefits of cigarette smoking	Percentage, principal component analysis, unadjusted and adjusted odds ratio
III	Quantitative study (cross-sectional survey)	352/face-to-face interview	Adolescents (14-16 years) living in JD-HDSS	2011	Sociodemographic characteristics, environmental factors	Percentage, unadjusted and adjusted odds ratio
IV	Qualitative study	71/focus group discussion	Adolescent students (13-16 years)	2013	knowledge and norms of tobacco and smoking, potential health consequences and strategies to prevent smoking	Manifest Content analysis

RESULTS

Paper I: Establishing a health demographic surveillance site in Bhaktapur district, Nepal: initial experiences and findings

Paper I describes preliminary experiences of establishing an HDSS in Nepal as well as findings of the baseline survey conducted during October–December 2010. The establishment of JD-HDSS aimed to collect baseline data on sociodemographic and vital events; identify prevalent health problems, including NCDs; and provide appropriate sampling frames for future studies.

JD-HDSS comprises 2,712 households (1,155 in Jhaukhel and 1,557 in Duwakot) and 13,669 individuals (6,057 in Jhaukhel and 7,612 in Duwakot). The study population includes nearly 5% of the total population of Bhaktapur district. The median age of the population was 27 years for both males and females. Twenty percent of the population was adolescents (10–19 years of age), of which 49.5 % was female. Eighteen percent of individuals older than 6 years of age were illiterate and 75% of them were female. The crude birth and death rates were 9.7 and 3.9 per 1,000 population/year, respectively. NCDs including hypertension, diabetes mellitus, and cancer are major causes of death. The survey did not reveal any cases of infant and under-five mortality.

Nearly 15% of people older than 18 years were current smokers (n = 9,386). One in 5 males and 1 in 10 females smoked cigarettes. More than 10% of people reported being ill during the four weeks immediately preceding the survey. The most common causes of illness were respiratory problems, followed by heart disease, hypertension, and gastric ailments (Figure 5). The NCD prevalence for the age group older than 30 years (n = 5,448) was 4.3% (95% CI: 3.83-4.46). Nearly 30% of adults older than 30 years were smokers; of which 34.8% had NCDs. Nearly 25% of ill individuals visited a traditional healer.

Dental problems	1.1
Diabetes mellitus	2.6
Skin problems	2.9
Accidents and injuries	2.9
Heart diseases, including hypertension	8.8
Gastrointestinal problems	13.9
Bone and joint pain	14.4
Headache, vertigo, and dizziness	16.7
Fever	41.1
Respiratory diseases	41.9
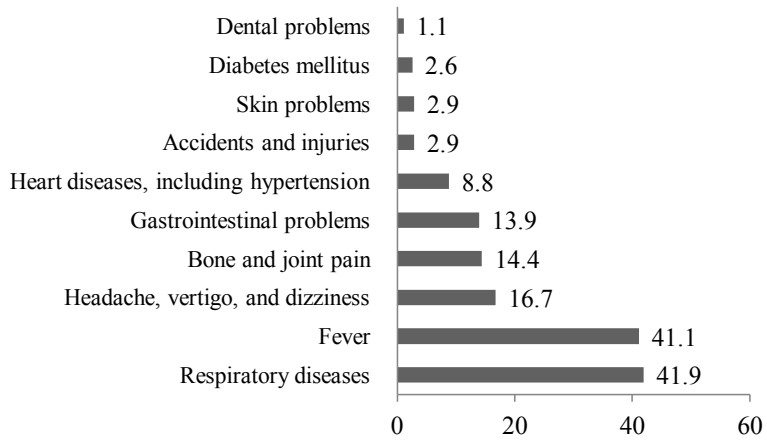
Figure 5. Top ten morbidities reported in JD-HDSS, Bhaktapur district.

Papers II and III: Psychosocial factors related to smoking susceptibility

Papers II and III examined the association between susceptibility to smoking and psychosocial factors associated with smoking among adolescents in JD-HDSS aged 14–16 years. I selected these age groups because they are vulnerable to initiating cigarette smoking. Paper II described the association between susceptibility to smoking and personal factors (i.e., perceived risks and benefits of smoking), and Paper III described sociodemographic and environmental factors associated with susceptibility to smoking.

Sociodemographic characteristics

Among 352 respondents (Papers II and III), 54.3% were male and 7 in 10 were 14–15 years of age. A majority of respondents belonged to the upper class group (55.7%), followed by the relatively advantaged group (37.8%), relatively disadvantaged group (4.0%), and socioeconomically disadvantaged group (2.6%) (Paper III). Eight in 10 respondents lived in a nuclear family and 97.4% were Hindus. Nearly 42% of the respondents' fathers were service-holders (who works in government/private offices), 29.27 % were farmers and 26.76% worked in business; the remaining fathers were either retired or unemployed. A

majority (63.81%) of the respondents' mothers were housewives. Two thirds of the respondents were studying at the secondary level, one fifth were at higher secondary level, and the remaining students were at the lower-secondary level. Based on the household assets score, 65% of respondents belonged to the lower class, followed by 33.5% in the middle class, and 1.5 % in the upper class (Paper III). The monthly median pocket expenditure of respondents was NPR 600 ($7.50) and the IQR was NPR 400–900 ($5.00–$11.25) (Paper III).

Measures of smoking susceptibility

The percentage of smoking susceptibility was 49.70% (95% CI: 44.49-54.93) (Paper III). Figure 6 shows information related to three items of smoking susceptibility. Among them, 21.9% intended to smoke (i.e., will smoke in the next 6 months), 34.5 % would not like to refuse to smoke if their friend offered them a cigarette, and 43.2% would like to smoke in the next 5 years.

Descriptive statistics: perceived risks and benefits of smoking

Before fitting the regression model (Paper II), I used principal component analysis (PCA) with varimax rotation to confirm how well the 13 risks and benefits items loaded on their respective categories. Based on the factor scores, PCA reduced these 13 items into 4 meaningful factors. Factors I and II contain items related to perceived likelihood of physical risks, factor III relates to perceived likelihood of social risks, and factor IV relates to perceived likelihood of social benefits.
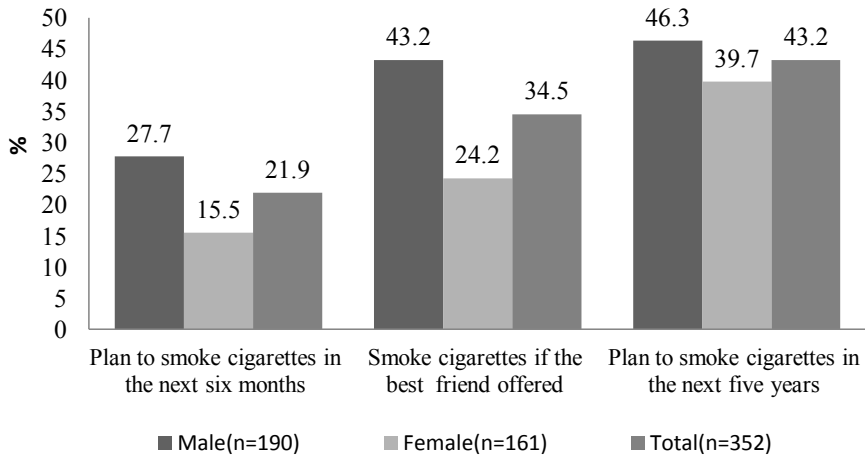
Figure 6. Sex-wise distribution of three items that measure smoking susceptibility in adolescents.

Further, physical risks are categorized as physical risk I and physical risk II because the short-term risk item (i.e., bad cold) is listed in factor I and the other three items (i.e., lung cancer, heart diseases, and facial wrinkles) associate with long-term risks [60, 63]. Perceived physical risk I includes items describing physical problems caused by habitual smoking (i.e., long-term risks and bad cold). Perceived physical risk II comprises items describing short-term risks of smoking (i.e., bad cough, bad breath, and trouble breathing) [60, 63]. Perceived social risks included "getting into trouble" and "smelling like an ashtray" [57]. Perceived social benefits included "looking cool," "feeling relaxed," and "becoming popular and feeling grown-up" [57].

Figure 7 shows chance estimates (0%–100%) for smoking-related long-term risks including bad colds (physical risk I), short-term risks (physical risk II), addiction risks, and social benefits, as reported by the respondents (Paper II). Based on median score, 50% of adolescents believed that there was a 78% chance (IQR: 58%–85%) of physical risk I if they smoked cigarettes. Similarly, for physical risk II (i.e., social risks, addiction risks, and social benefits) the

median was 82% (IQR: 80%–97%), 90% (70%–98%), 63% (55%–80%), and 25% (19%–35%), respectively (Paper II).
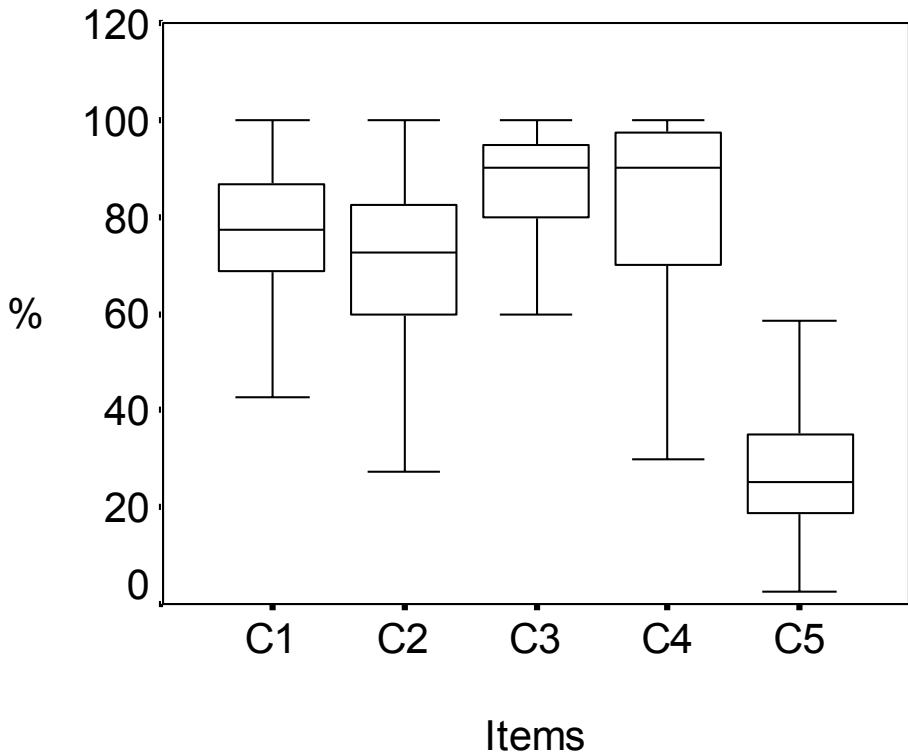
Figure 7. Perceptions of smoking-related risks and benefits among adolescents (14-16 years old) at JD-HDSS. Each box plot consists of minimum chance estimates (%), first quartile chance estimates (%), median chance estimates (%), third quartile chance estimates (%), and maximum chance estimates (%).C1=perceived score for physical risk I (lung cancer, heart disease, wrinkles, and bad colds); C2=perceived score for physical risk II (short-term risks); C3=perceived score for social risks of smoking; C4=perceived score for addiction risks; and C5=perceived score for social benefits of smoking.

Sociodemographic and environmental factors and smoking susceptibility

Table 4 describes the percentage distribution of smoking susceptibility according to sociodemographic and environmental factors (Paper III). More than 50% of adolescents who were exposed to different environmental factors were susceptible to smoking. Males had significantly higher rates of smoking susceptibility than females ($\chi 2$ =4.62, *p*=0.03). Discussion about harmful effects of smoking within the family associated with smoking susceptibility ($\chi 2$ =18.12, *p*<0.001).

Table 4. Demographic and environmental factors and smoking susceptibility among adolescents (14–16 years of age).

Variable	Number	Susceptible to smoking (%)
Male	191	54.97
Female	161	43.47
Parents smoke	211	51.7
Sibling smokes	40	57.5
Other family members/relatives smoke	197	55.3
Friend smokes	112	67.0
Teacher smokes	74	74.3
Exposure to secondhand smoke	294	52.4
Participation in concerts/picnics with friends	267	56.18
Exposure to pro-tobacco advertisements	230	56.52
Seen actors smoking in movies or on TV	235	54.04
Did not discuss the harmful effects of smoking in families	116	66.37

Table 5 and 6 describes predictors of smoking susceptibility based on multiple logistic regressions (Papers II and III). Susceptibility to smoking was significantly less likely when adolescents believed that short-term health consequences (physical risk II) would occur due to smoking (Paper II). Adolescents were more likely to initiate smoking if they believed no addiction risk occurred and also if they believed that smoking was beneficial (Paper II). Perception of physical risk I did not predict smoking susceptibility (Paper II).

Table 5. Predictors of smoking susceptibility among adolescents, personal factor.

Perceived risks and benefits of smoking[#]	AOR (95% CI)
Physical risk I (smoking-related long-term risks and bad colds)	1.20 (0.97–1.49)
Physical risk II (smoking-related short-term risks)	0.63 (0.50–0.77)
Smoking-related addiction risk	1.34 (1.08–1.65)
Smoking-related social risks	0.95 (0.77–1.15)
Smoking-related social benefits	1.42 (1.14–1.76)

[#] *AOR represents a full model including all five independent factors simultaneously. A 95% CI that does not include 1 is significant at $P < 0.05$. Perceptions were treated as an independent variable, and susceptibility to smoking was treated as a dependent variable. Unit correspond to quartiles coded as $0=1^{st}$ quartile and $3=4^{th}$ quartile.*

In table 6, the odds for smoking susceptibility were nearly 2.5 times higher among adolescents who were exposed to pro-tobacco advertisements (Paper III). Exposure to teacher smoking and participation in concerts/picnics increased the odds more than twofold. Likewise, the smoking behavior of family members/relatives increased smoking susceptibility nearly twofold (Paper III). The proportion of smoking susceptibility increased from 29% to 83% when the number of risk factors increased from 0 to 4. If adolescents were exposed to all

four risk factors, susceptibility to smoking increased 12 times compared to those exposed to fewer than two risk factors (OR=12; 95% CI: 3.69-44.70). Likewise, smoking susceptibility increased 2.50 (95% CI: 2.47-10.22) and 5.0 (95% CI: 1.26-4.99) times in respondents who were exposed to two and three risk factors, respectively (Paper III).

Table 6. Predictors of smoking susceptibility among adolescents environmental factors.

Environmental factors	AOR (95% CI)
Exposed to pro-tobacco advertisements	
No	Reference
Yes	2.49 (1.46-4.24)
Exposed to teacher smoking	
No	Reference
Yes	2.45 (1.28-4.68)
Participation in concerts/picnics with friends	
Never	Reference
Sometimes/most of the time	2.14 (1.13-4.04)
Other family members/relatives smoke cigarettes	
No	Reference
Yes	1.76 (1.05-2.95)

Figure 8 illustrates exposure to cumulative risk factors in adolescents (Paper III). The proportion of smoking susceptibility increased from 29% to 83% when risk factors increased from 0 to 4. Moreover, susceptibility to smoking increased 12 times in adolescents who were exposed to all four risk factors compared to those exposed to less than two risk factors (OR=12; 95% CI: 3.69-44.70).

Likewise, smoking susceptibility increased 2.50 times in respondents who were exposed to two risk factors (OR =2.5; 95% CI: 1.26-4.99). Compared to adolescents who were exposed to fewer than two risk factors, susceptibility to smoking increased fivefold when adolescents were exposed to three risk factors (OR=5; 95% CI: 2.47-10.22) (Paper III).
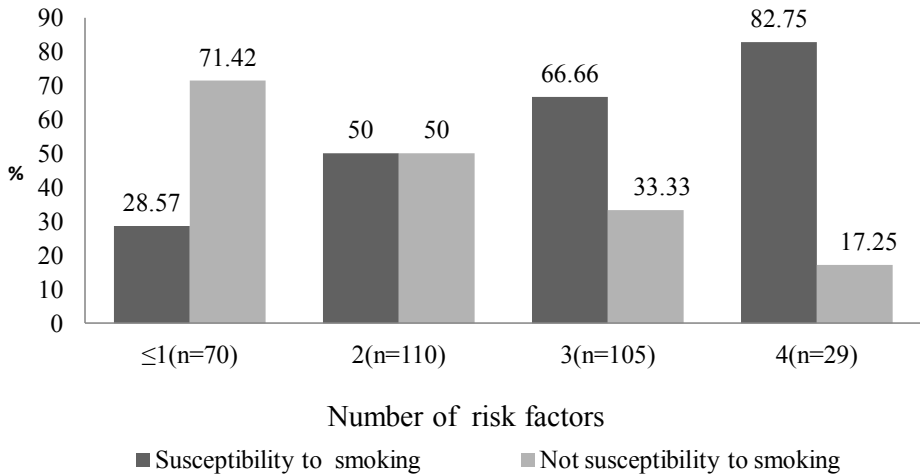
Figure 8: Percentage distribution of cumulative risk factors among adolescents. The variables which were significant in multivariable analysis were included to compute cumulative risk scores. There were mainly four variables, i.e. exposure to pro-tobacco advertisements, teachers smoke, participants in concerts/picnics with friends and other family members/relatives smoke cigarettes, were risk factors for smoking susceptibility. All these risk factors were dichotomous (respondents were either exposed or not to a particular risk factor). If they were exposed to particular risk, they obtained score 1, otherwise 0. Then, the obtained scores were summed and a cumulative risk index computed. The minimum risk score was 0 and maximum was 4.

Paper IV: Adolescents' opinions about cigarette smoking: a qualitative study of adolescent students in the Jhaukhel-Duwakot health demographic surveillance site, Bhaktapur district, Nepal

Paper IV described the findings of qualitative research obtained through FGDs. This paper aimed to explore several factors that might influence smoking initiation among adolescents.

The findings are presented in three categories covering the main themes of the study (Table 7). Each category includes two or three subcategories respectively.

Table 7. The result of the analysis.

Categories	Subcategories
Knowledge about smoking	Identification of tobacco products
	Consequences of smoking
Smoking influencing norms	Reasons for smoking initiation
	Smoking behaviors
Strategies to discourage smoking	Refusal skills
	Prevention strategies
	Policies

Knowledge about smoking

Identification of tobacco products

The participants had seen tobacco products and were familiar with the names of various products available. They also reported that they were easy to access. The participants mentioned the following products as "tobacco products": cigarettes, chewing tobacco, and Hookah (water pipe), as well as marijuana and opium. Even though the participants knew the name of tobacco products, they had difficulties differentiating between different types of products such as smoking

and smokeless products, unless probing questions were asked. The participants recognized that tobacco products are harmful to health. They explained this as due to the fact that tobacco contains chemicals that are likely to cause health hazards.

Consequences of smoking

The participants described two kinds of negative consequences of smoking: health related and financial.

Some participants were aware of short-term health consequences of smoking such as coughing, bad breath, dizziness, and headache. They also identified blackened teeth and lips, yellow nails, gum swelling, and eye redness as short-term effects of smoking. A 15-year old boy of a government school in grade 9 said:

My father smokes for many years, so his teeth are black.

The participants knew that cigarette smoking can cause lung and oral cancer, heart diseases, tuberculosis, asthma and ulcers of the mouth and stomach. A 15- year old boy of a private school in grade 9 said:

My father smokes so he has chance of having lung cancer. It is because he is suffering from asthma. His condition exacerbates more in the winter.

The participants also knew that smoking might have an effect on life expectancy. They agreed that smoking may reduce the lifespan of the people; but none was able to mention the amount of life years lost due to smoking. The addictive nature of smoking was not clearly expressed by the participants, except by a 16-year old girl in grade 10 of a governmental school who explained her experiences in the following way:

My brother started to smoke when he was in grade six and [became] addicted to cigarettes. When I told him to quit with cigarettes, he told, 'Sister, I can quit family and house but I cannot quit smoking''.

The participants were aware that there may be financial losses as a result of smoking cigarettes and that this could affect both the smokers and their family members. They agreed that *smoking is a waste of money*, and further explained that smokers may risk loss of property due to expensive treatment if they become ill due to smoking-related diseases. Some of the participating girls mentioned family members who had to spend many hours with sick persons (smokers) and thereby lost their income.

Smoking influencing norms

Reasons for smoking initiation

Most participants related smoking initiation to the influence of socio-environmental factors. They mentioned peer pressure, influence of seniors, family tensions, discourteous behavior of teachers, feasts and festivals (Holi and Shiva Ratri), parties, and people such as parents, brothers, relatives, friends, and teachers smoking around them as reasons for beginning to smoke. A 14-year-old boy in grade 8 of a private school said:

All of my friends smoke. I do not want to be the odd man out. Therefore, I smoke.

The participants had the opinion that curiosity, the wish to attract a girl, and tragic love stories contributed to smoking initiation. They also said that age (i.e. age of experimentation) is one of the reasons for smoking initiation. A 15-year-old boy in grade 8 of a private school expressed:

What if you don't enjoy this short life? Therefore, my friend smokes cigarettes and asks me to smoke.

Participants reported that adolescents start smoking at 14–17 years of age. The participants mentioned both poor and good academic performances as reasons for smoking. Those with poor academic performance smoke to relieve tension, whereas those with good academic performance smoke to share happiness.

Smoking behaviors

The participants reported that their friends were smokers, and that more boys than girls were smoking. When asked about caste-wise smoking behaviors, most participants said that members of all ethnic groups were smoking but that they had noticed that smoking was more common among Newar, Tamang, and Chhetri adolescents.

Participants further said that adolescents commonly smoke at the cinema, in the forest area, in the café or pool house, in the area behind the temple, and at a friend's house when parents are not at home. Most agreed that adolescent girls rarely smoke in public places. A 13-year-old girl in grade 8 of a governmental school said:

> *I have seen boys smoke cigarettes and mixing marijuana, sitting in a circle on a big lawn. Their behaviors are totally different from normal [adolescent] smokers.*

Strategies to discourage smoking

Refusal skills

The participants expressed confidence that they would be able to resist peer pressure and refuse to smoke if their friends began smoking. Some girls expressed that they would end a friendship if that friend offered them a cigarette while other boys and girls from both private and a governmental school said that they would probably smoke cigarettes if their friends offered them. Some participants from private schools said that they would stay away from smoking and they would tell their friends about the negative consequences of smoking. A 15-year-old boy in grade 9 of a government school said:

> *My uncle was a chain smoker and liked to stay alone at home. He used to express anger and quarreled with family members. No one liked him. Later, he quit smoking and became a prestigious businessman in the village. Now,*

he promotes us not to smoke cigarettes by sharing his bad experiences of smoking.

Most participants said they would be embarrassed to ask someone not to smoke but also said that it is easier to ask their parents and other family members not to smoke than older students and people outside the family. Some girls shared negative reactions from smokers. A 15-year-old girl in grade 10 of a private school said:

When I was travelling in a bus, there were only few passengers. So, the driver stopped the bus at the bus stop to have more passengers [and] *then he started to smoke a cigarette inside the bus. I was irritated by the smell of smoking,* [so]*I told the driver not to smoke. He reacted angrily, saying "Who are you to say. If you do not like it, you can change the bus".*

Prevention strategies

The participants agreed that schools should have strict rules about smoking and fine students who smoked near the school. They also said that both sale of cigarettes and smoking close to school premises should be restricted. When probed about the area of restriction, participants suggested 200–1000 m. They also suggested that there should be anti-smoking messages like posters in the school periphery and that schools should offer health education to students, teachers, and other staff at the school. Some had the opinion that schools should provide counseling to students who smoke.

Some boys and girls agreed that physical punishment should be given to students who smoked and that parents should be alerted about their children's behavior. A 13-year-old girl in grade 8 of a governmental school said:

Some students bring cigarettes in the school bag. The school bag of the students should be checked frequently in the classroom. If cigarettes are found in their bag, the students should be punished by a fine.

After probing, some participants opposed to having a smoking zone near the school because secondhand smoke affects them.

Policies

The participants agreed that the government should implement the existing Tobacco Control and Regulatory Act in a more strict way. Participants were also aware that the government had restricted smoking in public places and stated that smokers who smoked in public places should be fined. A 14-year-old boy in grade 9 at a private school shared the following thought:

> *There is a warning written in small font size on the package of cigarettes. None of the people notices it and they smoke cigarettes. I think it should be written in a big font size.*

The participants further suggested that pro-tobacco advertisements should be completely banned in public places and that the sale of tobacco products to adolescents and children should be banned as well. Likewise, some had the opinion that there should be heavy taxes on tobacco products, just as others said that tobacco industries should be closed and replaced by other industries.

DISCUSSION

This thesis aims primarily to understand the epidemiology of tobacco smoking among adolescents living in a peri-urban of Nepal. The thesis is divided into three sections: (i) establishing an HDSS in a peri-urban area near Kathmandu, the capital city of Nepal (Paper I); (ii) identifying psychosocial risk factors associated with smoking susceptibility among adolescents living in JD-HDSS (Papers II and III); and (iii) exploring adolescents' views on cigarette smoking and prevention strategies (Paper IV).

This thesis provides the first community-based, quantitative (Papers II and III) and school-based qualitative (Paper IV) studies that measure the relationship between psychosocial factors and smoking initiation among adolescents in Nepal. The results of my research reveal several findings regarding risk factors and smoking susceptibility, and also provide direction on designing effective preventive programs to control smoking in adolescents.

Challenges and ways for sustainability of HDSS

Although HDSS research projects provide several advantages, I encountered many administrative, geographical, social, and political challenges during the establishment of JD-HDSS (Paper I).

Community residents always have high expectations when programs are launched in their community. During the establishment of the Kaya HDSS in 2007, community members thought that the baseline survey would distribute plots of land [74], largely due to lack of awareness about the community activities of an HDSS. This misunderstanding emphasizes the need to involve local leaders in awareness campaigns that explain the purpose and objectives of HDSS.

Long-term funding presents another challenge for HDSS continuation. Practically, it is not possible to obtain long-term funding from current collaborative partners of HDSS. The necessity of generating funding, both

locally and from the government, is very in low- and middle-income countries, where local people and government authorities frequently do not understand importance of HDSS. Thus, INDEPTH Network is praiseworthy because it provides both financial and technical support for its members [75] and also helps strengthen HDSS.

Another challenge involves ethical issues dealing with the quality of data and publications that provide greater visibility for the study site [74, 76]. Due to cultural barriers, local people are not always willing to fully share information about their daily lives (e.g., sexual activities, smoking, and alcohol intake) [74]. Thus, ensuring and maintaining data confidentiality is essential.

Despite these challenges, selecting an HDSS area for this thesis was appropriate because HDSSs have always been tailored to local needs. For example, the HDSS in western Kenya began as a field study site for testing the effectiveness of insecticide-treated nets [77]. Additionally, HDSSs have been used for epidemiological studies, mainly to study the clustering of NCD risk factors [78]. Because Jhaukhel and Duwakot are currently undergoing rapid sociodevelopmental transition, JD-HDSS is optimal in terms of its current focus on urbanization and NCDs risk factors. This opened the possibility of conducting tobacco research at the JD-HDSS to prevent and control NCD.

Major findings: predictors of smoking susceptibility

Characteristics of smoking susceptibility

This thesis explores how and why adolescents become susceptible to smoking. Previous researchers have determined that smoking susceptibility is an important precursor of smoking behavior among adolescents [64, 79]. Smoking susceptibility is a major outcome of this thesis. Indeed, susceptibility occurs early in the sequence of cognitive changes that eventually result in experimentation with smoking and tobacco addiction [64, 80, 81]. Therefore, susceptibility is an identifiable risk factor in adolescents before smoking

behavior actually occurs. Susceptible adolescents are distinct from non-susceptible, non-smoking adolescents in their knowledge, attitude, and beliefs about cigarette smoking [80]. Several other factors associate with smoking susceptibility among adolescents and therefore the validity of smoking susceptibility should be further explored through follow up studies.

Perceived risks of smoking as a predictor of smoking susceptibility

In this thesis, adolescents knew about the long-term health risk of smoking but were less knowledgeable about its short-term health, social, and addictive risks (Papers II–IV). In reducing and preventing smoking in adolescents, knowledge of short-term risks (e.g., bad cough, and trouble breathing) supersedes knowledge of long-term risks [60]. Furthermore, awareness of social risks plays an important role in adolescents' decision to smoke [60].

The perceived addiction risks of smoking positively and significantly associate with susceptibility to smoking (Paper II). A US study argues that adolescents generally know the long-term health consequences of smoking but are less aware of its addictive nature [6, 60].

Perceived benefits of smoking as a predictor of smoking susceptibility

This thesis reveals that susceptible adolescents perceive higher benefits of smoking than non-susceptible adolescents (Paper II). A follow-up study shows that adolescents who believe smoking is beneficial are more likely to initiate smoking than those who believe such benefits do not exist [60, 63]. An earlier study reported that adolescents choose to smoke to impress others, look cool, or avoid getting into trouble, even when they know the potential for physical harm [60].

Pro-tobacco and anti-tobacco messages as a predictor of smoking susceptibility

In Papers II–IV, adolescents were exposed to both pro- and anti-tobacco messages. Pro-tobacco advertising was the strongest risk factor for smoking susceptibility (Paper III). Promotional activities of tobacco companies frequently target adolescents and youth, thereby contributing to the increased incidence of smoking initiation [82]. Although the Government of Nepal has banned tobacco advertisements in public places since 1998, ineffective implementation of tobacco control policies means that adolescents are continuously exposed to tobacco advertisements [43]. A recent national survey shows higher prevalence of tobacco use among those with low socio-economic status and illiteracy as well as among males [26]. The easily availability of tobacco products and cultural practices (i.e., use of smokeless tobacco products in social gatherings) could be major reasons for such higher prevalence of tobacco use. These are likely contributing factors for the ineffectiveness of tobacco control programs in Nepal as these tobacco products are "socially acceptable".

Surprisingly anti-smoking messages and curricula positively associated with smoking susceptibility (Paper III), and a longitudinal study shows that an anti-tobacco campaign alone is unlikely to counteract the effect of exposure to pro-tobacco media [83]. Further, ineffective anti-smoking messages may increase awareness and interest in tobacco use among non-smoking adolescents, thereby increasing their susceptibility to smoking [79].

Teacher smoking as a predictor of smoking susceptibility

Teacher smoking is viewed as a barrier to the introduction of prevention programs [84]. This thesis demonstrated that teacher smoking causes smoking initiation among adolescents (Papers III and IV). Teachers play a dual role when they exhibit anti-smoking attitudes at school but smoke openly in the community [17]. Thus, increasing adolescents' awareness of the harmful effects

of smoking among teachers and reducing prevalence for smoking might be effective in preventing smoking initiation among adolescents [84].

Family members smoking as a predictor of smoking susceptibility

In this thesis, most adolescents said they were exposed to smoking within their family environment (Papers III and IV). Such exposure influences adolescents' decision to initiate smoking. Paper III reveals a significant positive association between familialism (i.e., normative and behavioral influences of family members) and smoking susceptibility. Further, the rate of smoking initiation was highest in adolescents whose family members and best friends smoked [64]. Therefore, smoking restriction at home and other places might reduce smoking initiation among adolescents [85].

Effectiveness of health promotion to prevent smoking

This thesis increases understanding of smoking initiation in adolescents, and highlights the effectiveness of different health promotion theories in a Nepalese community (Papers II–IV). The evidence presented here will assist stakeholders and policy makers as they design intervention programs at local settings. Further, this thesis highlights the important role of local data in implicating effective health promotion interventions in a peri-urban setting in Nepal.

In a sociocultural context, it is possible to generate local data at many levels [86]. Four hierarchies of tobacco research aid understanding of the complex behavior of smoking at local level (Figure 9) [87]. The four hierarchies include (i) the micro level, which mainly involves environmental factors like family and friend smoking; (ii) the mezzo level, exemplified by smoke-free environments; (iii) the macro level, which involves policies of the tobacco industry; and (iv) the global level, which deals with the FCTC and globalization [87]. The framework of a multi-level, multi-dimensional approach (social norms of smoking and tobacco advertising etc) provides opportunities to understand smoking behaviors in a sociocultural context [86].
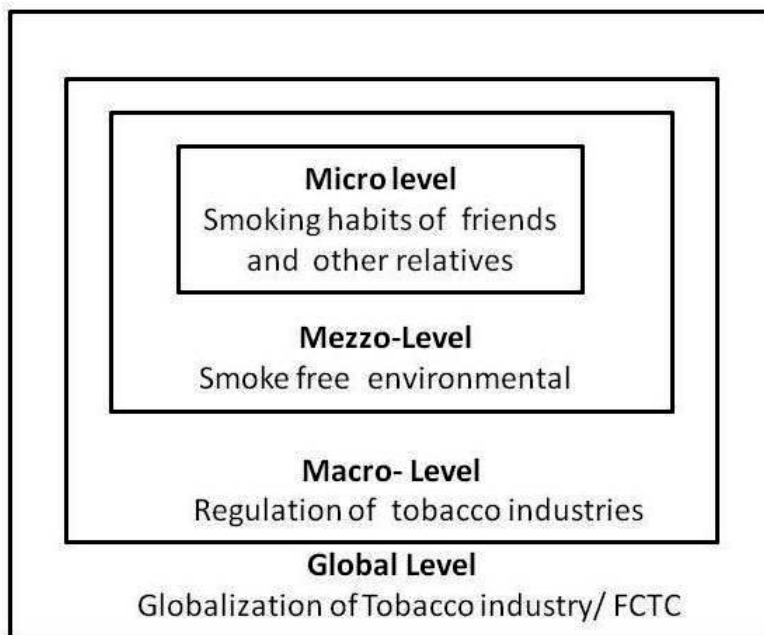
Figure 9.Hierarchies for tobacco control research [87].

Because the cultural context of developing countries like Nepal differs from that of developed countries, planning for the implementation of an intervention program requires local data. An intervention model adopted directly from developed countries can be inadequate and sometimes even misleading [88, 89]. Adopted models require contextual translation and utilization of locally available successful models [89].

Next, the evidence-based approach to tobacco control is particularly relevant to societies with limited resources for tobacco research [88]. Credible tobacco research in a local setting provides answers to specific local questions that are suited to the local environment and culture [88]. Knowledge generated in developing countries can also be relevant to the immigrant population in developed countries. For example, worldwide emergence of waterpipe smoking and the export of bidis from India are emerging public health issues in developed countries. These issues are difficult to evaluate fully within

developed countries [88]. Translating evidence into local and national policies requires continuous and strategic advocacy with stakeholders and media [89].

Mobilizing Youth for Tobacco-Related Initiatives in India (Project MYTRI) is an example of a successful school- and evidence-based intervention [90]. The project has reduced tobacco use over time, particularly cigarette smoking and bidi smoking, among adolescents in Delhi and Chennai. Project MYTRI provides evidence that a multi-component school-based program can be effective in reducing smoking prevalence in India and other developing countries [90]. Finally, the example of Project MYTRI can guide all stakeholders and policy makers as they work to implement a successful intervention program in Nepal.

Public health approaches to controlling tobacco smoking

Many countries enjoy strong public support for discouraging smoking initiation among adolescents [91]. Five widely used approaches to curb smoking include counter-advertising campaigns, targeted excise taxes, increased enforcement of regulations and acts, prohibiting the sale of cigarettes to minors, and school health programs [91].

Aiming to eliminate tobacco use, researchers and policy makers have proposed new endgame ideas for over a decade [92, 93]. Endgame strategies, particularly restrictions on sales and reducing the nicotine content of tobacco products, may be useful for many countries, [92, 93]. In Finland, the new Tobacco Act targets to end smoking initiation by children and adolescents [94], and the Government of Bhutan restricted the sale of tobacco in 2004 [95]; India has successfully banned the manufacture, sale, and use of gutkha and pan masala, thus reducing tobacco-related oral and oropharyngeal cancer [96]. The US government envisions a society that is free of tobacco-related death and diseases, and aims to reduce smoking prevalence by 2020 [97]. Koh et al. suggested that implementation often requires changes in social norms [98].

Thomson et al. reports that a tobacco endgame might be successful if it (i) targets zero or near zero prevalence of tobacco use, (ii) imposes a complete ban on the sale of tobacco, (iii) fully denormalizes tobacco use in society, and (iv) completely eliminates children's exposure to tobacco [92]. The same group suggested that the real endgame of tobacco strategies must require governments to state an end-target date within a maximum of 20 years and explore an explicit plan to achieve near zero prevalence of tobacco use. Likewise, non-tobacco nicotine should be available to tobacco users because such availability involves political and ethical issues. The endgame of tobacco control also requires international commitment. Such commitment will improve the balance of factors for endgames by strengthening the FCTC [92]. Thus, the Government of Nepal must have clear goals, plans, and timetables as well as a strong commitment to end tobacco use [92].

Methodological considerations

Combination of methods

The results of this thesis might be influenced by the quantitative and qualitative methods used in its studies. Each method was governed by the research questions and purposes of the study. A quantitative study (Papers II and III) tests a hypothesis through surveys [99], whereas a qualitative study explores and uncovers noble findings regarding smoking behavior that cannot be obtained from quantitative study [100]. Combining both methods mutually validated my findings and contributed to a more coherent and complete picture of the phenomenon (e.g., smoking behavior in adolescents) [101]. The combined approach also opened an opportunity for more comprehensive research on Nepal's smoking behaviors, thus increasing the understanding of complex phenomena that are difficult to measure by a single method [102].

Sampling techniques

Papers II and III applied probability-sampling techniques to determine the psychosocial risk factors of smoking. Probability sampling has many advantages, including the generalization of findings to the wider population; it also aids inferences about the characteristics of the larger population [103]. However, it is difficult to apply probability sampling in lack of sampling frame. Thus, the use of non-probability sampling techniques (e.g., snowball sampling and response-driven sampling) is an appropriate approach to identifying adolescent smokers in a community [104, 105]. Such methods are usually recommended in hidden populations (e.g., injection drug-users, men who have sex with men, and the homeless) [104], and also for adolescents' smoking behavior [106, 107]. This population lacks a sampling frame and has privacy concerns based on the stigma associated with the general population [104]. My alternative method for tobacco research in Nepal involves using snowball sampling to identify adolescent smokers and then selecting non-smoking adolescents according to age matching, sex, and ethnicity. The selection of non-smoking adolescent helps compare smokers and non-smokers.

Possible bias

Bias is to some extent unavoidable in epidemiological research, but especially in cross-sectional studies and FGDs [108] (Papers I–IV). Thus, the findings presented here are not free of bias. For example, many respondents reported that their friends smoke cigarettes but only a few disclosed their own smoking behaviors, leading to optimistic bias (Papers II and III). Optimistic bias, which results from overestimating the other's smoking behavior and underreporting one's own smoking habits [109], might explain the higher percentage of smoking susceptibility reported by this thesis. Furthermore, due to possible concern about obtaining a negative social image, we hypothesized that study participants may have underreported their smoking habits, a circumstance that

occurs more commonly among females than males [110]. Paper IV explored the possibility of dominant respondent bias. Some participants may be influenced by answers given by other respondents during interaction, even though researchers did their best to control it. In Paper I, enumerators interviewed participants at home during data collection, leading to selection bias (Paper I).

Temporal association

Bradford Hills provided nine considerations for assessing whether an observed association involved a causal component [111]. One of them is temporality, wherein the factor must precede the outcome it is assumed to affect [111]. Because this thesis is based on a cross-sectional study and FGDs, I was unable to establish temporal association (Papers II–IV). Thus, establishing a cause-and-effect relationship in tobacco research requires long-term follow-up studies.

Generalizability

The question of generalizability is important in any research [112]. Researchers usually seek reliability, representativeness, and credibility of findings in both quantitative and qualitative methods [112]. The need for generalization is different in different situations. For example, public health is always interested in policy making and intervention planning. Policy can be described as "a bundle of decisions and how they are put into practice" [113]. However, policy makers and researchers view policy differently. Policy makers focus on the "political situation and administrative routine of policy making," whereas researchers are interested in "control programs" [113]. In same way, the generalization of this thesis may vary between policy makers, statisticians, epidemiologists, and researchers. Generalizability depends on how these professionals or readers consider the research process and data extraction in qualitative research. To enhance generalizability, this thesis explained its methods of data collection and findings in detail.

Ethical considerations

All studies in this thesis (Papers I–IV) are rooted in the basic principles of research (i.e., autonomy of subjects, or respect of the subjects; benefice; and justice), as described and explained in the Belmont Report (1979) and the Helsinki Declaration (1964) [114, 115]. It is easy to explain these three principles in a research proposal (or theoretically), but applying them in practice is a big challenge for researchers [107]. Researchers face several ethical dilemmas at the individual level.

Researchers encountered an ethical dilemma about recruiting local enumerators. Because all respondents in this thesis were younger than 18 year of age, we needed parental permission before approaching them. Local enumerators informed both parents and adolescents about the objective of the study. Parents never believe their children smoke without evidence. Therefore, the adolescent smokers feared that local enumerators would tell their parents about their smoking habit, and were unwilling to tell local enumerators about their smoking activities. On the other hand, hiring local enumerators helped us identify adolescents in the community and added convenience to the process of gaining parental permission.

Adolescents participated in this thesis voluntarily. Although, researchers should respect participants' time, offering remuneration presented an ethical dilemma due to the high probability that smoking adolescents would use remuneration to purchase cigarettes. Therefore, we provided stationary items (e.g., diaries, pens, pencils, copies, etc.) rather than cash. Importantly, however, remuneration was not a benefit of participation.

The responsibility for maintaining confidentiality of data rested mainly with researchers and enumerators. However, hiring local enumerators for data collection increases the risk of revealing adolescents' smoking status to their

parents and the community people. This was another ethical dilemma for tobacco researchers.

Finally, public health focuses on the entire population, rather than the health of individuals [116]. No framework dedicated to public health ethics is concerned with individual behavior change for public health benefits [117, 118]. At present, research at the individual level is increasingly documented and anticipated for developing such guidance. Some have suggested that public health research should not limit itself to the risks and benefits to research participants alone, but rather should consider the risks and benefits to the entire population as a whole, especially regarding social value [117, 118]. To resolve ethical concerns in public health research, Childress et al [116] emphasized five "justificatory conditions": effectiveness of the studies, public health benefits rather than individual benefits, confirming the necessity of a study, the degree of infringement (i.e., interference) with individuals' liberty, and publically and transparently explaining and justifying the necessity of such infringement [116].

CONCLUSIONS

The baseline survey presented in this thesis demonstrates that it is possible to establish an HDSS site in Nepal for the collection of accurate and reliable data. Establishment of JD-HDSS also offered the opportunity to conduct smoking research. This thesis also reveals an association between smoking susceptibility in non-smoking adolescents and several psychosocial (i.e., sociodemographic, personal, environmental, and behavioral) risk factors. Further, my results show that personal (short-term risks of smoking and social benefits of smoking) and environmental (pro-tobacco advertisement, teacher smoking, other family members smoking rather than parents) risk factors strongly predict smoking susceptibility. Finally, I provide direction for future research regarding the design and target of effective intervention programs. Therefore, this thesis provides stakeholders and policy makers with important factors that require attention for efficient smoking prevention programs targeting Nepalese adolescents.

FUTURE PERSPECTIVES

This thesis reveals several areas for future research about discouraging smoking initiation among youth.

Tobacco smoking among adolescents involves complex behaviors that are motivated by several psychosocial and biological behaviors. Therefore, adolescent smoking behavior requires explanation that identifies causative factors gained through longitudinal studies. Likewise, smoking behavior among adolescents progresses through several stages, from pre-contemplation to established smoker. The influence of psychosocial factors varies in each stage. Thus, effective intervention programs must identify the causative factors of smoking initiation at each stage behavioral stage.

Additionally, future research on preventing smoking initiation should focus on combining qualitative and quantitative methods to expand the scope of inquiry by assessing a wider range of data. The identification behavioral changes over time will require follow-up studies using both methods. Research based on a combination of health behavioral theories and psychosocial risks factors might increase understanding of the influences that affect smoking initiation among adolescents.

Finally, there is a need for multi-component intervention programs that facilitate changes in attitude and behavior by enhancing personal and environmental component skills that discourage smoking initiation.

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