TOBACCO CONSUMPTION, ENVIRONMENTAL TOBACCO SMOKE EXPOSURE AND ILLICIT DRUG USE: A STUDY ON SELECTED SOUTH ASIAN COUNTRIES

MOHAMMAD ALAMGIR KABIR

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Designation: Profesor Dr. Goh Kim Leng
Jabatan Statistik Gunaan
Fakulti Ekonomi & Pentadbiran
Universiti Malaya
50603 Kuala Lumpur
MALAYSIA

ABSTRACT

The trend of tobacco consumption (TC) is on the increase in the developing and under-developed countries including South Asian region. TC and the closely related problems of environmental tobacco smoke (ETS) exposure and illicit drug use (IDU) are increasingly alarming in South Asian countries. This study aims to explore the prevalence, patterns and determinants of (i) TC among youths and adults, (ii) ETS exposure among adults at home, workplace and public places, and (iii) IDU among males in selected South Asian countries. The associations between TC and ETS, and TC and IDU were also examined.

This study utilized data from (i) Global Youth Tobacco Survey-2007 that covered 2,242 Bangladeshi, 1,444 Nepalese and 1,377 Sri Lankan youths aged 13–15 years, (ii) Global Adult Tobacco Survey-2010 that covered 9,629 Bangladeshi and 69,296 Indian adults aged 15 years or more, (iii) Bangladesh Demographic and Health Survey-2007 that covered 3,771 males aged 15-54 years, and (iv) Bangladesh Urban Health Survey-2007 that covered 1,576 males aged 15-24 years that lived in urban slums. Univariate, bivariate, and multivariate (binary, ordinal, and multinomial logistic regressions) and classification and regression tree (CART) analyses and diamond-shaped equiponderant graphs were used for analysis.

Prevalence of youth TC was 6.9% in Bangladesh, 9.4% in Nepal and 9.1% in Sri Lanka with higher rates among males. Common significant predictors include TC among friends, exposure to smoking at home and other places, and teaching of smoking hazards in schools. Availability of free tobacco products from vendors significantly influenced Bangladeshi and Sri Lankan youths. Prevalence of adult TC was 43.3% in Bangladesh and 34.6% in India. Males and those older had a higher tendency to use tobacco products. Adults with no education were more likely to use tobacco products in Bangladesh (odds ratio, OR=4.9) and India (OR=3.0) compared to others with tertiary

education. Adults with the poorest wealth status were more likely to consume tobacco products in Bangladesh (OR=2.3) and India (OR=3.0) compared to those from the richest wealth status. Better knowledge, attitude and perception towards TC significantly reduced the TC rates in both countries. CART analysis had the highest classification accuracy for characterizing smoking patterns. Age of TC initiation, wealth status and gender were important variables for classifying smoking behavior. Other classifying variables include place of residence, educational attainment, and warnings printed on packaging of tobacco products.

Older adults and females had significantly less exposure to ETS in Bangladesh and India. Larger family size increased the chance of exposure at home. Those with higher education and knowledge on ETS had lower chance of exposure at home and workplaces, but they had higher exposure at public places. Smoking ban at home and workplaces significantly reduced the chances of being exposed to ETS. The results also suggested that TC increased the likelihood of exposure to ETS, and a higher frequency of TC tend to worsen the problem.

Prevalence of IDU among young males in urban slums and the general male population in Bangladesh were 9.1% and 3.4%, respectively. Significant predictors of IDU include education, duration of living in slums, and sexually transmitted infections. The logistic regression analysis revealed that those who used tobacco products daily had significantly higher likelihood of IDU. This likelihood also increased significantly with frequency of tobacco use. The impact of TC on IDU was remarkably higher among males in slums compared to the general male population. Understanding of the influencing factors of TC, ETS and IDU provides helpful insights for tobacco control policy formulation in South Asian region, as well as policy lessons for other low and low-middle income countries.

ABSTRAK

Tren penggunaan tembakau (PT) semakin meningkat di negara membangun dan kurang membangun termasuk rantau Asia Selatan. PT dan masalah pendedahan kepada persekitaran asap tembakau (PAT) dan penggunaan dadah (PD) yang berkait rapat semakin membimbangkan di negara-negara Asia Selatan. Kajian ini bertujuan untuk meneroka kelaziman, corak dan penentu (i) PT di kalangan belia dan orang dewasa, (ii) pendedahan kepada PAT di kalangan orang dewasa di rumah, tempat kerja dan tempat awam, dan (iii) PD di kalangan lelaki di negara-negara Asia Selatan terpilih. Perhubungan antara PT dan PAT, dan PT dan PD turut dikaji.

Kajian ini menggunakan data daripada (i) *Global Youth Tobacco Survey* 2007 yang meliputi sebanyak 2,242 orang belia dari Bangladesh, 1,444 orang belia dari Nepal dan 1,377 orang belia dari Sri Lanka yang berumur 13-15 tahun, (ii) *Global Adult Tobacco Survey* 2010 yang meliputi 9,629 orang dewasa dari Bangladesh dan 69,296 orang dewasa dari India yang berumur 15 tahun atau lebih, (iii) *Bangladesh Demographic and Health Survey* 2007 yang meliputi 3,771 orang lelaki berumur 15-54 tahun, dan (iv) *Bangladesh Urban Health Survey* 2007 yang meliputi 1,576 lelaki berumur 15-24 tahun yang tinggal di kawasan miskin bandar. Analisis univariat, dwiperubah, dan multivariat (regresi logistik binari, ordinal, dan multinomial) dan pokok klasifikasi dan regresi atau (CART) dan graf segi enam sama berbentuk berlian telah digunakan.

Kelaziman PT belia adalah 6.9% di Bangladesh, 9.4% di Nepal dan 9.1% di Sri Lanka dengan kadar yang lebih tinggi di kalangan lelaki. Faktor yang signifikan adalah PT di kalangan rakan, pendedahan kepada merokok di rumah dan tempat lain, dan pengajaran tentang bahaya merokok di sekolah. Produk tembakau yang boleh diperoleh secara percuma daripada pembekal menjadi pengaruh kepada belia dari Bangladesh dan Sri Lanka. Kelaziman PT dewasa adalah 43.3% di Bangladesh dan 34.6% di India.

Lelaki dan mereka yang lebih tua mempunyai kecenderungan yang lebih tinggi untuk menggunakan produk tembakau. Orang dewasa yang tidak mempunyai pendidikan mempunyai kemungkinan yang lebih tinggi untuk mengguna produk tembakau di Bangladesh (*odds ratio,* OR=4.9) dan India (OR=3.0) berbanding dengan mereka yang berpendidikan tertiari. Orang dewasa dalam golongan paling miskin lebih berkecenderungan untuk mengguna produk tembakau di Bangladesh (OR=2.3) dan India (OR=3.0) berbanding dengan mereka dalam golong paling kaya. Pengetahuan, sikap dan persepsi yang lebih baik terhadap PT mengurangkan kadar PT di kedua-dua negara ini. Analisis CART mempunyai ketepatan pengelasan tertinggi untuk mengkaji corak merokok. Umur permulaan PT, status kekayaan dan jantina adalah pembolehubah penting bagi mengklasifikasikan tingkah laku merokok. Pembolehubah klasifikasi yang lain adalah tempat tinggal, tahap pencapaian pendidikan, dan amaran yang dicetak pada paket produk tembakau.

Warga tua dan wanita kurang terdedah kepada PAT di Bangladesh dan India. Saiz keluarga yang lebih besar meninggikan pendedahan kepada PAT di rumah. Mereka yang berpendidikan tinggi dan berpengetahuan mengenai PAT mempunyai kemungkinan yang lebih rendah untuk terdedah kepada PAT di rumah dan di tempat kerja, tetapi mereka lebih terdedah kepada PAT di tempat awam. Larangan merokok di rumah dan di tempat kerja mengurangkan peluang untuk pendedahan kepada PAT. Keputusan juga menunjukkan bahawa PT meningkatkan kemungkinan untuk terdedah kepada PAT, dan kekerapan penggunaan cenderung untuk memburukkan lagi masalah tersebut.

Kadar kelaziman PD di kalangan lelaki muda di kawasan miskin bandar dan penduduk lelaki umum di Bangladesh adalah sebanyak 9.1% dan 3.4% masing-masing. Faktor yang mempengaruhi PD termasuk pendidikan, tempoh tinggal di kawasan miskin, dan jangkitan kelamin. Keputusan regresi logistik mendedahkan bahawa orang-

orang yang menggunakan produk tembakau setiap hari mempunyai kemungkinan PD yang lebih tinggi. Kemungkinan ini juga meningkat dengan ketara dengan kekerapan penggunaan produk tembakau. Kesan PT pada PD adalah amat tinggi di kalangan lelaki di kawasan miskin bandar berbanding dengan penduduk lelaki umum. Pemahaman faktor-faktor yang mempengaruhi PT, PAT dan PD memberikan pandangan yang berguna untuk penggubalan dasar bagi pengawalan tembakau di rantau Asia Selatan, dan juga pengajaran dasar kepada negara-negara berpendapatan rendah dan rendah pertengahan yang lain.

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ACPR	Associates for Community and Population Research
ASH	Action on Smoking and Health
ATI	Anti-Tobacco Information
ATS	Amphetamine-Type Stimulants
ATU	Adolescent Tobacco Use
BBS	Bangladesh Bureau of Statistics
BDHS	Bangladesh Demographic and Health Survey
BHF	British Heart Foundation
BLR	Binary Logistic Regression
BPC	Bangladesh Population Census
BUHS	Bangladesh Urban Health Survey
CART	Classification and Regression Tree
CDC	Centres for Disease Control and Prevention
CEB	Census Enumeration Block
CEPA	California Environmental Protection Agency
CHAID	Chi-Square Automatic Interaction Detector
COTPA	Cigarettes and Other Tobacco Products Act
CUS	Centre for Urban Studies
ETS	Environmental Tobacco Smoke
FCTC	Framework Convention on Tobacco Control
GAO	General Accounting Office
GATS	Global Adult Tobacco Survey
GHS	General Household Survey
GSS	General Survey System
GYTS	Global Youth Tobacco Survey
HBM	Health Belief Model
IARC	International Agency for Research on Cancer
ICDDR, B	International Centre for Diarrhoeal Disease Research, Bangladesh
IDU	Illicit Drug Use
IIPS	International Institute for Population Sciences
KAP	Knowledge, Attitude and Perception
LAIA	Lung and Asthma Information Agency
LRT	Likelihood Ratio Test
MLR	Multinomial Logistic Regression
MMWR	Morbidity and Mortality Weekly Report
MoHFW	Ministry of Health and Family Welfare

MPOWER	Monitor, Protect, Offer, Warn, Enforce and Raise
MSMT	Mrigendra Samijhana Medical Trust
NATAA	National Authority on Tobacco and Alcohol Act
NCD	Non-Communicable Disease
NHS	National Health Statistics
NIDA	National Institute of Drug Abuse
NIH	National Institutes of Health
NIPORT	National Institute of Population Research and Training
NIPSOM	National Institute of Preventive and Social Medicine
NRC	Nuclear Regulatory Commission
NRT	Nicotine Replacement Therapy
NSPATC	National Strategic Plan of Action for Tobacco Control
NTCC	National Tobacco Control Cell
OLAP	On-Line Analytical Processing
OLR	Ordinal Logistic Regression
OR	Odds Ratio
PSU	Primary Sampling Unit
PTI	Pro-Tobacco Information
QUEST	Quick, Unbiased and Efficient Statistical Tree
RCPL	Royal College of Physicians of London
RTI	Research Triangle Institute
SEARO	South East Asia Regional Office
SES	Socio-Economic Status
SHS	Secondhand Smoke
SLT	Smokeless Tobacco
SOM	Self-Organizing Map
SPSS	Statistical Package for Social Sciences
SSU	Secondary Sampling Unit
STDs	Sexually Transmitted Diseases
STIs	Sexually Transmitted Infections
TC	Tobacco Consumption
TSU	Tertiary Sampling Unit
UNODC	United Nations Office on Drugs and Crime
USDHHS	United States Department of Health and Human Services
WB	World Bank
WHO	World Health Organization

CHAPTER 1: INTRODUCTION AND BACKGROUND OF STUDY

1.1 Overview

More than 400 years ago, tobacco consumption (TC) was limited to Native Americans, who used it exclusively for medicinal and ceremonial purposes. The tobacco was incredibly wide spread in Europe after Columbus discovered America (Brandt, 2007). Within 100 years, tobacco could be found growing and traded in all the major regions of the world. However, until the early 1900s, TC was almost entirely confined to chewing, the use of snuff, and pipe smoking by men. Cigarette use first began to grow in developed countries in the early 1900s after the newly industrialized tobacco industry instituted highly effective marketing methods (Eriksen, Mackay, & Ross, 2012). Taking both sexes together, the average cigarette consumption per adult in the United States was 1, 4, and 10 per day in 1910, 1930, and 1950, respectively, after which it remained relatively constant for some decades before declining progressively (Peto et al., 1994). By 1960, 50% of adult men in the United States were smoking cigarettes (Mackay, Eriksen, & Shafey, 2006). Similarly, in Great Britain, TC doubled in the first half of the twentieth century, from 4.1g per adult per day in 1905 to 8.8g in 1945 (one cigarette contains a gram of tobacco) (RCPL, 2002). Smoking prevalence among men in Great Britain reached 82% in 1948 (Wald & Nicolaides-Bouman, 1991).

Fortunately, the peak of TC has passed in most developed countries (**Table 1.1**), where smoking prevalence rates have been declining for several decades. In 2008, the percentage of Americans who smoked cigarettes fell to less than 20% and teen smoking fell to the lowest level in over 15 years (MMWR, 2008). Similarly, smoking prevalence rates in the UK fell to 22% in 2008 and are on track to meet the government's goal of 21% by 2010 (ASH, 2008). In many Northern, Southern, and Western European countries as well, the prevalence of smoking in men has fallen over the past 25 years (Peto & Lopez, 2004). The Japan, Australia and other developed countries also share the same experience. Though the prevalence of TC is still high in Japan, but it is declining rapidly (Eriksen, Mackay, & Ross, 2012).

Table 1.1: TC among Adults (Males & Females) in Selected Developed Countries

USA		UK		Japan		Australia	
Year	%	Year	%	Year	%	Year	%
1965	52 (**34**)	1960	61 (**42**)	1960	81 (**13**)	1964	58 (**28**)
1970	44	1965	58	1965	79	1974	44
1979	38	1970	55	1970	78	1980	40
1990	28	1980	42	1980	70	1986	32
2000	26	1990	31	1990	61	1991	32
2005	24	2000	29	2000	54	1995	30
2006	23.9	2005	23	2006	39.9	2001	29
2007	22.8	2008	22.8	2007	40.2	2007	23
2010	22 (**17**)	2010	22 (**21**)	2010	38 (**11**)	2010	20 (**16**)

Source: Eriksen, Mackay, & Ross, 2012; http://www.tobaccoatlas.org/fefault.html; www.quitsa.org.au; female TC are in parenthesis.

The substantial decline in TC in the developed countries has not happened elsewhere (**Table 1.2**). Among 1.2 billion people worldwide, about 40% of men and 10% of women are smokers (Shafey et al., 2009).

Table 1.2: Prevalence of TC in Selected Developing Countries*

Developing countries	**Description of TC**	**Adults**		**Youths**	
		Male	**Female**	**Male**	**Female**
Cambodia	Current cigarette smoking	48.0	3.6	7.2	3.0
China	Current cigarette smoking	60.8	4.2	7.1	4.1
Indonesia	Daily tobacco smoking	46.8	1.4	24.1	4.0
Malaysia	Current tobacco smoking	46.4	1.6	40.0	11.5
Mexico	Current cigarette smoking	30.4	9.5	27.8	28.5
Myanmar	Current tobacco smoking	48.9	13.7	22.5	8.2
Philippines	Current tobacco smoking	57.5	12.3	28.3	17.5
Poland	Daily tobacco smoking	34	23	21.4	17.3
Russia	Current tobacco smoking	60.0	23.2	30.1	24.4
Thailand	Daily tobacco smoking	36.6	1.6	21.7	8.4
Turkey	Current tobacco smoking	50.6	16.6	11.1	4.4
Ukraine	Daily tobacco smoking	62.3	16.7	29.8	22.2
Vietnam	Current tobacco smoking	49.4	2.3	6.5	1.5

Source: Eriksen, Mackay, & Ross, 2012; WHO, 2009

*__Note__: Term developing countries & low income countries (LICs) are used interchangeably in this study.

Tobacco remains a very common addiction among men in many low- and middle-income countries, although much less so among women (Eriksen, Mackay, & Ross, 2012). In fact, the proportions of cigarette production and consumption taking place in developing countries are rising by just under 1% a year (WHO, 2008). In addition to direct smoking, people are also exposed in other ways through environmental tobacco smoke (Eriksen, Mackay, & Ross, 2012). ETS can be side-stream smoke from the burning tip of a cigarettes, *bidis*, cigars, or pipe, and mainstream smoke, which smokers exhale. Side-stream smoke is the major component of ETS exposure and over 3,000 different chemicals, including irritant gases, carcinogens and fine particles are contained in ETS (WHO, 2009). Nonsmokers or smokers who live or work with a smoker generally have the greatest exposure to ETS. Although ETS in public places is important as a nuisance, it usually contributes only a small amount to personal ETS exposure (WHO, 2009). There is no safe level of ETS exposure. Globally, approximately 40% of children and 33% of nonsmoking adults were exposed to ETS in 2004 (Eriksen, Mackay, & Ross, 2012). The Western Pacific region has the highest rate of ETS exposure with more than 50% of men, women, and children exposed to ETS in that time period (Eriksen, Mackay, & Ross, 2012). It was evident that the more smokers in the society, the higher the risk to be exposed to ETS (Eriksen, Mackay, & Ross, 2012; Moira & Helen, 2003; Patja et al., 2009).

Like widespread TC and exposure to ETS, substance use and their impacts on the individual, family and community level are increasing globally. Particularly, the impacts of illicit drug use (IDU) are huge in developing countries because of poor health infrastructure and limited resources (UNODC, 2010). Globally, around 155 to 250 million people (i.e. 3.5% to 5.7% of the global population) aged 15 and above have used illegal drugs at least once. Of these, some of the commonly used illicit drugs are Cannabis (129 to 191 million), Amphetamine-type stimulants (ATS) (13.7 to 52.9

million), opiates (notably heroine) (12.8 to 21.9 million) and cocaine (15 to 19 million). Opiate users experience the highest level of harm (UNODC, 2010).

1.2 Overview of Tobacco Consumption, Environmental Tobacco Smoke Exposure and Illicit Drug Use in South Asian Countries

Like other low- and middle-income countries, tobacco remains a very common addiction among populations in South Asian countries, where the prevalence of TC among women was higher than other developing countries (**Table 1.3**). The consumption of tobacco in the region is diverse in character. For example, traditionally, Bangladeshi men smoke cigarettes and *bidis*, and chew tobacco leaf such as *zarda, sada pata, gul, khoinee*. However, women usually do not smoke but chew tobacco leaf. In India, among the prevalent smoking forms of tobacco, *bidi* is the most popular product, especially in rural areas. It is estimated that one-third of all tobacco produced in India is used for *bidi* making (Gupta & Asma, 2008; Reddy & Gupta, 2004).

Table 1.3: Prevalence of TC in Selected South Asian Countries

Core South Asian countries	**Description of TC**	**Adults**		**Youth**	
		Male	**Female**	**Male**	**Female**
Bangladesh	Current tobacco use	48.5	25.4	9.1	5.1
Bhutan	Current tobacco smoking	8.7	4.9	18.3	6.3
India	Current tobacco use	57.0	10.8	16.8	9.4
Maldives	Current tobacco use	37.4	15.6	8.5	3.4
Nepal	Current tobacco smoking	31.6	17.2	13.0	5.3
Pakistan	Current tobacco smoking	32.4	5.7	12.4	7.5
Sri Lanka	Current tobacco smoking	39.0	2.6	12.4	5.8

Source: Eriksen, Mackay, & Ross, 2012; WHO, 2009

Cigarette smoking is the second most popular form of tobacco smoking in India, and is observed mainly in urban areas. Hookah, chuttas, dhumti, chillum, cigars, cheroots and pipes are some other forms of tobacco smoking used in different parts of the country (Gupta & Asma, 2008). Paan (betel quid) with tobacco is the most common form of chewable tobacco. Dry tobacco areca-nut preparations, such as paan masala, gutkha and mawa, are also popular (Reddy & Gupta, 2004). Along with smoking and chewing, other tobacco products such as mishri, gul, bajjar, gudakhu, etc., are widely used as applications to the teeth and gums. Many of these products are also popular among females (Reddy & Gupta, 2004). In general, like other South Asian countries, Indian males smoke as well as chew tobacco whereas females mainly use chewing forms of tobacco, except in a few areas where prevalence of smoking among females is higher (IIPS, 2007). More or less similar products are used in other South Asian countries (Eriksen, Mackay, & Ross, 2012).

The evidence showed that exposure to environmental tobacco smoke (ETS) is also serious in South Asian region compared to developed countries and this is due to population density, lower level of knowledge and awareness, lack of strict public law enforcement (IIPS, 2011; Oberg et al., 2011; WHO, 2010). Article 8 of WHO Framework Convention of Tobacco Control (WHO FCTC) addresses “protection from exposure to tobacco smoke” in eight particular public places. Out of eight, India and Sri Lanka declared 6 to 7, Nepal declared 3 to 5 and Bangladesh declared up to 2 public places for complete ban of smoking (Eriksen, Mackay, & Ross, 2012; WHO, 2008).

While smoking cigarettes and *bidis* were common habits among the general male population in Bangladesh, TC was also widespread among the young males (Choudhury et al., 2007; Kabir et al., 2012; Palipudi et al., 2012). Like TC, the prevalence of substance use and its impacts were increasingly serious in Bangladesh and other neighbouring countries (Banglapedia, 2006; Choudhury et al., 2007; Kabir et al., 2012; Palipudi et al., 2012; UNODC, 2010). Bangladesh is vulnerable to the impacts of illicit drug use (IDU) because of its proximity to the drug trafficking zones of the Golden Triangle and the Golden Crescent. Phensedyl (a cough suppressant syrup containing codeine phosphate) is produced lawfully in India and easily available in neighbouring Bangladesh through drug trafficking. The overall vulnerability also increases in Bangladesh as this country shares some of its border with Myanmar, the largest drug abuse country (Banglapedia, 2006). The annual prevalence of cannabis (locally known as *Ganja*) in the population aged 15 to 64 years was 3.3% in Bangladesh (UNODC, 2010). Besides, annually about 4 metric tons opium (popularly known as heroine) was consumed in Bangladesh, and the abuse is likely to increase in the future (UNODC, 2010). Almost all the heroine consumed in Bangladesh originates from India, the leading consumer of opium (UNODC, 2010).

1.3 Mortality Statistics in Developed, Developing and South Asian Countries

The tobacco consumption and its associated consequences in developed countries is declining rapidly. However, in developing countries the TC in any form is still high resulting in the high death rates (WHO, 2011). In 2011, tobacco related illnesses killed almost 6 million people, with nearly 80% of these deaths occurring in low- and middle income countries (Eriksen, Mackay, & Ross, 2012). The projected global tobacco caused deaths by 2015 are malignant neoplasms (33%); almost equal 29% for respiratory diseases and cardiovascular diseases; 3% are digestive diseases, and the rest 5% from diabetes, lower respiratory infections, and tuberculosis (Eriksen, Mackay, & Ross, 2012). TC in any form is dangerous and is the single most preventable cause of deaths. Deaths from smoking are directly related to smoking prevalence and exposure to environmental tobacco smoke (ETS). Although tobacco-related deaths between 2002 and 2030 were projected to slowdown in developed countries, such deaths were anticipated to increase from 3.4 million to 6.8 million in developing countries (Ezzati et al., 2002; Mathers & Loncar, 2006).

A projection showed, in 1990s, tobacco caused deaths is about 1 million a year in developing countries, and 2 million in developed countries. By 2000, death tolls were similar in developing and developed countries. However, it is expected that annual toll of mortality due to TC, will rise dramatically to around 7 million deaths per annum in the 2020s or early 2030s (**Table 1.4**).

Table 1.4: Tobacco Related Deaths in Developed and Developing Countries

Region	1990s	2000	2020s/early 2030s
Developed countries	2 million	2 million	3 million
Developing countries	1 million	2 million	7 million
Total	3 million	4 million	10 million

Source: Eriksen, Mackay, & Ross, 2012; WHO, 2009

The evidence also clearly showed the burden of deaths from tobacco is shifting from developed to developing countries. Another projection (**Figure 1.1**) showed the gap in tobacco related deaths and illnesses between the developed and developing countries in coming years.

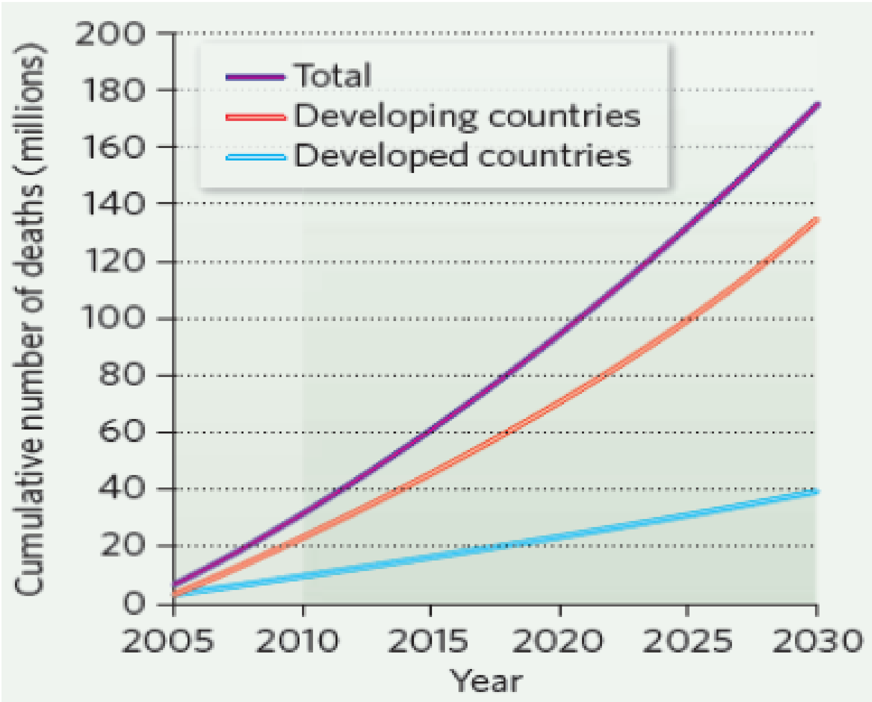

Figure 1.1: The Estimated Number of Tobacco Related Deaths (Millions) between Developed and Developing Countries (**Source:** Samet & Wipfli, 2010)

In South Asia, approximately 1.2 million people die every year from tobacco related illnesses (WHO, 2009). TC irrespective of types brought huge damage to human health in this region (Eriksen, Mackay, & Ross, 2012). For example, 57,000 people died in 2004 due to tobacco-related diseases and illnesses in Bangladesh (Zaman et al., 2007). Moreover, a nationally representative study in India reported about 930,000 adult deaths due to tobacco related diseases and illnesses and about 70 percent of them are between the aged 30–69 years (Jha et al., 2008). The other regions have significantly higher number of deaths due to TC (WHO, 2009). In addition to direct smoking, the problem of ETS is also enormous globally. An estimate of about 600,000 premature deaths per year worldwide (Öberg et al., 2011), approximately the same number of people who are killed by measles or women who die during childbirth each year were related to ETS (Mathers & Loncar, 2006).

Globally, the number of ETS related deaths among nonsmokers in 2004 were among men (26%; 156,000), women (47%; 281,000) and children (28%; 166,000) (Eriksen, Mackay, & Ross, 2012). The distribution of global deaths attributed to ETS exposure by WHO regions in 2004 were America (5.6%; 33,700), Africa (8.8%; 52,900), Eastern Mediterranean (10.6%; 64,100), Western Pacific (19.5%; 117,400), South-East Asia (26.9%; 162,300), and Europe (28.6%; 172,300) (Eriksen, Mackay, & Ross, 2012). Among adults, ETS causes serious cardiovascular and respiratory diseases, including coronary heart disease and lung cancer (WHO, 2010). The evidence also showed that the problem of ETS is also more serious in South Asian region compared to developed countries (IIPS, 2011; Oberg et al., 2011; WHO, 2010). Broadly, four types of adverse health effects occurred due to illicit drug use: (a) toxic effects of drugs i.e. overdoses, (b) effects of intoxication i.e. accidental injury and violence, (c) development of dependence, and (d) adverse health effects from sustained chronic, and regular use i.e. physical diseases (UNODC, 2010). Based on death statistics, IDU takes a back seat than the use of other substances. For example, globally 5.1 million, 2.25 million and 250,000 deaths occurred in 2004 were related to TC, alcohol use and IDU respectively. However, looking at years of life lost, 2.1 million and 1.5 million were attributed to IDU and alcohol respectively. This is because younger people are generally more vulnerable to drug-related deaths (UNODC, 2010). Due to lack of data on developing countries including South Asian region, it is not fully known how drug use affects health, society and the economy.

1.4 Natural History of Tobacco Consumption, Environmental Tobacco Smoke Exposure and Illicit Drug Use

The natural history of TC is often conceptualized as a series of steps that proceed from never use, to trial, experimentation, established use, attempt to quit, relapse, and/or maintenance of cessation (**Figure 1.2**).

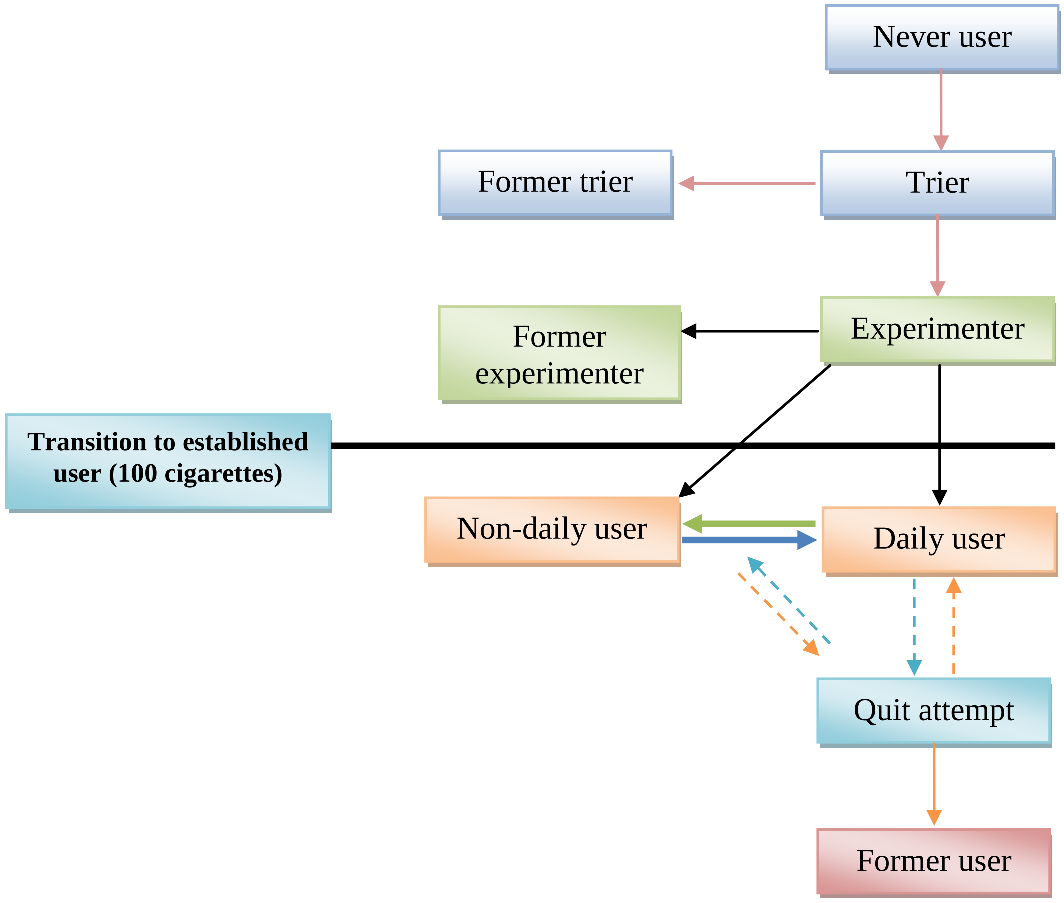

Figure 1.2: Natural History of Tobacco Consumption
(**Source:** Choi et al., 2001; Hughes et al., 2003; USDHHS, 1994)

Prior to actual initiation of use, never users can be tempted to TC. After initial trial, users can either continue to experiment or discontinue and become former triers. Experimenter can either progress to established user or discontinue use and become former experimenters. Research suggests that nicotine dependence may appear during the experimentation phase, before the user becomes an established user (Fidler et al., 2006; O'Loughlin et al., 2003). The exact threshold of established use is unknown and likely to vary consistently, but is often considered as having smoked at least 100 cigarettes in lifetime, or being exposed to a similar amount of other tobacco products. Established use is generally manifested as daily use. However, persistent and regular non-daily use can also take place (Trosclair et al., 2005). Once past the threshold of established use, discontinuance involves an attempt to quit, with the outcome of each quit attempt being either relapse or maintenance of cessation (Hughes et al., 2003; USDHHS, 1994; West, 2006). Quit attempts can be planned or spontaneous, involve abrupt discontinuance or gradual reduction in use before quitting, and may or may not be assisted by one or more several available treatment strategies (West et al., 2001).

Along with other smoked tobacco products, smoking cigarettes and *bidis* was found to be the main sources of ETS exposure. Burning cigarettes or *bidis* produce smoke mainly in the form of mainstream smoke (MS), the smoke inhaled by the smoker during puffing, and side stream smoke (SS), the smoke released by the smouldering cigarette while not being actively smoked. Because of the lower temperature in the burning cone of the smouldering cigarette, many tobacco burning products were enriched in SS compared to MS (Eriksen, Mackay, & Ross, 2012). Nonsmokers or smokers were exposed to the mixture of SS that is released from the cigarette’s burning end and the MS breathed out by the active smoker (First, 1985). This combination of SS and breathed out MS is recognized as ETS. Smokers and nonsmokers living with smokers are exposed to ETS. For instance, parents and other family members, and guests smoking at home, and friends, colleagues and others smoking at workplace and other places have causal link with ETS exposure (LAIA, 1999).

TC has long been recognized as a “gateway drug” to other illicit substances, which harm both psychosocially and pharmacologically (Kandel & Yamaguchi, 1993), particularly in individuals with attention-deficit or hyperactivity sickness (Biederman et al., 2006).

1.5 Brief Description of Smoked, Smokeless Tobacco Products and Illicit Drugs

Based on the latest information from Tobacco Atlas (Eriksen, Mackay, & Ross, 2012) and (UNODC, 2010), a brief description of smoked and smokeless tobacco products, and illicit drugs is as follows:

(a) Smoked Tobacco (ST)

Manufactured cigarettes: most commonly consumed tobacco products worldwide and accounted for 96% of total worldwide sales.

Bidis**:** consist of a small amount of crushed tobacco, hand-wrapped in dried *temburni or tendu* leaves, and tied with string. It tends to deliver more tar and carbon monoxide than manufactured cigarettes because users must puff harder to keep them lit. *Bidis* are mostly used in South Asian countries.

Pipes: made of clay or other substances, tobacco is placed in the bowl, and the smoke is inhaled through the stem. Pipes are used worldwide.

Cigars: made of air-cured and fermented tobacco rolled in tobacco-leaf wrappers. The long aging and fermentation process produces high concentration of carcinogenic compounds that are released upon combustion. The concentrations of toxins and irritants in cigars are higher than in cigarettes. It has a worldwide prevalence.

Water pipes: also called shisha, hookah, *narghile*, or hubble-bubble and operated by water filtration and indirect heat. Flavoured tobacco is burned in a smoking bowl covered with foil and coal and the smoke is cooled by filtration through a basin of water and consumed through a hose and mouthpiece. The product is popular in North Africa, Mediterranean, and parts of Asia, but now spreading to other parts of the world.

(b) Smokeless Tobacco (SLT)

This form of products is usually consumed orally or nasally, without burning or combustion. The use increases the risk of cancer and leads to nicotine addiction similar to that produced by cigarette smoking or other smoked tobacco products. Different types of SLT are: chewing tobacco (most prevalent in Indian subcontinent); snuff (most prevalent in Scandinavian and US but becoming popular worldwide); and dissolvable (most prevalent in high income countries). The chewing tobacco is an oral SLT product that is placed in the mouth, cheek, or inner lip and sucked or chewed. They are also referred to as “spit tobacco” because of the tendency by users to spit out the built-up tobacco juices and saliva. Such products are consumed worldwide. In the Indian subcontinent, the varieties of chewing tobacco include plug, loose-leaf, chimo, toombak, gutkha, and twist; pan masala or betel quid that consists tobacco, areca nuts *(Areca catechu)*, slaked lime (calcium hydroxide), sweeteners, and flavouring agents wrapped in a betel leaf *(Piper betle)*; varieties of pan masala such as kaddipudi, hogesoppu, gundi, kadapam, zarda, pattiwala, kiwam, and mishri among others. In addition to the above tobacco products, tobacco industries are marketing their products (nicotine patch, nicotine gum, nicotine lollipop, nicotine water, E-cigarettes, sticks, strips, orbs and snus and also combustible cigarettes) as nicotine replacement therapy. These products are claimed as less harmful and heavily regulated but they have the side effects and continuum of harm among others (Eriksen, Mackay, & Ross, 2012).

(c) Illicit Drugs

Worldwide, the commonly used illicit drugs are Cannabis, Amphetamine-type stimulants (ATS), Opiates (notably heroine) and Cocaine. However, using different names, the illicit drugs in Bangladesh include *Ganja* (cannabis), *Charas* (hashish), Phensidle, Pethedine, Heroine (opium), Morphine, and Injectable drugs (Khan et al., 2006; NIPORT, 2009).

1.6 Rules and Regulations on TC, ETS and IDU in Selected South Asian Countries

This section describes briefly the rules and regulations relevant to the study. The WHO's Framework Convention on Tobacco Control (WHO FCTC 2005) was the only treaty that is devoted entirely to tobacco control with the following main provisions: (a) defense against tobacco company interference; (b) security of tobacco workers in health and environment; (c) developing the monitoring system, exchange of information among stakeholders, and to take legislative actions; (d) rules regarding contents, packaging & labeling in tobacco products; ban of sales to minors; stopping of illicit trades; and regulation of smoking at work and in public places; (e) increasing price and tax to reduce products demand; complete ban on advertising, support and promotion; and develop knowledge and awareness about harmful effects of tobacco through education and training. Bangladesh, India, Nepal and Sri Lanka has signed and ratified the WHO FCTC treaty after its inception. Along with the treaty, the **MPOWER** package of FCTC is a series of six proven policies aimed at reversing the global tobacco epidemic (Eriksen, Mackay, & Ross, 2012; WHO, 2008).

M=Monitor tobacco use and prevention policies.

Surveillance is essential to support sound policy. India and Sri Lanka have complete monitoring system. However, Bangladesh and Nepal have only moderate monitoring system (Eriksen, Mackay, & Ross, 2012).

P=**P**rotect people from tobacco smoke.

Article 8 of FCTC addresses "protection from exposure to tobacco smoke i.e. ETS" in eight particular public places. Out of eight, India and Sri Lanka declared 6 to 7, Nepal declared 3 to 5 and Bangladesh declared up to 2 public places designated as completely smoke-free (Eriksen, Mackay, & Ross, 2012; WHO, 2008).

O=**O**ffer help to quit tobacco consumption.

Article 14 addresses "demand reduction measures concerning tobacco dependence and cessation" (WHO, 2003). Nicotine replacement therapies (NRT) and pharmacologic agents such as bupropion, varenicline, and cystisine are now available in many countries. Communication technologies such as telephone quit lines, text messaging, online counseling, and social media offer support for reducing tobacco dependence. Psychological and behavioral therapies, such as hypnosis, meditation, and acupuncture have also been employed. The selected South Asian countries have NRT and/or some cessation services but neither provides cost-covered services. However, in Sri Lanka quit line services are provided (Eriksen, Mackay, & Ross, 2012).

W=**W**arn about the dangers of tobacco.

Mass media campaigns have the influence on TC, encouraged quit attempts, and improved quit rates. India has all appropriate characteristics[1], Nepal has 5-6 appropriate characteristics, and Sri Lanka has 1-4 appropriate characteristics. However, Bangladesh has no campaign implemented (Eriksen, Mackay, & Ross, 2012). **Article 11** addresses health warnings in tobacco products and required at least 30% and preferably 50% of the observable area on a cigarette pack within three years of becoming a party. Warnings should be extended to all tobacco products (smoked and smokeless) within a short period of time. In 2012, plain packaging was first implemented, which is specifically the standardization of cigarette packaging that removes all product advertising including colors, logos, and brand imagery, and enforces restrictions on font size and type. Bangladesh has "medium warnings and missing some appropriate

[1] Appropriate characteristics are based on whether the campaign was part of a comprehensive tobacco control program; whether research informed an understanding of the target audience; and whether materials were pretested; as well as how the campaign was promoted, placed, and publicized; and the extent to which campaigns were evaluated.

characteristics[2] or large warnings and missing many appropriate characteristics". The other three countries such as India, Nepal and Sri Lanka have "no warnings or small warnings" (Eriksen, Mackay, & Ross, 2012).

E=**E**nforce bans on tobacco advertising, promotion, and sponsorship.

Article 13 addresses bans of "tobacco advertising, promotion and sponsorship" in any media (Gilmore et al., 2009; WHO, 2003; WHO, 2008). The selected South Asian countries have prohibition on national TV, radio, and print media along with some but not all other forms of direct[3] and /or indirect[4] advertising (Eriksen, Mackay, & Ross, 2012).

R=**R**aise taxes on tobacco.

The seminal and recent IARC report on tobacco tax increases of tobacco tax are most effective and significant tobacco control policies (Gilmore & Reid, 2013; IARC, 2004). A 10% increase in cigarette prices reduces cigarette demand by 2–6% in high-income countries and by 2–8% in low- and middle-income countries. Bangladesh and Sri Lanka have excise tax between 50-69.9%, whereas in India and Nepal the rate is fewer than 30% (Eriksen, Mackay, & Ross, 2012).

In addition to MPOWER, **Article 12** of FCTC addresses "education, communication, training and public awareness" to reduce TC (WHO, 2003; WHO, 2008). In recent years there has been some effort for the prevention of TC in the schools in South Asian countries (WHO, 2003; WHO, 2008). **Article 16** addresses "sales to and

[2] Large, Medium and Small Warnings means the average coverage of front and back of package is at least 50%, between 30 and 49%, less than 30% respectively. Appropriate characteristics are based on percentage of package covered; whether warnings are mandated; appearance on packets and external packaging; and description of specific harm. The consideration also covers if warnings are large, clear, visible, and legible; written in main language of the country; and includes pictures.

[3] Direct advertising includes television, radio, magazine, direct mail, email, telemarketing, coupons, brand loyalty programs, and other methods to promote tobacco products directly to consumers.

[4] Indirect advertising uses brand names, trade names, trademarks, emblems, etc., to indirectly promote tobacco products through "brand stretching" (brand names are used as part of other product names), event sponsorships, product placement in television and films, and other methods.

by minors” of tobacco products (WHO, 2003). India, Nepal and Sri Lanka have strict laws on selling of tobacco products to minors. However, Bangladesh does not have any such law (Eriksen, Mackay, & Ross, 2012). Furthermore, each country has their country specific control programs. For example, the Government of Sri Lanka passed the National Authority on Tobacco and Alcohol Act (NATAA) in 2006 (NATAA, 2006) to discourage the intake of tobacco and alcohol among young children and adults. In 2005, the Government of Bangladesh passed a comprehensive tobacco control law in line with FCTC. The Government also passed rules to facilitate the enforcement of law in 2006 (MoHFW, 2007; WHO, 2009). The National Strategic Plan of Action for Tobacco Control (NSPATC, 2007-2010) is being implemented (MoHFW, 2007). The National Tobacco Control Cell (NTCC) has been established with technical assistance of WHO, which has become the hub of national coordination of tobacco control activities (MoHFW, 2007). The Government of Nepal has also banned tobacco promotion in the electronic media in 1999 and promoted anti-tobacco messages (MSMT, 1999). The Government of India passed ‘Cigarettes and Other Tobacco Products Act, 2003 (COTPA)’ to prohibit the intake of tobacco products, which are injurious to health (MoHFW, 2003). The smoke-free rules in India were revised in October, 2008. ‘Public places’ were redefined so as to include all workplaces and to authorize personnel responsible for enforcement of law for maintaining smoke-free public places across the country. Country specific laws were proposed in India for implementation at the national, state and district level (WHO, 2009).

1.7 Problem Statement and Significance of the Study

The WHO reports that in 2011, tobacco related illnesses killed almost 6 million people, with nearly 80% of these deaths occurred in low- and middle-income countries. By the year 2030, 8 million people are projected to die annually due to such diseases. The

South Asian region contributed significantly higher (about 1.2 million) to the statistics than other regions (Eriksen, Mackay, & Ross, 2012; WHO, 2009). TC and associated consequences are decreasing rapidly or levelling off in developed countries and some middle-income countries, but the prevalence is still high or increasing in developing countries including South Asia, mostly due to population expansion in the region (Ezzati et al., 2002; Mathers & Loncar, 2006; Samet & Wipfli, 2010). Like direct smoking, environmental tobacco smoke (ETS) exposure caused about 600000 premature deaths per year worldwide, and one third of adults are regularly exposed to ETS which causes serious cardiovascular and respiratory diseases, including coronary heart disease and lung cancer (Eriksen, Mackay, & Ross, 2012; Öberg et al., 2011; WHO, 2010). The evidence showed that the ETS problem is also serious in South Asian region compared to developed countries and this is due to population density, lower level of knowledge and awareness, lack of strict public law enforcement (IIPS, 2011; Oberg et al., 2011; WHO, 2010).

Tobacco-related consequences on the youths are different from those on adults. Youths are more vulnerable to develop strong addictive behaviour with a high likelihood to result in long-term TC. Since youths have a longer period of TC, and if they get addicted from a young tobacco initiation age, they are replacements for smokers who quit or die. In addition, for youths in schools, any negative health outcomes may directly affect absenteeism in class and examination, and increase the dropout rate. Moreover, TC put extra strains on family budget especially for the poor and will indirectly increase the government expenditure on health and education (Eriksen, Mackay, & Ross, 2012; WHO, 2009). The tobacco industries are shifting their business focus from developed to developing countries and targeting the youths especially girls. Girls are getting more attention because the prevalence of TC is lower among them than their male counterparts in South Asia (Eriksen, Mackay, & Ross, 2012; WHO, 2009). Despite established country-specific tobacco control laws and policies, and WHO's Framework Convention on Tobacco Control (WHO FCTC), high TC and nicotine dependence is still a major concern in South Asia. Prevalence, patterns and determinants of TC vary across different socio-demographic groups; knowledge, attitude and perception towards TC; geographical areas and exposure to ETS (Eriksen, Mackay, & Ross, 2012; WHO, 2011).

Like the widespread TC, IDU and their impacts on the individual, family and community levels are increasing globally. Particularly, the impacts of IDU are huge in developing countries because of poor health infrastructure and limited resources (UNODC, 2010). Geographically Bangladesh is highly vulnerable to the impacts of IDU because of its proximity to the drug trafficking zones of the Golden Triangle and the Golden Crescent, and its common boundary with India (a leading consumer of opium) and Myanmar (the largest drug abuse country) (Banglapedia, 2006; UNODC, 2010). Besides, TC has long been proposed as a "gateway drug" to other illicit substances, which harm both psychosocially and pharmacologically (Kandel & Yamagchi, 1993) particularly in individuals with attention-deficit or hyperactivity disorder (Biederman et al., 2006).

Most of the studies conducted so far dealt with micro-level data and the selection of predictors on TC was also limited. Due to lack of national level data on TC and its diverse influencing factors (i.e. predictors) in South Asian region, little is known about the vulnerability of these issues. Numerous studies on TC among youths and adults used binary logistic regressions. They mostly analyzed dichotomous outcomes whether one is smoking cigarettes or not. However, in South Asian countries, diverse tobacco products (cigarettes, *bidis*, and other smoked tobacco products, and smokeless tobacco products) are used and there is a need for advance statistical methods for analysis. A few studies on developed countries used classification and regression tree

(CART), a data mining technique, for characterizing smoking patterns. This technique was not used for characterizing smoking patterns in South Asian countries. However, CART has enormous statistical properties over traditional methods (Agresti, 2007; Giskes et al., 2005; Hagman et al., 2008; Moon et al., 2012; Ruben & Canlas Jr, 2009; Soni, et al., 2011; Srinivas et al., 2010). For ETS exposure, most of the studies utilized binary logistic regressions for different settings such as at home (yes or no), at workplace (yes or no), and at public places (yes or no). However, ETS exposure is not limited to dichotomous category only, as exposure can be at different levels (little, some, more, most) and therefore more advanced techniques such as multinomial and ordinal logistic regressions should be used rather than binary logistic regression only. In addition, diamond-shaped equiponderant graphs (Li et al., 2003) can be used to display ETS exposure in different settings by age groups. This type of advanced presentation was not used in analyzing ETS exposure in South Asian countries. To examine association between TC and IDU, bivariate analysis was commonly used in some studies on South Asia. However, it is appropriate to use logistic regressions adjusted for other variables as confounders to measure such type of relationships (Padrão et al., 2011; Patton et al., 2005; Perera et al., 2005).

In relation to the points raised by WHO FCTC, and policies of other developed countries, the implementation of some strategies such as “warning messages on tobacco products” and “concept of plain packaging” was confusing in South Asian countries. However, graphic advertisements about the harmful effects of tobacco at points of sale and at mass media and involvement of religious and community leaders were not addressed adequately in the literature on this region.

In view of the harmful effects of TC, ETS and IDU on health and socio-economic development of developing countries like South Asia, there is an urgent need for public health interventions, with programs designed more effectively using information from influencing factors. It should be noted that, WHO along with other voluntary organizations, whether at the global, regional, or country specific levels, have tried to reduce or control their adverse health effects, but the outcomes are not uniform (Eriksen, Mackay, & Ross, 2012; Samet & Wipfli, 2010; WHO, 2009). Numerous studies have been conducted on TC, ETS and IDU, and their adverse health effects in many developed countries and some middle-income countries. However, comprehensive research on developing countries where their consequences are serious lags behind. Researches on TC, ETS and IDU and their influencing factors in South Asian countries are limited. Therefore, the factors identified in this study will help to fill the research gap and also offer helpful insights for the design and implementation of control programs on these issues.

1.8 Research Questions

There are three main research questions to be answered in this study. These are:

- How are socio-economic, demographic and environmental factors and health knowledge associated with tobacco consumption behavior? Are peers', friends', parental or familial TC the predictors of youth tobacco usage?
- What are the factors associated with environmental tobacco smoke (ETS) exposures among adults? Is there any association between ETS and TC?
- What are the factors influencing illicit drug use? How strong is the association between IDU and TC?

1.9 Research Objectives

The specific objectives of the research are:

- To examine the prevalence, patterns and determinants of tobacco consumption among youths and adults in South Asia.

- To examine the prevalence, patterns and determinants of environmental tobacco smoke (ETS) exposure among adults, and the association between ETS and TC.
- To examine the prevalence, patterns and determinants of illicit drug use, and the association between IDU and TC.

1.10 Outline of Thesis

The rest of the thesis is outlined as follows. **Chapter 2** reviews the current and past literature, mostly on prevalence, patterns and determinants of TC among youths and adults; environmental tobacco smoke exposure; knowledge, attitude and perception towards the consequences of TC; and illicit drug use. The review includes theories related to TC and health behavior among youths and adults and ETS exposure, and theories on TC and IDU. This chapter also reviews the literature on statistical techniques commonly used in TC studies and other methods related to the thesis. **Chapter 3** provides an overview of different sets of data used in this study, their sampling procedure, and the variables used. This chapter also provides the conceptual and analytical frameworks along with a brief explanation of the statistical techniques. **Chapter 4** reports the findings on TC among youths and adults. This chapter also incorporates the analysis based on a data mining technique for characterizing smoking patterns of adults. **Chapter 5** provides the empirical findings on environmental tobacco smoke (ETS) exposure among adults. The analysis covers the suitable techniques for ETS exposure in different settings. **Chapter 6** explores the empirical findings on illicit drug use and its association with TC among males. This chapter also compares the findings for the general male population and young urban slum male population. Finally, **Chapter 7** provides a brief summary, policy recommendations, contributions and limitations of the study. In addition, this chapter also includes suggestions for future research.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The number of studies conducted on the tobacco consumption (TC), environmental tobacco smoke (ETS) exposure, and illicit drug use (IDU) has grown significantly over the last few decades. The list of works that cover a wide area of studies on national development policies and strategies related to these issues is also long. This chapter provides a review of literature relevant to these three core issues and is divided into three main sections. **Section 2.2** reviews the theories related to TC and health behavior among youths and adults, ETS exposure among adults, and theories on drug use and abuse. **Section 2.3** reviews the empirical findings on prevalence, patterns and determinants of TC among youths and adults. This section also reviews the literature on knowledge, attitude and perception (KAP) towards the consequences of TC, environmental tobacco smoke exposure among adults, and IDU and its association with TC among males. **Section 2.4** reviews the literature on statistical tools and techniques relevant to this study, especially regressions, data mining techniques and diamond-shaped equiponderant graphs. Finally, the chapter concludes by highlighting the research gaps in literature in **Section 2.5**.

2.2 Theoretical Framework

2.2.1 Health Belief Model (HBM)

This is a psychological model that describes and predicts health behaviours, focussing on the attitude and beliefs of individuals, by using key variables (Rosenstock, Strecher, & Becker, 1994) including perceived threat (susceptibility & severity of health condition); perceived benefits; perceived barriers; cues to action; various demographic, socio-psychological, and structural variables that directly affects an individual's perceptions and thus indirectly influences health-related behaviour and self-efficacy. Bandura (1977) first introduced this idea of health behaviours. Therefore, the HBM theory assumes that self-destructive behaviour, such as smoking and drug use occurs when individuals, (a) have little knowledge or sometimes lack of adequate information about the health risks that occur due to their behaviour; (b) do not understand the susceptibility to the consequences of their behaviour; (c) do not understand that if they avoid such behaviours, the health risks will decrease; (d) encounter other informational obstacles to change their behaviours. Therefore, the HBM theory suggests that the strengthening of perception about the health risk and harshness of the penalties of their physical vulnerability might change the behaviour of individuals with such risky indulgence.

2.2.2 Theory of Reasoned Action and Theory of Planned Behaviour

According to the theory of reasoned action (Ajen & Fishbein, 1980; Fishbein, Middlestadt, & Hitchcock, 1994; Fishbein, 2008) and the theory of planned behaviour (Ajzen, 1991), an individual's intention is influenced by any one or both of the following two mechanisms: (a) attitude toward performing the behaviour, or one's overall feeling of favourability toward performing the behaviour, and/or; (b) subjective norms, or the degree to which salient significant referents are perceived to approve (or not approve) the behaviour. Attitude and norms are, in turn, influenced by the underlying principles that motivate them. The different penalties for performing the behaviour may be noticeable and held with belief of different strengths by diverse groups of the population. Therefore, the consequences that drive the behaviour of one group (e.g., youths) may differ significantly from another group (e.g., adults).

2.2.3 The Integrative Model

In the integrative model, attitude, perceived norms, and self-efficacy are functions of underlying beliefs associated with each of them (Fishbein & Ajzen, 1975, 2010). For instance, a youth's perceived norms toward TC (e.g., whether friends or family members approve of youth TC) may influence the intention to adopt the risky behaviour of TC. In such situation, campaign messages may be useful to change those norms and behaviours. Nevertheless, a tobacco user could have intentions to quit such behaviours but may have deficiency in self-efficacy that would allow such behaviour to continue. In that case, campaign messages may target improvements of self-efficacy.

2.2.4 Protection Motivation Theory

According to the protection motivation theory (Rogers, 1975), whether one will change a health destructive behaviour such as TC (whether smoked or smokeless products) and drug use depends on the perceived harshness of a susceptible event (e.g., heart disease, lung cancer, stroke, emphysema etc.), and the perceived likelihood of the event. The motivation to change depends on the efficacy of the suggested preventive behaviour (the perceived reply efficacy), and the perceived self-efficacy (i.e., the level of confidence in one's ability to accept the suggested preventive behaviour).

2.2.5 Social Cognitive Theory

The social cognitive theory is a learning theory based on the philosophy that people learn by observing what others do and will not do; these procedures are essential to considerate personality **(**Bandura, 1977, 1986, 1989). While social cognitists agree that there is a reasonable amount of inspiration on development generated by learned behaviour shown in the environment in which one grows up, they believe that the individual person (and therefore cognition) is just as significant in determining moral development. This is a triadic, vigorous and reciprocal contact of personal factors, behaviour, and the environment with key the constructs of reciprocal determinism, symbolizing, vicarious, forethought, self-regulatory, and self-reflective capability.

2.2.6 Social Development Theory

The social development theory explains qualitative changes in the structure and framework of society that help the society to better understand its aims and objectives (Catalano & Hawkins, 1996; Hawkins & Weis, 1985). This is a general theory of human behavior that assumes similar developmental procedures leading to either pro-social or antisocial consequences.

2.2.7 Theory of Triadic Influence and other Social Theories on Youth TC

A systematic review (Kimberly, 2003) showed how the theory of triadic influence, primary socialization theory, social identity theory and social network theory influenced adolescent TC behaviour. For instance, factors influencing the risky behaviour of adolescents can be categorized into three hierarchical levels. Individual characteristics (e.g., age, gender, education, etc.) form the first level. The second level relates to the immediate social environment (e.g., friends, family members, peer groups, etc.). The third level is made up of the broader social environment (e.g., society, media influence, governmental policy, etc.). Furthermore, some theories explain that tobacco-related consequences on the youths are different from those on adults (Ajen & Fishbein, 1980; Ajzen, 1991; Fishbein, Middlestadt, & Hitchcock, 1994). Youths are more vulnerable to develop strong addictive behaviours with a high likelihood to result in long-term TC. Since youths have a longer period of smoking if they get addicted from a young age of tobacco initiation, and are replacements for smokers who quit or die, they remain the targets of tobacco industries (WHO, 2009). The tobacco control policies influence tobacco related behaviours through a causal chain of policy-specific variables, health behaviours, and psychosocial mediators (Flay et al., 1999; Fishbein, Middlestadt, & Hitchcock, 1994).

2.2.8 Theory on Environmental Tobacco Smoke Exposure

Theories of behavior change, especially psychological theories, include thoughts, beliefs and experiences as important mediating factors of behavior change. These factors are organized in hierarchical levels showing mutual interactions between activities taking place at different levels from the physiological to the broadly societal factors (Winett, King, & Altman, 1989; Stokols, 1992). For example, the behavior of not smoking around others can have both directed (obvious) and indirect effects for ETS control. The indirect effects can occur through the actions of influencing others to behave in a similar manner. Such effects can also influence the subsequent likelihood of the smoker in persisting with the behavior. Understanding individual actions require different theoretical models on those involved in negotiating social change. There are also differences in the tasks for smokers and non-smokers in negotiating with others to achieve smoke-free areas.

Contemporary theories of behavior change (Glanz, Lewis, & Rimer, 1997; Kok et al., 1996) postulate broad classes of variables that influence behavior change: (1) attitudes and beliefs about the behaviors; (2) beliefs about self-efficacy to enact and/or maintain the target behavior change; (3) the role of contextual factors, particularly social factors, either directly and/or mediated through beliefs of the behavior; (4) previous experience with the behavior either directly or indirectly through the processes of social influence; (5) priority for action, a person can only pursue a limited number of goals at any one time; and (6) the notion of a stage-based or systematic step-like progression towards behavior change.

According to the trans-theoretical model (TTM) of behavior change (Prochaska, DiClemente, & Norcross, 1992), pre-contemplation, contemplation, preparations, action, and maintenance are conceived in terms of readiness to change. Weinstein (1988) identified a stage prior to pre-contemplation and termed it blissful-ignorance where the person has not really come into contact with the possibility that their behavior might be harmful, which may often is the case in uninformed populations. Based on TTM in ETS control where trials of new behaviors are likely to be important, it may also be useful to combine preparation and action into the stage of behavioral exploration. This may be more realistic than postulating a discrete shift from no action to ideal levels of ETS control. To get a person to consider moving from pre-contemplation to contemplation requires making the information available and salient, and encouraging a focus on the implications. By contrast, encouraging trials of ETS control measures involves providing advice on suggestions and strategies that are most likely to be useful and, if necessary, reframing set-backs as learning experiences.

2.2.9 Theories on Drug Use and Abuse

National Institute of Drug Abuse (NIDA), USA published more than 40 theories on drug use (Lettieri, Sayers, & Pearson, 1980). These theories mostly concentrated on IDU or on alcoholism and can be broadly categorized into (a) biological, (b) psychological, and (c) sociological. Each of the theories focusses on different range of factors that are vital in defining why people use and abuse substances (Lettieri, Sayers, & Pearson, 1980). Briefly, biological theories assume some specific physical mechanisms of individuals that drive or influence them either to experiment with drugs or to abuse them once they are exposed to it, and they cover with two aspects, namely, constitutional and environmental. They are related to the genetic theories (Kolata, 1987; Schuckit, 1980, 1984) and the theory of metabolic imbalance (Dole & Marie, 1980). The psychological theories rely on psychological factors with two basic varieties, reinforcement theories (McAuliffe & Robert, 1980) with positive and negative reinforcements (Bejerot, 1972) and psychodynamic theories (Ausubel, 1980a). The later class includes factors such as inadequate personality and self-esteem, or self-derogation, and problem behavior proneness. The biological and psychological theories tend to emphasize individualistic factors (Jessor & Jessor, 1978). In contrast, sociologists tend to explain the behavior using broader structural factors. The focus of their theories comes from seven partially overlapping theories (Akers et al., 1979; Cloward & Ohlin, 1960; Hirsch & Spinelli, 1970; Merton, 1957) for explaining drug use. They are: (1) anomie, (2) social control, (3) self-control, (4) social learning and subcultural, (5) selective interaction or socialization, (6) social disorganization, and (7) conflict.

The gateway drug theory (popularly known as gateway theory or gateway hypothesis or gateway effect) explains that the use of less harmful drugs may lead to a future risk of using more hazardous hard drugs and/or crime (Golub & Johnson, 2001; Pundey, 2002). The health behavior model of stress indicates that individuals under stress have a higher tendency to pick up health-detrimental behaviors like TC and IDU, where the problem is more severe among those with low income and social status (Dell et al., 2005; Fisher et al., 2005).

2.3 Empirical Evidence

2.3.1 Youth Tobacco Consumption

The prevalence of tobacco consumption (TC) of any form and the resulting death rates were still high in developing countries (WHO, 2009). The gap in TC related death rates between developing and developed countries is likely to increase over the next several decades (Samet & Wipfli, 2010). The increase in youth TC, not only in percentages but also in numbers, in developing countries widened this gap further (WHO, 2009). The prevalence of youth TC in developing countries varies by country and gender. The males were more likely to consume tobacco than females (Lim et al., 2006;

Sirirassamee et al., 2009; WHO, 2009). Globally, the prevalence of using any tobacco products among youths ranged from 3.3% to 62.8%, with approximately 25% of users having used the products for the first time before they were 10 years of age (WHO, 2009). The prevalence of TC among youths (males vs. females) aged 13-15 years in some selected countries was as follows: Cambodia (male 7.2%, female 3.0%); China (7.1%, 4.1%); Malaysia (40.0%, 11.5%); Mexico (27.8%, 28.5%); Philippines (28.3%, 17.5%); Poland (21.4%, 17.3%); Russia (30.1%, 24.4%); Turkey (11.1%, 4.4%); Ukraine (29.8%, 22.2%); Vietnam (6.5%, 1.5%); Indonesia (24.1%, 4.0%); Myanmar (21.7%, 8.2%), and Thailand (21.7%, 8.4%). The prevalence of TC among youths (males vs. females) aged 13-15 years in South Asian countries was reported as follows: Bangladesh (male 9.1%, female 5.1%); Bhutan (18.3%, 6.3%); India (16.8%, 9.4%); Maldives (8.5%, 3.4%); Nepal (13.0%, 5.3%); Pakistan (12.4%, 7.5%); and Sri Lanka (12.4%, 5.8%) (Eriksen, Mackay, & Ross, 2012; WHO, 2009). Furthermore, a study in Thailand, Vietnam, and Malaysia showed a growing trend of TC among youths (Thanh et al., 2005; Vichit-Vadakan et al., 2004). In Thailand, TC rates among youths of aged 15-19 years were found to be more than doubled between 1999 (about 6%) and 2003 (about 16%) with significant increases among the girls (Vichit-Vadakan et al., 2004). A study in Vietnam showed more than 43% of youths aged 16-23 years had experimented with smoking. About 33% males smoked at least one cigarette per day and most of them started smoking in their teens (13-18 years old) (Thanh et al., 2005).

Youths are the target for tobacco industry, because they represent replacement users who quit or die (Gilmore, 2012; WHO, 2011). The GYTS found that worldwide, about 20% of students aged 13-15 years were currently using tobacco products, where 9% were smoking cigarettes and 11% were using other tobacco products (BHF, 2009; Wipfli & Samet, 2009). Though the survey findings showed that use rate among girls in many countries stayed at less than 10%, but in some other countries, the prevalence of

TC among girls and boys were trending in the same direction. Studies on Thailand, Vietnam, and Malaysia showed that age, gender, school performance, and smoking among friends, parents, family members and school staff significantly influenced initiation and smoking behavior among students (Vichit-Vadakan et al., 2004). Some studies reported socio-demographic and environmental conditions, parental and peer influence, motivational and programmatic inclination as likely reasons for youth TC (Kokkevi et al., 2007; Leatherdale et al., 2005b). Family history of smoking and peer influence has substantially increased the likelihood of smoking initiation among youth at an earlier age compared to those living in non-smoking environment (Chassin et al., 2005; Leatherdale et al., 2005b). Youths exposed to smoking at home generally perceived smoking as a social norm and have the tendency to follow this risky behaviour (Sirirassamee et al., 2009). Similarly, exposure to smoking at schools and other places also explained the smoking behaviour of youth, as they feel it is socially acceptable to smoke after witnessing other students smoking near or in schools (Leatherdale & Manske, 2005).

Research on youth TC has examined the influence of youth characteristics and features in immediate social environment (Eisenberg & Forster, 2003; Poulsen et al., 2002; Scal et al., 2003; USDHHS, 1994). Although factors from a broader social environment were less understood, school-level characteristics were found to be related to experimental and regular smoking (Leatherdale et al., 2005a; Leatherdale & Manske, 2005; Leatherdale et al., 2005b; Maes & Lievens, 2003; Wakefield et al., 2000). For example, initiation of TC was more likely to occur in elementary schools (Leatherdale & Manske, 2005), while secondary schools (Leatherdale et al., 2005a, 2005b) had higher TC rates among senior students, and particularly among students with many friends who smoked (Leatherdale et al., 2005a, 2005b). Students who had friends and family members that used any tobacco products were more likely to be ever users

(Kaufman et al., 2002; Leatherdale et al., 2005b; Simons-Morton, 2002; Wu et al., 2003). Perception of smoking such as buzz, and cool image, or group membership can easily influence youths to initiate smoking (Anderson et al., 2002; Bandura, 1986).

Smoking among youths was strongly associated with living with one or more smokers (Craig & Mindell, 2008; Fuller, 2007). A survey in England on 11-15 years old showed only 4% who did not live with a smoker were a regular smoker, compared with 10% living with one smoker, 15% with two smokers and 25% with three or more smokers in their household (Fuller, 2007). In Britain, one study on teenagers of 11-15 years old showed the respondents whose parents were both smokers were more likely to be a smoker. It also showed that they were more likely to smoke if their friends were smokers (Craig & Mindell, 2008). A study in South London showed, smoking by parental figures (biological or not) was linked with a higher occurrence of smoking among teenagers. This study also showed that maternal smoking had a greater influence on both sons and daughters (Fidler et al., 2006). A longitudinal study in Liverpool on 12-16 years old youths found the association between parental and adolescent smoking status. Ninety-nine per cent of regular adolescent smokers in the study lived with at least one smoker in the house (Woods et al., 2008). A study on youths who were 15 years old in seven countries in Europe, including Scotland and Wales, found that incidence of smoking was lower among those from intact families and significantly higher among those from stepfamilies (Griesbach et al., 2003). A Scottish survey in 2006 among 13-15 year old non-smokers found that their family had a negative attitude to smoking compared to regular smokers (Maxwell et al., 2007). A large scale study in selected European countries (UK, Slovenia, Romania, Greece, Croatia, and Bulgaria) with national probability samples of 16 years old adolescents showed older siblings' smoking was strongly associated with adolescent smoking behaviors, but the extent of influence was not the same as that of peers' smoking (Kokkevi et al., 2007).

Walsh and Tzelepis (2007) systematically reviewed 30 qualitative studies that covered peer influences on adolescents and TC. Seven qualitative studies found that peer influence encouraged tobacco initiation among teenagers. Nineteen of the studies found that teenagers primarily experienced smoking as a social and group activity carried out with their smoking peers. A subsection of these studies concluded that smoking provides a common activity for bonding and breaking into new social situations (Fry et al., 2008). Seventeen studies stated the view that adolescent smokers directly forced their non-smoking peers into smoking, although actual incidents were rarely reported in the studies. When comparing the relationship between this qualitative evidence and that from the quantitative literature, the qualitative literature found that adolescents who chose to join peer groups were aware that it may impact their own smoking behavior. This supports the quantitative evidence that the effects of peer selection are significant factors in affecting adolescent smoking (Walsh & Tzelepis, 2007).

The European smoking prevention framework study in Denmark, Finland, Netherlands, Portugal, Spain and the UK on 13-14 years old teenagers, using cross-sectional regression analyses found that in the UK (and across all the countries), the adolescents' smoking behavior was most strongly linked with that of friends, compared to parental smoking (De Vries et al., 2003a). The study which also researched samples of 16 year olds from the UK and Eastern Europe found that, across the countries, peers' smoking was very strongly connected with adolescent smoking behaviors (Kokkevi et al., 2007). For a younger age group, the secondary school phase (12-16 years old) of the Liverpool longitudinal study on smoking found that in all years of the study period (2002-2006), friends were overwhelmingly the source who provided them with their first cigarette (Woods et al., 2008). One cohort survey in England found that 25% of youths in school years 7, 9 and 11 who had a low sense of 'neighborhood belonging' smoked compared with 14% of those with a high sense of neighborhood belonging (Morgan et al., 2006).

Some studies have shown the influence of psychosocial factors on youth TC. For example, studies on youths in USA found that parental smoking termination, parenting style and smoking related parenting practices had an effect on smoking behaviors of the youths (Chassin et al., 2002, 2005). In China, it was found that smoking among influential persons and attitude towards smoking both directly and indirectly influenced youth smoking behaviors (Chen et al., 2006). A study in Japan recommended that self-confident efficacy to struggle against peer pressure, parental connection, adjustment to schooling, and divergent peer influence were the potentially significant factors related to smoking among Japanese youths (Ando et al., 2007). Gender differences have a strong consequence on smoking in most of Asian countries. In Thailand, Bangladesh, and India for example, incidence of smoking among male youths was higher than female youths (Sirirassamee & Sirirassamee, 2006). A study on Thailand showed that peer pressure had strong effect on adolescent smoking behaviors. Youths who have many close friends who smoked tend to imitate their smoking behavior because they want to be accepted by their peers (Sirirassamee et al., 2009).

Parents and older siblings were considered as role model for youths. Youths who saw their parents and older siblings smoked might perceive smoking as a social norm and follow this behavior (Sirirassamee et al., 2009). The factors among others, connection to family and friends, school factors, lifestyle, parental and peer smoking have influenced youth tobacco smoking (Ma et al., 2003; Piko, 2001). Family members' behaviors and attitude regarding smoking have been reported to be one of the strongest factors of smoking initiation among youths (Ma et al., 2003; Pinilla et al., 2002; Viatro et al., 2004). Parental TC may legitimize TC in the perception of their children, or alternatively, it may be a substantial lesson for the children on the harmful and addictive nature of TC (Meijer et al., 1996). Peers have been commonly cited as major reasons for smoking initiation (Pinilla et al., 2002; Viatro et al., 2004). Usually youths reported an inner self-pressure to smoke if others around them do so in order to avoid possible exclusion by peers, to gain social endorsement, and to achieve a sense of self-sufficiency and independence (Sasco & Vainio, 1999). The influence of peers on regular smoking was greater than that of parents and siblings (Sasco & Vainio, 1999). A study on youths aged 15–21 years in Scotland found that friends had larger impact on smoking than did parents or siblings (West et al., 1999). Peer network influences were powerful in the TC process, and a higher prevalence of TC and a stronger peer network, will increase the prediction of TC (Kotwal et al., 2005). Curiosity, peer pressure, and the feeling of maturity have been revealed to be the important factors responsible for the commencement of smoking among youths in Malaysia (Manaf & Shamsuddin, 2008; Naing et al., 2004). Smoking among close friends, and older siblings were important determinants for adolescent smoking behaviors among Thai adolescents (Rudatsikira et al., 2008; Tawima et al., 2009). In many studies, parental smoking status was related to youth smoking behaviors (Chassin et al., 2002; Wakefield et al., 2000). However, family role in tobacco control policy on adolescent smoking behavior has been poorly investigated (WHO, 2010).

Adolescent smoking behaviours were influenced by parental, peers and environmental predisposition (Tarafdar et al., 2009). Smoking status among family members especially parents have influence on youth smoking behaviors as those who lived with smokers were more likely to start smoking at an early age compared to those who live in a non-smoking home environment (Akpinar et al., 2006; Kestila et al., 2006; Khuder et al., 2008). Youths with larger family size tend to become smokers, because there is higher chance of having at least one member of the family being a smoker which in turn influenced smoking behaviors of other family members (Tyas &

Pederson, 1998). A study in Bangladesh found that smoking was significantly associated with parental smoking, and exposure to smoking at home, school and or public places (Rahman et al., 2011). Parental smoking status significantly increased the smoking risk among their children, who were more likely to be prospective smoker if they saw their parents smoking in front of them (Flora et al., 2009; Kwamanga et al., 2003). Father's smoking habit has a significant influence on youth smoking habit in Bangladeshi communities, and the risk could be almost double if they witnessed their fathers smoking (Tarafdar et al., 2009). In such situation, adolescents may develop a 'norm' to smoke and consider smoking as a tolerable behavior, knowing that their parents also smoke. It was also found that smoker parents were less likely to deter smoking among their own children. In smoking friendly environment, the youths have easier access to tobacco products at home and they learn the skills of TC by copying their parents (Shamsuddin & Haris, 2000).

2.3.2 Adult Tobacco Consumption

About 40% of the smokers in the world were from China, India, Indonesia and Russia. China has 20% of the world population, and this country produced and consumed about 30% of the cigarettes produced in total (Eriksen, Mackay, & Ross, 2012; WHO, 2009). The prevalence of TC among adults (males vs. females) aged 15 years and above in some selected countries was as follows: Cambodia (male 48.0%, female 3.6%); China (60.8%, 4.2%); Malaysia (46.4%, 16.3%); Mexico (30.4%, 9.5%); Philippines (57.5%, 12.3%); Poland (34.0%, 23%); Russia (60.0%, 23.2%); Turkey (50.6%, 16.6%); Ukraine (62.3%, 16.7%); Vietnam (49.4%, 2.3%); Indonesia (46.8%, 1.4%); Myanmar (48.9%, 13.7%) and Thailand (36.6%, 1.6%). The prevalence of TC among adults (males vs. females) aged 15 years and above in South Asian countries was as follows: Bangladesh (male 48.5%, female 25.4%); Bhutan (8.7%, 4.9%); India (57.0%, 10.8%);

Maldives (37.4, 15.6%); Nepal (31.6%, 17.2%); Pakistan (32.4%, 5.7%) and Sri Lanka (39.0%, 2.6%) (Eriksen, Mackay, & Ross, 2012; WHO, 2009). While women accounted for about 20% of the world's 1 billion smokers, their use rates were on the rise because they remained the targets of the tobacco companies (Blecher & van Walbeek, 2004; CDC, 2008; WHO, 2009).

Patterns and practices of TC varied globally. The TC among adults has leveled off or decreasing along with related death rates in many developed countries and some middle income countries. However, TC as well as its associated consequences was rising in many developing countries (Wipfli & Samet, 2009). In comparison with developed countries, the prevalence of TC in developing countries has lagged more or less 40 years. For instance, in China, TC among males averaged 1, 4, and 10 times per day in 1952, 1972, and 1992, respectively (Peto & Lopez, 2004). The increase in prevalence of TC in developing countries was largely due to the result of complete change and globalization of the tobacco business between1970-1998. Because of business dissemination and aggressive publicizing, prevalence of TC among males in many developing countries now approached or surpassed 50% (Wipfli & Samet, 2009).

There were few female tobacco users until after 1920 in developed countries. As a business strategy, for example, Marlboro was launched as a brand for females in 1924 (Brandt, 2007). Over 40% of the females in the United States and Great Britain were smokers by 1974 (Samet, 2004). In the past 25 years, the prevalence of TC among females in developed countries has dropped sharply. However, in some Central, Eastern, and Southern European countries, the prevalence of TC was still high and rising among females. This scenario of rising TC among females in some developed countries has narrowed the gap of gender differentials in recent years (BHF, 2009). In developing countries, where females smoked far less than their male counterparts they were found to be target of marketing by the tobacco companies (Wipfli & Samet, 2009).

The prevalence of smoking among women remained at less than 5% in many Asian and African countries. For example, in Bangladesh, smoking tobacco among females was 1.5% compared to 44.7% among males. However, smokeless tobacco use among females and males (27.9% vs. 26.4%) was approximately the same (Eriksen, Mackay, & Ross, 2012; MMWR, 2008). The prevalence of smoking was much lower among females than males in Thailand (3.1% vs. 45.6%). However, the prevalence of smokeless tobacco use was found higher among females than males (6.3% vs. 1.3%) (Eriksen, Mackay, & Ross, 2012; MMWR, 2008). Some findings revealed that the traditional social acceptance of smokeless tobacco use among females in Southeast Asian countries and the older women were using more smokeless tobacco than the younger women (Gupta & Ray, 2003). In Thailand and Bangladesh, it was found that for both males and females, smokeless tobacco use was increased according to age group, and more dominant among rural residents than their urban counterparts (MMWR, 2008; WHO, 2010).

Studies in Western countries have related social and economic factors and smoking to the harm caused on those in the disadvantaged groups (Barbeau et al., 2004). Some independent studies at global level (Rani et al., 2003), national level (Hosseinpoor et al., 2011) and sub national (Sorensen et al., 2005) level from developing countries have shown association of TC with demographic, social and economic factors such as age, education, gender, occupation, ethnicity and place of residence. Country representative data on prevalence of TC (with some limitations on age groups and gender representation) were made available from DHSs in Bangladesh (NIPORT, 2009), Egypt (Ministry of Health, 2008), India (International Institute for Population Sciences & Macro International, 2007), Philippines (National Statistics Office, 2008), Turkey (Hacettepe University Institute of Population Studies Ankara, 2003), and Vietnam (National Committee for Population, Family and Children, 2005).

The findings from these data sources revealed that adult TC was higher among males, people living in rural areas, and those with low level of education and low social-economic background.

In terms of the temporal trend of socioeconomic disparities in smoking, the existing literature mainly concentrated on developed countries. Over the past few decades, socioeconomic disparities in smoking prevalence have been widening with the declining of overall smoking prevalence in most developed countries (Giskes et al., 2005; Najman et al., 2006; Smith et al., 2009). Davy (2007) analyzed the General Household Survey (GHS) data from 1972 to 2004/05 in UK. The results indicated that people living in manual households were more likely to become smokers than those in non-manual households, but both groups later gave up smoking at similar rates. People with higher socioeconomic status were more likely to adopt healthier behavior because they have more access to health information due to their higher social positions and were more receptive to health messages with better logical thinking skills (Yen & Moss, 1999). On the other hand, studies on China reported that people in low-income households in low-income areas smoked fewer cigarettes than high-income households, and poorer former smokers were more likely to cite cost of smoking as a reason for quit (Yang et al., 2001).

Country specific TC reflected a composite interaction of personal, familial, cultural, and social factors, plus exposure to tobacco advertising (WHO, 2010). For instance, findings from the United States of America showed that girls and young women were particularly vulnerable to beliefs about self-image and weight control, and also influenced by their female friends and role models, who smoked or consumed tobacco products (WHO, 2010). In history, tobacco companies have taken advantage of the gradually liberalized social attitude toward females and their increased economic empowerment for aggressive marketing strategies (Shafey et al., 2004). The lack of operative tobacco control policies that occurred in low and middle-income countries result in an increase in TC and tobacco-related diseases and deaths. It was found that in all countries, socio-economic factors significantly influenced the TC behaviors among adults. The poorest and least educated people in developed countries have the utmost smoking rates (WHO, 2009). For example, in UK, only 16% of the females and 18% of the males in the highest socioeconomic groups were smokers; whereas in the lowest socioeconomic groups, the corresponding rates were 29% and 32%, respectively (NHS, 2007). An identical inverse relationship was also found between educational status and smoking prevalence. Educational attainment was the most frequently used indicator for describing socioeconomic disparities in smoking (Aekplakorn et al., 2008). With very few exceptions (Cavelaars et al., 2000), the majority of studies reported that smoking was more prevalent among the less-educated factions of the population (Aekplakorn et al., 2008). With respect to occupation and smoking prevalence, a number of studies reported that smoking was more prevalent among blue-collar or unskilled workers than in white-collar workers or administrative professionals (Lee et al., 2007). However, occupational class often showed smaller differences in smoking prevalence, compared with educational attainment. Income was a less consistent predictor of smoking than education and occupation. Higher smoking prevalence was generally found in population with lower household income or wealth level (Schaap et al., 2008). However, in some Southern European countries, such as Italy, Spain, Portugal, and Greece, females with higher income were more likely to be smokers than their counterparts with lower income (Huisman et al., 2005). In some developing countries, no association was found between income and smoking prevalence (Aekplakorn et al., 2008). Several studies applied multivariate analyses to disentangle the associations of different socio-economic status (SES) indicators with smoking prevalence. These studies revealed that much of impact of income or occupational disparities on TC could be explained by education (Laaksonen et al., 2003).

In developing countries, studies regarding TC based on socioeconomic groups were limited with diverse results depending on the population investigated. It was found that in some low- and middle-income countries, the prevalence of smoking was high among those wealthier, whereas the inverse was found in the high-income countries (Jha & Chaloupka, 2000). However, recent studies on TC in low-income countries found a social gradient that is similar to that in Western countries. For instance, TC was more prevalent among the poor, less educated, and low occupational status in India, China, Bangladesh, Nepal, Sri Lanka, Maldives, Vietnam, Indonesia, Pakistan, Mexico, Guatemala, Poland, Hungary, and South Africa (Spigner et al., 2007; WHO, 2009). In Bangladesh, those with lower educational background, residing in rural areas, doing labor oriented work and poor socio-economic status were more likely to be users of cigarettes or *bidis* and other tobacco products (Kabir et al., 2012; Khan et al., 2006). It was also found that the prevalence of TC decreased gradually from lower to higher educational levels for both sexes and in both rural and urban areas. Less educated males started to use tobacco earlier than the better educated males (Khan et al., 2006).

2.3.3 Knowledge, Attitude and Perception (KAP) towards the Consequences of TC

TC was greatly influenced by the level of knowledge of ill effects of tobacco products, individual attitude towards use of tobacco and perceptions about the social acceptance (WHO, 2009). Attitude had a more important role than knowledge. For instance, attitude toward TC were more strongly connected with TC than knowledge about effects of TC (Ashley et al., 2000). It has been shown that knowledge of specific harms of tobacco helps increase motivation for quitting (WHO, 2008). Knowledge of health risks and attitude towards smoking were associated with actions to support smoking restrictions and quitting (Abdullah et al., 2010; Chen et al., 2009; Lim et al., 2006; Mei et al., 2009). Awareness of the health risks of smoking was positively associated with support for smoke-free public places among the adults (Abdullah et al., 2010; Chen et al., 2009; Mei et al., 2009) and the same association was also well-established among Taiwanese adults (Chen et al., 2009). The level of knowledge of ill effects due to TC was found positively correlated with education attainment (Hammond et al., 2006). Knowledge of diseases caused by TC significantly influenced smoking behaviors (Nsereko et al., 2008).

The study showed that, attitude were much easier to chance compared to behavior (Cooper, 2007), and therefore, instead of quit smoking, smokers tend to accept a positive attitude towards smoking. Same findings were reported by several other studies (Parerri-Wattel, 2006). Attitude depends on individual behaviors and can be changed when the person was able to predict the harmful effects in short run compared to any effects in long term (Oncken et al., 2005). Knowledge level was related to gender and education (Aryanpur et al., 2009; Finney et al., 2008), but some studies (Torabi et al., 2002) did not show any association with demographic factors. TC was considered as intolerable and seen to be unacceptable social customs in some Asian countries which had generally conservative societies (Sreeramareddy et al., 2010). Besides the change of social structure and women's empowerment through education and employment, urbanization and marketing approaches of tobacco companies in targeting women have also increased TC among them (Edens et al., 2010).

Some earlier studies discovered that compared to prior tobacco users and non-users, current users especially the heavy users have more positive attitude towards TC (Taylor et al., 1998). In addition to status of TC, attitude regarding TC was also associated with socio-economic characteristics of the individuals. Education has played an important role in shaping attitude. For instance, individuals with higher educational achievement have more negative attitude regarding TC. Results showed that those with higher income believed that cancer, heart disease and stroke were strongly linked with TC compared to those with low income (Manfredi et al., 1992). It was found from some studies that knowledge, attitude and perceptions vary according to status of TC, where tobacco users had less knowledge and perceptions but more positive attitude about TC compared to non-users (Ma et al., 2003; Nabile et al., 2000). The level of education was strongly linked with knowledge, attitude and perception scores. Knowledge on the health effects of tobacco products among the tobacco users and non-users have varied significantly (Lim et al., 2006; Manfredi et al., 1992; Oncken et al., 2005).

Both knowledge and attitude were linked with TC practices in many studies (Ashley et al., 2000; Ma et al., 2003; Nabile et al., 2000; Yu et al., 2002). From a cross-sectional survey in Taiwan, cigarette smoking was significantly associated with knowledge about and attitude toward smoking (Chen et al., 2001). The study showed that attitude was significantly better among women compared to men. Attitude about harms of TC was good but awareness was low and this signified the lack of direct educational programs, and the lack of attention to increase public awareness of tobacco hazards by mass media and other sources (Aryanpur et al., 2009).

2.3.4 Environmental Tobacco Smoke Exposure

Usually, TC involves both the use of smoke and smokeless tobacco products. Tobacco may be smoked in other forms such as smoking of pipes, cigars, water pipes, shisha, hookah, narghile, or hubble-bubble. However, cigarettes and *bidis* were found to be the main sources of exposure among nonsmokers or smokers from the smoking by others. Burning cigarettes or *bidis* produce smoke mainly in the form of mainstream smoke (MS), i.e., smoke inhaled by the smoker during puffing, and side stream smoke (SS), i.e., smoke released by smoldering cigarettes while not being actively smoked. Because of the lower temperature in the burning cone of a smoldering cigarette, many tobacco burning products were more enriched in SS than MS (Eriksen, Mackay, & Ross, 2012). Nonsmokers or smokers were exposed to the mixture of watery SS released from the cigarette's burning end and the MS exhaled by the active smoker (First, 1985). This combination of watery SS and MS has been referred to as environmental tobacco smoke (ETS) or secondhand smoke (SHS). ETS exposure was also commonly referred to as passive smoking (PS) or involuntary smoking (IS).

More than 3,000 diverse chemicals, as well as irritant gases, carcinogens and fine particles are contained in tobacco smoke (WHO, 2009). Nonsmokers or smokers who live or work with a smoker generally have the highest exposure to ETS. Although ETS in public places posed significant hazards, it usually contributed only a slight amount to personal exposure to ETS (WHO, 2009). It was revealed that about one-half of the smoke generated was side stream smoke when cigarettes or other smoked tobacco products were smoked. The released smoke contains basically all of the same carcinogenic (cancer-causing) and toxic agents that have been recognized in the mainstream smoke inhaled by smokers (IARC, 2004). Nonsmokers who were exposed to ETS absorbed nicotine and other compounds just as smokers. Although an unintentional smoker would be exposed to less concentrated smoke than that inhaled by a smoker, research has confirmed that health risks that aroused from inhaling this form of smoke depended on the level or extent of exposure (Patja et al., 2009).

The smoke can blow from one room to another within a building, even if doors to a smoking area were closed. Toxic chemicals from ETS pollution persevere well beyond the period of active smoking, and then gripped to carpets, hangings, garments, food, equipment and other materials. These toxins can persist in a room for weeks and months after someone has smoked there (Singer & Hodgson, 2002), even if windows were opened or fans and air filters were used.

ETS exposure is most common preventable health threats in the community. The projected attributable deaths due to ETS equaled 603,000, of which 28% were projected to be children (WHO, 2009). Although ETS exposure is a well-known risk factor for cancer among adults, there was emerging evidence that it might also be associated with childhood cancers (Boffetta et al., 2000; Filippini et al., 2002; Krajinovic et al., 2000). ETS has been recognized as a pivotal risk factor for a number of health problems among women and adults. The risk exposure to pregnant women includes reduced fetal growth, low birth weight, pre-term delivery and sudden infant death (CEPA, 2005; Filippini et al., 2002). The other risks are spontaneous abortion, intrauterine growth retardation, adverse impacts on cognition and behavior, allergic sensitization, elevated decreased pulmonary function growth and adverse effects on fertility or fecundity, and elevated risk of stroke (CEPA, 2005). ETS exposure causes asthma induction and exacerbation, eye and nasal irritation, middle ear contaminations, heart disease mortality, acute and chronic heart disease morbidity, and alteration in vascular properties for adults irrespective of sex (CEPA, 2005). The association between ETS and lung cancer has been the focus of about 50 studies (CEPA, 2005) and a number of expert panels (CEPA, 2005; IARC, 2004; NIH, 1999; NRC, 1986). There were approximately 20 published studies of breast cancer and ETS (CEPA, 2005), more than 30 studies on childhood cancer and parental smoking (CEPA, 2005), and some studies on brain cancer (CEPA, 2005). Some studies have also related cancers of the nasal cavity, head and neck, stomach, cervix, and bladder, and adult leukemia to ETS (CEPA, 2005; Kasim et al., 2005). ETS was found to be linked with abnormal levels of lung function and increased bronchial sensitivity in both adults and youths (USDHHS, 2006; WHO, 2009). Studies found that ETS exposure among adults and children was a general health threat and exerts major harmful effects on the cardio-respiratory system (Balmes et al., 2003; Iribarren et al., 2001).

Findings from some methodologically robust data on adult ETS exposure showed that ETS posed higher risk after a single brief exposure compared to frequent exposure for prolonged periods of time challenging the conventional belief (Flouris et al., 2005, 2008, 2009). Some evidence undoubtedly demonstrated that ETS has a substantive role in the advancement of chronic diseases (Eisner, 2009). Lifetime exposure to ETS was connected with chronic obstructive pulmonary disease among adults (Eisner, 2009). Some 16 to 24% of lung cancer among adults was due to ETS exposure and this was mainly work-related ETS (Vineis et al., 2007). A meta-analysis of workplace ETS exposure showed a 24% increase in lung cancer risk among workers (Stayner et al., 2007). It also showed that lung cancer among nonsmoker adults exposed to ETS at home had relative risk of 1.3 times higher compared to nonsmokers not exposed at home. In addition to a large and growing health burden, ETS exposure also caused economic problems for individuals and the nations, arising from costs of direct health care as well as indirect costs from reduced productivity (WHO, 2009).

It was found that people from lower socio-economic status experienced higher exposure to ETS and higher risk of lung cancers (Curtin et al., 1999; Samet, 1993). Some study reported that the population of lower socio-economic status has higher prevalence of smoking and consequently a higher likelihood of exposure to ETS (Abdullah et al., 2011). Children from deprived households were found to be more exposed to ETS even after accounting for parental smoking status (Akhtar et al., 2007; Sims et al., 2010). Some studies noted that those with lower socio-economic status, such as low parental education, having a large family, being unemployed, low household income and from single parent families was significantly associated with exposure to ETS (Akhtar et al., 2007; Bolte et al., 2009; Hyland et al., 2009; Sims et al., 2010). It was found in some empirical studies that age, gender, parental and peer smoking status were significantly associated with ETS exposure (Rachiotis et al., 2010; Rudatsikira et al., 2007). Concentrations of ETS were higher in homes where both parents smoked (Kotani et al., 2006; Sims et al., 2010). It was also noted that the husband's smoking history was a good proxy for a wife's ETS exposure and young children were more likely to experience exposure to ETS (Öberg et al., 2011), possibly due to the amount of time spent at home. The people from lower socio-economic status were exposed to ETS more regularly than those with high socio-economic status due to differences in household smoking restrictions (Efroymson et al., 2001).

Knowledge about the harms of ETS significantly influenced TC behaviors and there is evidence of improved level of knowledge among adults with higher education (Abdullah et al., 2011; WHO, 2009). Education has a positive role and both uneducated smokers and nonsmokers do not fully comprehend the health risks of ETS (Öberg et al., 2011). Those with higher awareness of health risks through knowledge, attitude and perception towards ETS and higher education were more likely to express support for smoke-free homes, workplaces and public places (Abdullah et al., 2010; Chen et al., 2009; Evans et al., 2012; Liu et al., 2008; Mak et al., 2008; Mei et al., 2009; Öberg et al., 2011). Empirical findings showed that wives with husband who never smoked had lower incidences of chronic cough and differences were largest when comparing wives with husband who never smoke and those with heavily smoking husband (Koo et al., 1988). Several factors contributed to ETS exposure among adults. Age, gender, smoking status of parents and peers were significantly associated with exposure to ETS in many countries (Rachiotis et al., 2010). A study in England found that concentrations of ETS were higher in homes where both caregivers smoked and also in homes where only the mother smoked compared to the father only (Marbury et al., 1993). With the extensive establishment of smoke-free workplaces and public places, home had become the principal source of exposure to ETS among children and non-smoking adults (Mak et al., 2008; Öberg et al., 2011; USDHHS, 2006).

2.3.5 Tobacco Consumption and Illicit Drug Use among Males

Like widespread TC, substance use and their impacts at the individual, family and community level are increasing globally. Particularly, the impacts of IDU are huge in developing countries because of poor health infrastructure and limited resources (UNODC, 2010). While smoking cigarettes and *bidis* were common habits among the general male population in Bangladesh, TC was also widespread among the young males (Choudhury et al., 2007; Kabir et al., 2012, Palipudi et al., 2012). TC has long been recognized as a "gateway drug" to other illicit substances, which harm both psychosocially and pharmacologically (Kandel & Yamaguchi, 1993), particularly in individuals with attention-deficit or hyperactivity sickness (Biederman et al., 2006).

Globally, around 155 to 250 million people (i.e. 3.5% to 5.7% of the global population) aged 15 and above have used illegal drugs at least once. Of these, some of the commonly used illicit drugs are Cannabis (129 to 191 million), Amphetamine-type stimulants (ATS) (13.7 to 52.9 million), opiates (notably heroine) (12.8 to 21.9 million) and cocaine (15 to 19 million). Opiate users experienced the highest level of harm (UNODC, 2010). Bangladesh is particularly vulnerable to the impacts of IDU because of its proximity to the drug trafficking zones of the Golden Triangle and the Golden Crescent. Phensedyl (a cough suppressant syrup having codeine phosphate) is produced lawfully in India and easily marketed in neighboring Bangladesh through drug trafficking. The overall vulnerability also increases in Bangladesh as this country shares some border with Myanmar, the largest drug abuse country (Banglapedia, 2006). The annual prevalence of cannabis (locally known as *Ganja*) in the population aged 15 to 64 years was 3.3% in Bangladesh (UNODC, 2010). Besides, annually about 4 metric tons opium (popularly known as heroine) was consumed in Bangladesh, and its use is likely to increase in the future (UNODC, 2010). Almost all the heroine consumed in Bangladesh originated from India, the leading consumer of opium (UNODC, 2010).

Rapid and unplanned urbanization along with massive rural-to-urban migration due to the combination of push and pull factors were the major forces of slum growth in developing countries including Bangladesh (Khan & Kraemer, 2008; Khan, 2012). About one-third of the urban populations in Bangladesh were slum dwellers (CUS, 2005), who were often neglected and deprived of basic amenities and services. Moreover, they were exposed to higher risks due to poor housing and neighborhood environment, risky lifestyles, lack of health knowledge, and poor physical and psychosocial health (Khan & Kraemer, 2008; Khan et al., 2009). Risky lifestyle behavior involving TC and IDU was more prevalent in slum areas (WB, 2007). As most of the slum dwellers were poor migrants from rural areas, they face difficulties in the new environment and hence suffer from poor psychosocial health linked to high stress and depression. Most of the migrants usually miss their families, friends and familiar social network and receive less support in stressful situations. High stress tends to induce smoking and deviations from normal lifestyles (Volzke et al., 2006). The health behavior model of stress indicates that individuals under stress have a higher tendency to pick up health-detrimental behaviors like TC and IDU, which was more severe among those with low income and social status (Dell et al., 2005; Fisher et al., 2005). Lack of social networking due to anonymity in the new environment and the absence of elderly family members to provide support among new rural-to-urban migrants were also factors that led to adoption of risky lifestyles. Undesirable features of slums increased the tendency of risky lifestyle behaviors, which was also revealed through higher prevalence of TC among slum dwellers compared to non-slum dwellers in Bangladesh (Khan et al., 2009).

It was found that TC of any form and IDU was positively associated (Chen et al., 2001; Hanna & Grant, 1999; Kamal et al., 2010; Mohler-Kuo et al., 2003; Padrão et al., 2011; Richter et al., 2002). Further supporting evidence for this association was found in many studies. The increased frequency of cigarette smoking may be an indicator for more serious patterns of IDU (Bailey, 1992). Mohler-Kuo et al. (2003) and Khan et al. (2006) reported a positive association between regular smoking and IDU. Another study showed that regular TC was the predictor of life-time drug use (Hanna & Grant, 1999). Chen et al. (2001) found that the use of illicit drugs was more than 6 times higher among tobacco users than non-users. In addition, it was found that cannabis use during teenage and young adulthood was related with an increased risk of TC and nicotine dependence (Patton et al., 2005). Moreover, life-time smoking was associated significantly to alcohol, cannabis, hard drug and multiple drug use disorders, as reported by Lewinsohn et al. (1999). Padrão et al. (2011) reported a positive association between TC and alcohol use. Several studies have also found a noteworthy association between TC and IDU, such as the use of cannabis or cocaine, alcohol, caffeine, and so on (de Leon et al., 2003; Hettema et al., 1999; Schmitz et al., 2003). Some other studies also found substantial association between psychiatric morbidity and IDU after controlling for smoking (Martinez-Ortega et al., 2006). It was also apparent that the heaviest alcohol users were more likely to become the heaviest smokers (Perera et al., 2005).

2.4 Statistical Tools and Techniques

2.4.1 Logistic Regressions

Many tobacco related studies have employed logistic regression in their analysis (Abdullah et al., 2011; Chen et al., 2009; Edens et al., 2010; Hosseipoor et al., 2011; Kabir et al., 2012; Khan et al., 2006, 2009; Padrão et al., 2011; Palipudi et al., 2012; Rachiotis et al., 2010; Rahman et al., 2011; Rudatsikira et al., 2008; Sims et al., 2010; Sirirassamee et al., 2009; Tarafdar et al., 2009; Tawima et al., 2009). The main reason is to deal with variables that are categorical. Linear regression cannot deal with dependent variables that are categorical in nature and the alternatives are a number of regression techniques, including logistic regression (Agresti, 2007; Harrell, 2001; Long, 1997). Frequently "logistic regression" refers to the technique for problems in which the dependent variable is dichotomous (the category of dependent variable is limited to two categories). When there are more than two categories, the techniques are referred to as multinomial logistic regression and if the multiple categories are ordered, then ordinal logistic regression is used (Bender & Grouven, 1997; Chan, 2004, 2005; Kwak & Clayton-Matthews, 2002; Van Houwelingen & le Cessie, 1988). Logistic regression was used to predict the outcome of a categorical dependent variable based on one or more independent variables. The categories or groups of the dependent variables are mutually exclusive and exhaustive, that is a case can only be in one group or the other, and every case must be a member of one of the groups. Large sample sizes are recommended since maximum likelihood estimators for the coefficients are large sample approximations. Therefore, the recommendation for logistic regressions should be at least 50 cases per predictor (Bender & Grouven, 1997; Kwak & Clayton-Matthews, 2002; Van Houwelingen & le Cessie, 1988).

The maximum likelihood (or ML) estimation is used to fit the model. To test the significance of the logistic regression, two hypotheses are of interest (a) null hypothesis, which states that all the coefficients in the regression equation take the value zero, and (b) alternative hypothesis that the model with predictors currently under consideration is significant and differs from the null value of zero, i.e. is considerably better than the chance or random prediction. The log likelihood (LL) is the basis for tests of a logistic model and is based on –2LL ratio. This is a test of significance of difference between the likelihood ratio (–2LL) for the investigator’s model with predictors minus the likelihood ratio for the baseline model with only a constant in it (Chan, 2004, 2005; Hausman & McFadden, 1994; Menard, 2002; Pampel, 2000). The Hosmer and Lemeshow (H-L) test for binary logistic regression, and Pearson and Deviance tests for multinomial and ordinal logistic regressions are used to measure the goodness of fit of the model. Moreover, the Pseudo R^2 (Cox & Snell, Nagelkerke, and McFadden) statistics are for measuring the strength of association between the dependent and independent variables. The overall classification accuracy (in percent) shows the percentage of cases that are correctly classified by the model (Chan, 2004, 2005; Hausman & McFadden, 1994; Menard, 2002; Pampel, 2000). However, in ordinal logistic regression, tests of parallel lines are used with the assumption that the relationships between the predictor variables and the logits are same for all the logits (Bender & Grouven, 1997; O'Connell, 2005).

2.4.2 Classification and Regression Tree (CART): A Data Mining Technique

In comparison to logistic regressions, data mining techniques have not been widely applied for tobacco related research. A few studies that employed this class of methods are Moon et al. (2012), Schane et al. (2010) and Gervilla et al. (2011). Data mining (DM) is the application of special algorithms established from a few disciplines, namely, statistics, artificial intelligence, machine learning, database sciences, and information recovery (Han & Kamber, 2001). DM techniques can be used for different data types covering databases, text, spatial data, temporal data, images, and other complex data (Frawley et al., 1991; Hearst, 1999; Roddick & Spiliopoulou, 1999; Zaïane et al., 1998). The purpose of technique is for knowledge discovery in databases, text and web mining, and they utilize the toolsets and process to yield products which are useful knowledge but different from the original data set (Benoît, 2002; Fayyad et al., 1996; Han & Kamber, 2001). DM is the way of discovery interesting patterns that are not obviously part of the data and which can be used to find out new knowledge of data and to make predictions (Witten & Frank, 2005). DM is a multi-staged process of mining earlier unexpected information from large databases. It detects patterns from data and infers associations and rules from them. This mined information can be applied for prediction and in classification models by detecting relations within the data records or between the databases. The identified patterns and guidelines can then be used for decision making and forecasting the effects of those decisions (Clifton, 2010).

The fundamental principle of data mining is that there are unseen but useful patterns inside data and these patterns can be used to infer rules that allow for the forecast of future results (GAO, 2004). Before the period of 1960 and the beginning of the computer age, a data analyst with expert knowledge and training in statistics can find patterns, make extrapolations, and discover interesting information which is then conveyed via written reports, graphs and charts. But today, the task is too complex for a single expert (Fayyad et al., 1996). Information is spread across multiple platforms and deposited in a wide variety of formats, some of which are structured and some unstructured. Data sources are often inadequate and some data are continuous while others are discrete. All forms of DM are based on the principle to learn new characteristics of the data by applying certain procedures to find patterns and to create models which can then be used to make forecasts, or to find new data associations (Benoît, 2002; Fayyad et al., 1996; Hearst, 2003). The other significant principle is the importance of presenting the patterns in an understandable way. Once patterns have been recognized, they must be taken to the end user in an effective way that allows the user to act on them and to provide reaction for decision making (Han & Kamber, 2001).

The DM techniques such as neural networks (NN), decision trees (ID3, c4.5, CHAID, QUEST, and CART), self-organizing map (SOM), linear regression (local, global), exponential regressions, logistic regression, k-means, CN2, K-NN, radial basis function and bays classifiers are divided into two broad groups, namely, descriptive (clustering) and predictive (classification and regression) (Benoît, 2002; Dunham, 2003; Fayyad et al., 1996; Han & Kamber, 2001; Witten & Frank, 2005). However, the challenge is to decide the appropriate data mining techniques and proper use for application, for instance, when neural networks (NN) are appropriate and when are the decision trees (DTs)? When is data mining suitable as opposed to just working with interpersonal databases and reporting? When would OLAP (On-line analytical processing) and multidimensional database be appropriate? An approach commonly followed in finding a suitable technique is by trial and error. The choice of techniques depends on the types of problem and information available. The advice is to take a robust model that could be an under-performer and perform the analysis without delay, compared to what some of the finest data mining techniques could provide but require a great deal of time to understand and interpret (Benoît, 2002; Dunham, 2003; Witten & Frank, 2005).

Decision trees are predictive models that classify the data into leaf and node, viewed as part of a tree until the entire set has been analyzed. Each branch of the tree is created according to the classification criteria and the leaves of the tree are divided based on all the possible outcomes of the criteria under study. Decision trees produce guidelines that are mutually exclusive and jointly extensive and work from a forecast target downward in what is known as a "greedy" search. It classifies information at each branch point without losing any of the data. For instance, the number of total observations in a parent node is equal to the sum of the observations contained in its two children nodes. Decision tree approach is easy to understand in contrast with other DM techniques (Romei & Turini, 2011; Sarker et al., 2011; Yoo et al., 2012). So it can be used either for the search of new information within databases or building predictive models.

The decision tree algorithms include ID3, C4.5, Chi-Square Automatic Interaction Detector (CHAID), Quick, Unbiased, Efficient Statistical Tree (QUEST) and Classification and Regression Trees (CART). The CART was found appropriate

(Agresti, 2007; Daeppen et al., 2000; Dunham, 2003; Giskes et al., 2005; Hagman et al., 2008; Moon et al., 2012; Ruben & Canlas, 2009; Soni, et al., 2011; Srinivas et al., 2010) due to the following reasons: (a) CART offers a concise way for describing groups with elements that vary in terms of the dependent variable. A set of rules concerning the decisions to be taken to assign a certain element to a class is presented graphically. CART detects "splitting" variables based on a thorough search of all possibilities. Since competent algorithms are used, it is able to search all potential variables as splitters, even in problems with many hundreds of probable predictors. (b) The predictor variables are hardly nicely distributed, many variables are not normally distributed and different groups may have evidently different degrees of variation or variance. Composite interactions or patterns may exist in the data, for instance, the value of one variable (e.g., age) may markedly affect the importance of another variable (e.g., weight). These types of relations are generally difficult and virtually impossible to model when the number of relations and variables becomes extensive. CART is often able to discover complex relations between predictors which may be difficult or impossible to discover using traditional multivariate techniques. CART can handle numerical data that are highly skewed or multi-modal, as well as categorical predictors with either ordinal or non-ordinal construction. Therefore, time could be saved which would otherwise be spent defining whether variables are normally distributed, and making conversion if they are not. (c) CART can competently handle data with a combination of categorical and continuous variables. The Chi-square test is used for categorical variables and F-test is used for continuous variables. For instance, most studies of smoking behaviors among adults have used logistic regression technique which is based on parametric assumption of the dependent variable. However, the parametric assumption of logistic regression often limits its application to data that are the combination of categorical and continuous variables. In that case, CART algorithms can be used to overcome the limitations posed by the logistic regression. CART is naturally non-parametric and no assumptions are made concerning the underlying distribution of the predictor variables and can successfully handle any data type. (d) CART algorithm can efficiently handle missing data through surrogates. For cases in which the value for a variable is missing, other independent variables having high relations with the original variable are used for classification. (e) It is relatively automatic 'machine learning' and less input is needed for analysis. This is a noticeable difference from other multivariate modeling methods, in which widespread input from the analyst, analysis of provisional results, and subsequent modification or refinement of the method is essential. (f) CART has good properties of visualization and simple for non-statisticians to interpret, and more likely to be feasible and practical, since the structure of the rule and its inherent logic are apparent to the readers.

It is descriptive in nature, which makes it easy to understand and interpret the results of the model. In addition, it has the efficiency and scalability of data mining algorithms; useful for handling high-dimensionality and noise as well as uncertainty and incompleteness; uses knowledge in data mining; has pattern evaluation and knowledge integration; has the protection of security, and privacy in data mining (Daeppen et al., 2000; Dunham, 2003; Giskes et al., 2005; Hagman et al., 2008; Ruben & Canlas, 2009; Soni, et al., 2011; Srinivas et al., 2010.

2.4.3 Diamond-shaped Equiponderant Graph

In biomedical and other studies, three-dimensional (3-D) bar graphs are usually used to describe how two categorical variables mutually contribute to an outcome which is continuous in nature (Farahmand et al., 2000; Huang et al., 1997; Klag et al., 1996). However, majority of the 3-D bar graphs do not represent associations between the response variable and each of the two predictors. Moreover, 3-D bar graphs are subject to misconception and misperception if not properly used, and are limited to data that exhibit non-overlapping trends (Cleveland & McGill, 1984; Harris, 1999; Wilkinson, 1999).

Currently, two-dimensional (2-D) substitutes, such as mosaic (Friendly, 1994; Hartigan & Kleiner, 1981, 1984; Wilkinson, 1999), grouped bar graphs (Tufte, 1983), grouped dot plots and framed rectangle charts (Cleveland & McGill, 1984), and Trellis display (Becker, Cleveland, & Shyu, 1996) have been used to overcome these limitations posed by 3-D bar graphs. It should be noted that, none of these 2-D bar graphs can equally represent the associations between a continuous response or outcome and each of the two categorical predictors in a single plot (Li et al., 2003).

The diamond-shaped equiponderant graphs provide a graphing methodology that projects 3-D bar graphs into 2-D whereby the third dimension is replaced with a polygon whose area and middle vertical and horizontal lengths represent the outcome or response which is continuous in nature (Li et al., 2003). The graphical demonstration is invariant to rotations and avoids outcomes in categories being concealed by other visualization effect, for example, changing of scales. Therefore, diamond-shaped equiponderant graphs circumvent the limitations of both 3-D bar graphs and the 2-D substitutes, while preserving the desired feature of 3-D bar graphs. The diamond-shaped equiponderant graphs have not been applied widely in tobacco related studies. A few that applied this graphical representation includes (Twose et al., 2007).

2.5 Research Gaps

2.5.1 Gaps in Empirical Findings

Prevalence, patterns and determinants of TC among youths and adults are commonly researched for developed and middle-income countries. Several studies also reported on ETS exposure, and knowledge, attitude and perception (KAP) about the consequences of TC and the association between TC and IDU. Such studies, however, are very much limited for South Asian countries such as Bangladesh, India, Nepal and Sri Lanka. Few studies have reported the prevalence of TC, ETS and KAP in South Asian countries, and they are limited to very country specific information and while showing huge gap about the issues from cross-country comparisons. It should be mentioned that TC and its adverse effects is not an issue of individual country but rather a cross-border, regional and global problem.

2.5.2 Methodological Gaps

Most of the studies conducted so far dealt with data that may not allow statistical inference at the national level. Due to lack of national level data in many developing countries including South Asian region, little is known about the vulnerability of these issues. Literature also showed that analysis was restricted to choosing few common variables only. Most of the studies on TC among youths and adults used binary logistic regressions. They mostly analyzed dichotomous outcomes i.e. whether one is smoking any cigarettes or not. However, in South Asian countries, diverse tobacco products (cigarettes, *bidis*, and other smoked tobacco products, and also smokeless tobacco products) are used. In addition, knowledge, attitude and perception (KAP) about the consequences of TC is complex issues and deserve more advanced statistical analysis using multinomial and ordinal logistic regressions. Moreover, a few studies in developed countries applied classification and regression tree (CART), a data mining technique, for characterizing smoking patterns. This advanced analysis was not found in the literature on TC related studies in South Asian countries.

For ETS exposure, most of the studies utilized binary logistic regressions for different settings such as at home (yes or no), at workplace (yes or no), or at public places (yes or no). However, exposure level of ETS is not limited to two dichotomous categories only. The level of exposure (little, some, more, most) deserves more attention using techniques such as multinomial and ordinal logistic regressions rather than binary logistic regression only. In addition, diamond-shaped equiponderant graphs were used to display ETS exposure in different settings by age groups and gender in developed countries. This type of advanced presentation was absent in the literature on South Asian countries. Some studies in South Asian countries utilized bivariate analysis to measure association between TC and IDU. However, logistic regression between TC and IDU adjusted for other variables as confounders were reported in the literature on developed countries to measure association between TC and IDU. Same attention ought to be given in the investigation of the association between TC and IDU in developing countries.

2.5.3 Gaps in Policy Level

In relation to the points raised by WHO FCTC and policies of other developed countries, some strategies such as “warning messages on tobacco products” and “concept of plain packaging” may have more ambiguity for implementation in South Asian countries. Such strategies may not be effective or suitable for regions with low literacy rate. However, graphic advertisements about harmful effects of tobacco at points of sale and in mass media, and involvement of religious and community leaders in tobacco control programs were not addressed adequately in the literature on this region.

CHAPTER 3: METHODOLOGY

3.1 Introduction

Tobacco consumption (TC), exposure to environmental tobacco smoke (ETS) and illicit drug use (IDU) are preventable public health problems. The understanding of these issues will help the authorities to take proper policy options at the national, regional and international levels. The literature reviewed in Chapter 2 has highlighted the importance of these issues and provides the foundation for the conceptual and research framework developed in this chapter. This thesis used data from four cross-sectional surveys, namely, Global Youth Tobacco Survey (GYTS, 2007: Bangladesh, Nepal and Sri Lanka), Global Adult Tobacco Survey (GATS, 2010-2011: Bangladesh and India), Demographic and Health Survey (DHS, 2007: Bangladesh) and Urban Health Survey (UHS, 2007: Bangladesh). These surveys were conducted by international and regional organizations with the collaboration of local agencies. Therefore, this chapter provides a discussion about these four different data sources, and their methodologies, country selection, conceptual and analytical frameworks and statistical tools and techniques used in subsequent chapters. **Section 3.2** explains the data source and selection of countries included in this study. **Section 3.3** gives a brief explanation about GYTS and its sampling procedure, while, **Section 3.4** provides a brief explanation about GATS and its sampling procedure. BDHS and BUHS and the sampling procedure are explained in **Sections 3.5** and **3.6**, respectively. **Section 3.7** provides the conceptual and analytical frameworks for the entire study. **Section 3.8** described the statistical tools and techniques used in this thesis.

3.2 The Data

3.2.1 Data Source

The study utilized data from secondary sources, namely, Global Youth Tobacco Survey (GYTS), Global Adult Tobacco Survey (GATS), Bangladesh Demographic and Health Survey (BDHS), and Bangladesh Urban Health Survey (BUHS). In addition, some other sources from the World Health Organization (WHO), World Bank (WB), Centers for Disease Control and Prevention (CDC) and PubMed data bases were used to obtain supplementary information.

3.2.2 Sample of Study

Out of seven South Asian countries, four countries namely Bangladesh, India, Nepal and Sri Lanka were included for analysis in this study based on the criteria set in **Table 3.1**. The selection was targeted at a well representation of the region, some information on the selected countries are as follows:

- Ranking by population size (India-1, Bangladesh-3, Nepal-4, Sri Lanka-5) in column 2
- Ranking by population density (/km^2) (Bangladesh-2, India-3, Sri Lanka-4, Nepal-6) in column 3
- Two low-income countries (Bangladesh and Nepal) and two lower-middle income countries (India and Sri Lanka) in column 4, based on GNI per capita
- Religion (representation of Muslim, Hinduism, Buddhist and Christian) in column 5
- Percentage change in tobacco production in tons and percentage of total agricultural land on which tobacco was grown in column 6 (two highest and two lowest)
- Geographical vulnerability- neighboring countries of China (largest producer and consumer of tobacco), Myanmar (largest drug abuse), and drug trafficking zones of Golden Triangle and Golden Crescent

- Data availability (GATS is for Bangladesh and India; recent GYTS is only available for Bangladesh, Nepal and Sri Lanka; DHS and UHS are for Bangladesh only)

Table 3.1: Information on Countries Included in Study

Country	Population * Size	Density (/km^2)*	GNI per capita (2011)[a]	Religion [b] (%)	% CTP [c] (%TATP)[d]
Bangladesh	161,083,804 (**3**)	1,119 (**2**)	$770 **(LI)**	M(90),H(9), C(0.5)	15.00 (0.31)
Bhutan	716,896 (**6**)	19 (**7**)	$2,070 **(LMI)**	H(25),B(75)	-11.00 (0.02)
India	1,205,073,612 (**1**)	367 (**3**)	$1,410 **(LMI)**	M(13.4),H(80.6) ,C(2.3)	19.2 (0.21)
Maldives	396,334 (**7**)	1,330 (**1**)	$6,530 **(UMI)**	M(100)	0 (0)
Nepal	29,890,686 (**4**)	203 (**6**)	$540 **(LI)**	M(4.2),H(80.6), B(10.7)	-34.4 (0.06)
Pakistan	190,291,129 (**2**)	239 (**5**)	$1,120 **(LMI)**	M(96),H(1.9), C(1.6)	-2.5 (0.20)
Sri Lanka	21,481,334 (**5**)	327 (**4**)	$2,580 **(LMI)**	H(10.9),B(70.4), C(9.8), M (8.5)	-29.4 (0.08)

Source: *CIA, World Fact book, 2012; [a] World Bank, 2012; LI (Low Income:$ ≤1,025); LMI (Lower Middle Income: $1,026-4,035); UMI (Upper Middle Income: $4,036-12,475); [b]http://en.wikipedia.org/wiki/South_Asia#Religions (M-Muslim, H-Hinduism, B-Buddhist, C-Christian); [c] % change in tobacco production in tonnes (2000-2009); [d] % of total agriculture land on which tobacco is grown (Eriksen, Mackay, & Ross, 2012).

The study utilized data from four national surveys as mentioned in Section 3.2.1. The GYTS, GATS, and BDHS data were released for public use between 1~2 years after collection, while the BUHS data were made available after 5 years from collection. The coverage of data for the three analytical chapters for this study is explained below:

(a) The analysis in Chapter 4 focuses on TC among youths and adults. A total of 5,063 youths aged 13-15 years from Bangladesh, Nepal and Sri Lanka; and 78,925 adults aged 15 years and above from Bangladesh and India, were included in the analysis of this chapter to achieve the first objective of the study.

(b) For Chapter 5 that explains ETS exposure among adults, the sample involves 78,925 adults aged 15 years and above from Bangladesh and India to meet the second objective of the study.

(c) To meet the third objective of the study related to IDU among male adults in the general population as well as urban slums, the sample consists of 3,771 males aged 15-54 years from Bangladesh and 1,576 males aged 15-24 years from urban slums of Bangladesh. The details are **Figure 3.1.**

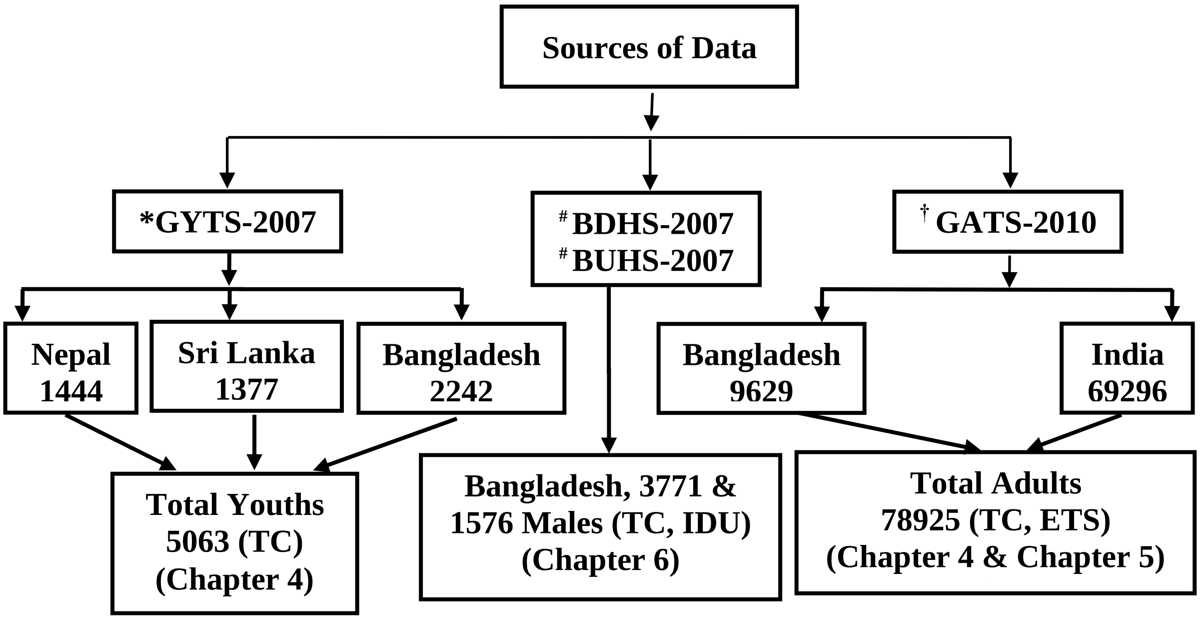

Figure 3.1: The Schematic Presentation of Data from Selected Surveys

Note: *GYTS-2007 data was released for public use in December 2009; † GATS-2010 data was released for public use in December, 2011; # Bangladesh Demographic and Health Survey (BDHS-2007) data was released for public use in October, 2009 and Bangladesh Urban Health Survey (BUHS-2007) data was released for public use in 2012.

The next four sections (3.3-3.6) provide a brief description of the sampling methodology and other issues pertaining to the four surveys.

3.3 Global Youth Tobacco Survey (GYTS)

The Global Youth Tobacco Survey (GYTS, 2007) was designed and conducted by the World Health Organization (WHO) and Centres for Disease Control and Prevention (CDC). This is a school based survey that employed a two-stage cluster sampling design to produce a representative sample of students in secondary grades 7-10, covering students in the age group of 13-15 years. The sampling procedure is in **Figure 3.2**.

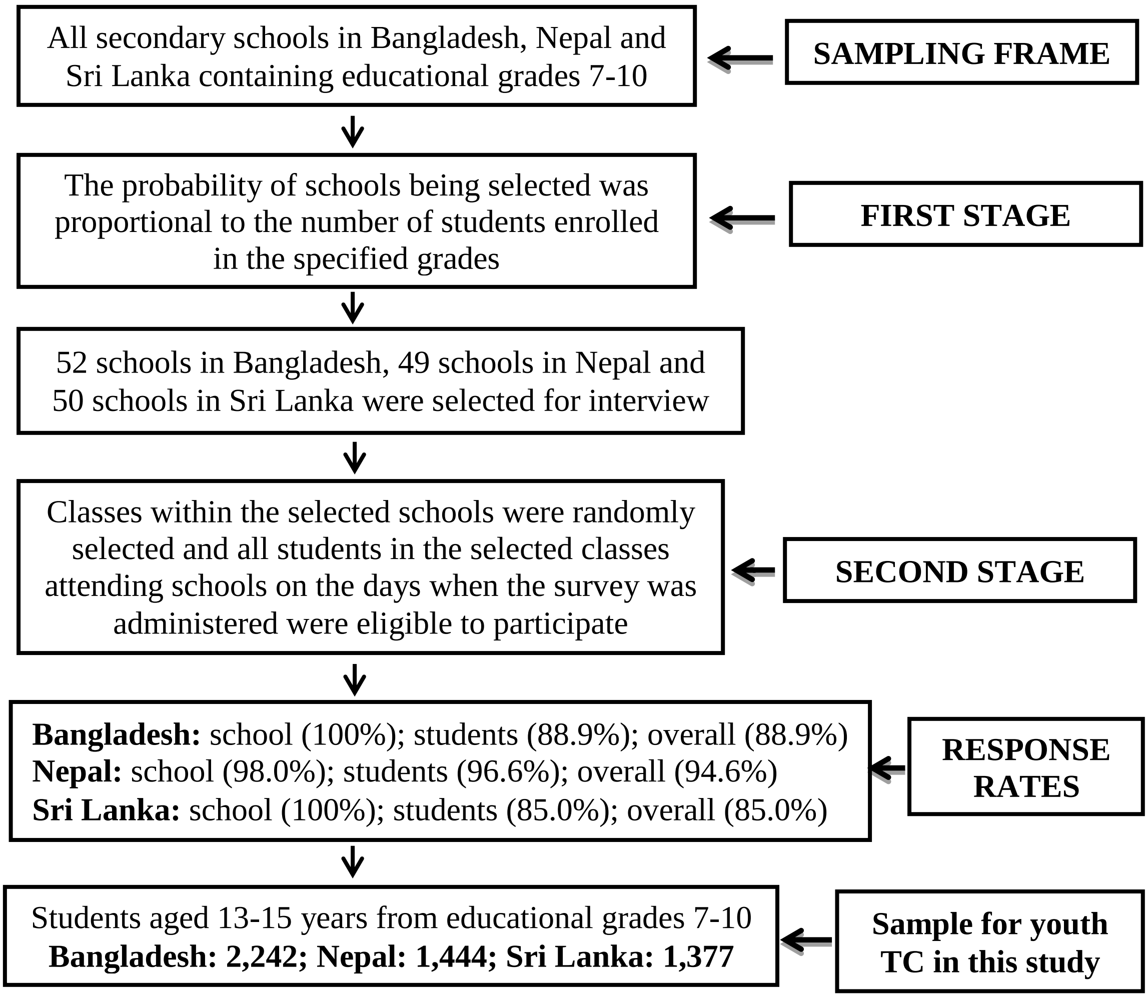

Figure 3.2: Sampling Procedure, Summarized from GYTS Report

In GYTS, background characteristics; information on smoking (current and ever); exposure to environmental tobacco smoke (ETS) at home and public places; pro-tobacco and anti-tobacco media exposure; smoking cessation and other related information were collected. In addition to the core GYTS questions, the country-specific questions such as prevalence of *bidi* smoking, and use of other tobacco products (e.g. smokeless, chewing tobacco, cigars, pipes, *gutkha*, pan etc.), school policies prohibiting use of tobacco, health hazards of tobacco related curricula, perceptions and attitudes about tobacco use, access to and availability of tobacco products were also included in the questionnaire. Student participation was voluntary and their identity was kept anonymous in the self-administered data collection procedures.

A weighting factor was applied to data on each student to adjust for non-response (by school, class, and student) and variation in the probability of selection at the school, class and student levels. A final adjustment using the weights according to grade and gender in proportion to the population of school students in the selected grades in each sampling site was also taken into account. Therefore, the GYTS sample designs produced representative, and independent cross-sectional estimates for each of the selected countries. The detailed methodology and data collection procedure were given in the country specific report of GYTS 2007 (Gunasekara, 2008; Pandey et al., 2008; WHO, 2008).

3.4 Global Adult Tobacco Survey (GATS)

Coverage of the survey was targeted at all men and women aged 15 years and above, and considered Bangladesh and India to be their primary place of residence. Survey also included the individuals residing in Bangladesh and India even though they may were not citizen of the country. Those excluded were individuals visiting Bangladesh and India (e.g. tourists), adults staying in a military base or group quarters (e.g. a dormitory), and those in hospitals, prisons, nursing homes and other such institutions during survey. The participation in the survey was purely voluntary. Before starting the interview, the interviewer read out the statements from the consent form and proceeded to the interview only after the respondent gave his or her consent. Even though a respondent consented for the interview, he/she could withdraw from the study at any time in the course of the interview. Respondents also had a right to refuse to answer any question without providing any reason. The sample design for Bangladesh and India provided cross-sectional estimates for the country as a whole as well as by urban and rural areas, and gender.

(a) GATS of Bangladesh

Based on the sampling frame from Bangladesh Bureau of Statistics (BBS), the implementing agency of Bangladesh population census in 2001, the GATS was a three-stage stratified cluster sample of households. The sampling procedure is in **Figure 3.3.**

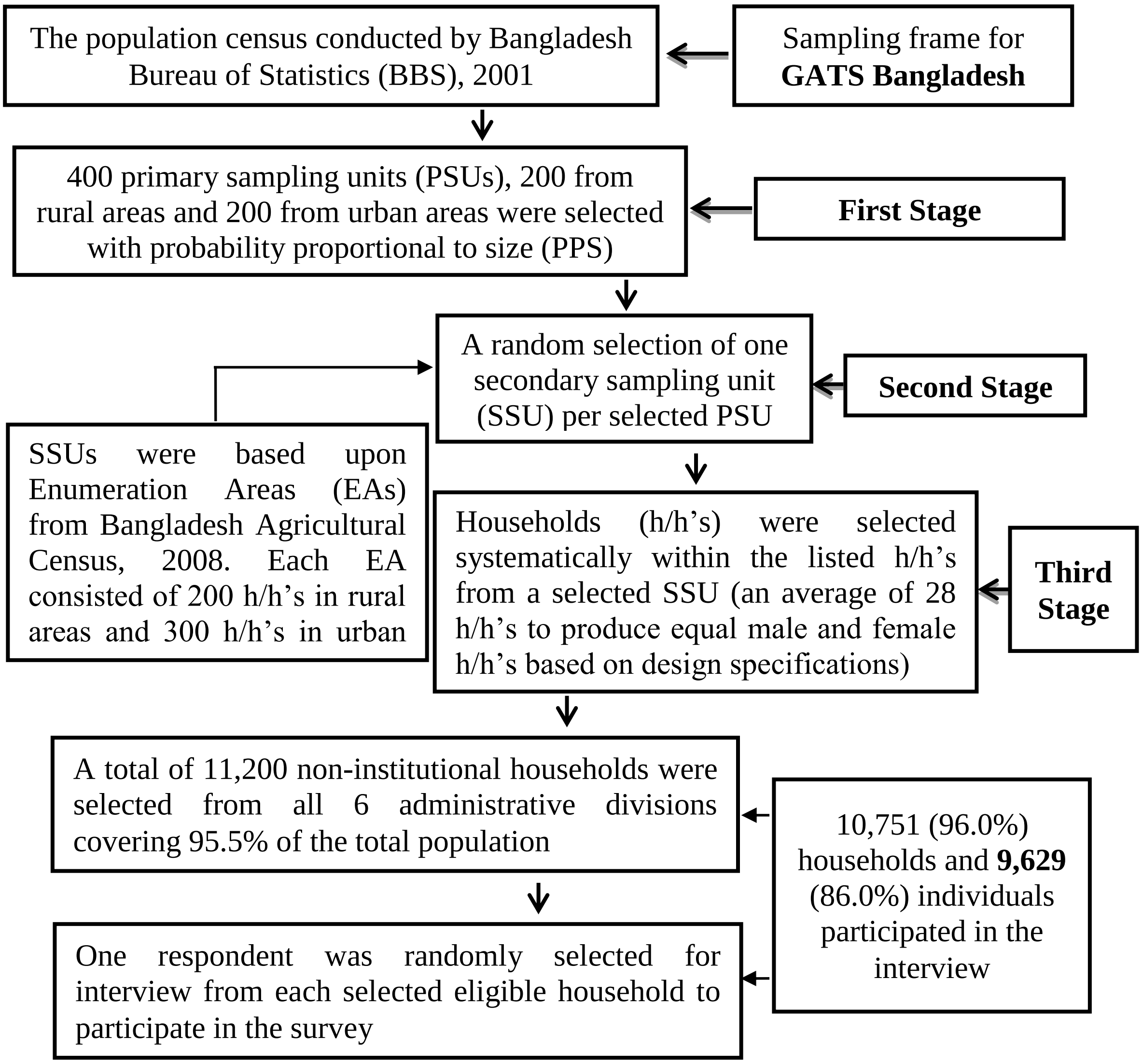

Figure 3.3: Sampling Procedure, Summarized from GATS (Bangladesh) Report

(b) GATS of India

The survey covered all the 29 states (including Delhi) and the two Union Territories (UTs) of Chandigarh and Puducherry, covering about 99.92 percent of the total population of India enumerated in the 2001 Census. The sampling was done independently in each state/UT and independently in urban and rural areas within the state/UT. In urban areas, three-stage sampling was adopted for the selection of households.

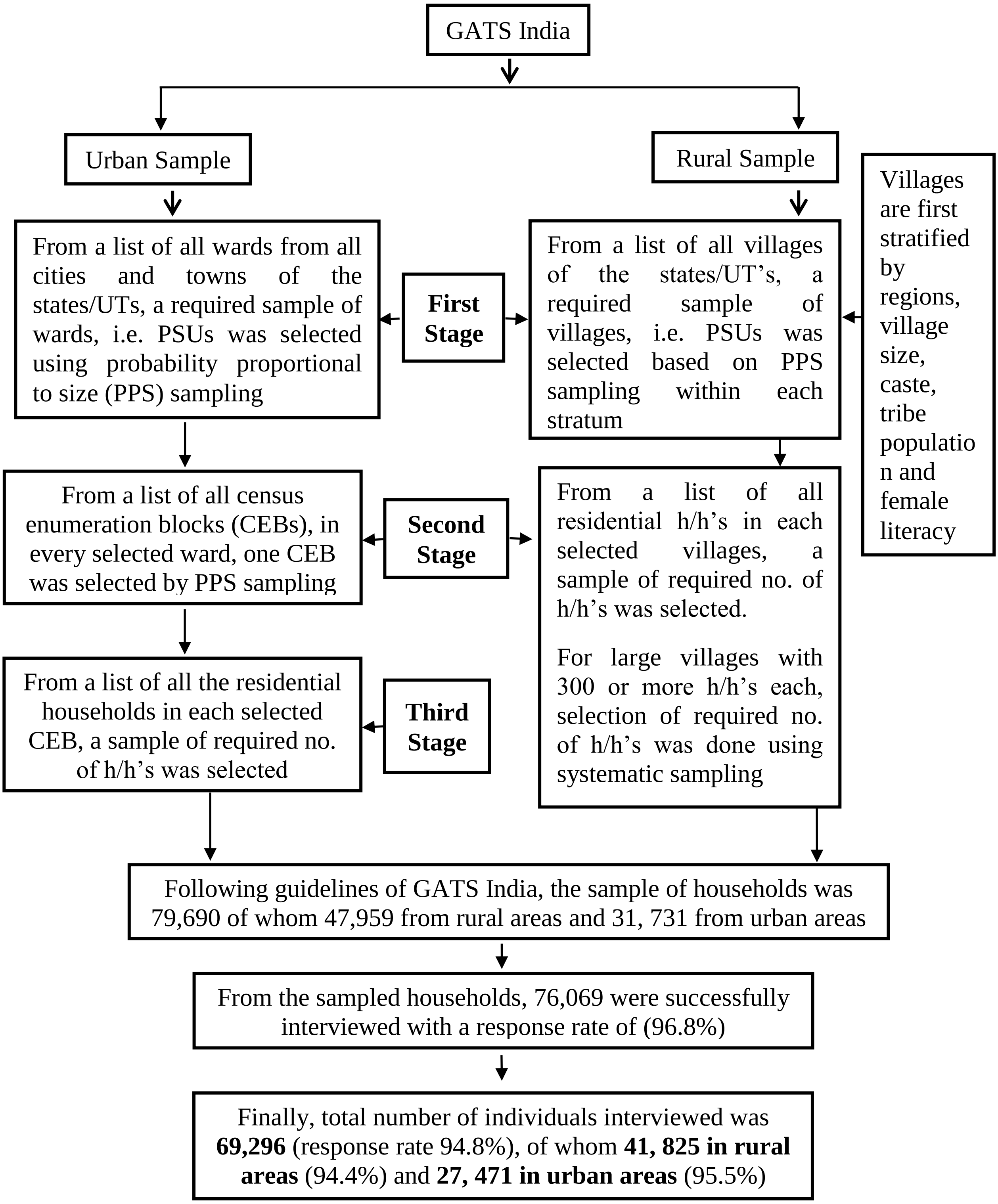

Figure 3.4: Sampling Procedure, Summarized from GATS (India) Report

The primary sampling units (PSUs) were the city wards, secondary sampling units (SSUs) were census enumeration blocks (CEBs) and tertiary sampling units (TSUs) were households. In rural areas, two-stage sampling was adopted for the selection of households. The primary sampling units (PSUs) were villages and secondary sampling units (SSUs) were households. The sampling procedure of GATS India is in **Figure 3.4**.

GATS in Bangladesh and India used two types of questionnaires: the household questionnaire and the individual questionnaire. The questionnaires were based on GATS core and optional questions which were designed for use in countries implementing GATS. The Ministry of Health & Family Welfare of Bangladesh and India with the consultation of local agencies (NIPSOM, NIPORT and BBS for Bangladesh and IIPS for India) and international collaborators such as WHO South East Asia Regional Office and Centers for Disease Control and Prevention conducted the survey. The GATS was the first survey ever conducted in Bangladesh and India that used electronic means of data collection at a national level. The General Survey System software, developed by Research Triangle Institute International was used to facilitate the design, administration, collection, and management of the survey data on handheld computers, specifically a Microsoft Windows-based platform running Windows Mobile 5.0 or Mobile 6.0, often called Pocket PC systems. The electronic data collection was useful to facilitate the complex skip pattern used in the GATS questionnaire, and the system had some in-built validity checks on questions during the data collection. A repeated quality control mechanism was used to test the quality of questionnaire programming. The main steps involved in quality control checks were version checking for household and individual questionnaires, date and time checks, skipping patterns and validation checks. The entire process including questionnaire, data collection using handheld machines and data aggregation to prepare raw data for analysis was pretested. The standard ethical clearance for respective countries and consent from respondents were obtained for the survey.

The household questionnaire was administered to the head of household or any adult member in the absence of the head. The household questionnaire collected information of all usual residents in the sampled household to identify all eligible persons from the household (either male or female based on sampling strategy) among whom a respondent was selected for the individual questionnaire. For all the listed household members, basic information on age and sex were collected. The information on age was used to identify the eligible respondent for the individual questionnaire. The questionnaire also collected information on current use of smoke and smokeless tobacco.

The individual questionnaire was administered to the individuals aged 15 and above, selected randomly for the interview through handheld machines. The information was collected on (1) background characteristics; (2) tobacco smoking (current and ever); (3) smokeless tobacco use (current and ever); (4) smoking cessation; (5) information on environmental tobacco smoke exposure; (6) tobacco economics; (7) pro-tobacco and anti-tobacco media information; (8) knowledge, attitude and perception (KAP) regarding tobacco use and its consequences.

To improve representativeness of the sample in terms of the size, distribution and characteristics of the population, the data were suitably weighted. The weights were derived from design weight (reciprocal of the probability of selection), household response rate and individual response rate. For India, a post stratification calibration was carried out for age-sex-residence distribution in the survey period in each state/UT. The detailed methodology and data collection procedure were given in the country specific report of GATS Bangladesh and India (IIPS, 2011; WHO, 2010).

3.5 Bangladesh Demographic and Health Survey (BDHS)

Based on the sampling frame from Bangladesh Bureau of Statistics (BBS), the implementing agency of the Bangladesh Population Census (BPC) in 2001, the BDHS was conducted using a two-stage stratified sample of households. The sampling procedure is given in **Figure 3.5**. Each enumeration area (EA) as defined in the BPC covered a number of dwelling units.

First stage: Selection of 361 EAs using systematic sampling with probability proportional to size (227 EAs from rural areas and 134 EAs from urban areas)

All households in the selected EAs were listed and the sampling frame was drawn up

Second stage: Selection of households (a sample of 10,461 households) using systematic sampling (approximately 30 households per EA)

Successfully interviewed households were 10,400 (99.4% of the selected households)

Ever-married men aged 15-54 years in every second household (4,074) were selected and **3,771** were successfully interviewed (response rate 92.6%)

Figure 3.5: Sampling Procedure, Summarized from DHS (Bangladesh) Report

The National Institute of Population Research and Training (NIPORT) under the Ministry of Health and Family Welfare, Mitra and Associates (a Bangladeshi research firm) and Macro International Inc., Maryland, USA were assigned to conduct the survey. BDHS used five questionnaires and the contents were based on the MEASURE DHS model questionnaires. The questionnaire for the men was used to collect information from ever-married men aged 15-54 years. They were asked questions on background, socio-economic and demographic characteristics of respondents, awareness of sexually transmitted diseases (STDs), TC and IDU among others. The detailed methodology and data collection procedure were given in the BDHS report (NIPORT, 2009).

3.6 Bangladesh Urban Health Survey (BUHS)

The BUHS employed a nationally representative sample based on a multi-stage cluster sampling approach. First, a scientifically valid sampling frame for slums (primary sampling units) which provided the location of slum communities and their approximate populations was prepared. Based on the proportion of population in each slum to total population, the sample was selected using probability sampling method. Next the survey set out to locate, map, and record the basic characteristics of each slum in six City Corporations of Bangladesh. A concurrent effort involved the mapping of *mahallas* of City Corporations (along with estimation of their population size). The survey covered a sample of 13,819 adult men, aged 15-59 years from slums (6,488 respondents with response rate 88.6%), non-slum (5,667 respondents with response rate 85.1%) and district municipalities (1,664 respondents with response rate 83.7%). Of these, 1,576 men aged 15-24 years were from slum areas, which are the target group of this study.

The National Institute of Population Research and Training (NIPORT) under the Ministry of Health and Family Welfare, Government of Bangladesh, MEASURE Evaluation (USA), ICDDR, B: Knowledge for Global Lifesaving Solutions, and Associates for Community and Population Research (ACPR) conducted the survey. With the above sample design, the BUHS collected detailed information concerning health, health-care seeking behaviour, characteristics of individuals and their households and communities in slum and non-slum areas of City Corporations, as well as the neighbourhoods of District Municipalities. Given the detailed information available on the characteristics of individuals and their households and communities, the survey made it possible to categorize individuals who were most exposed to different degree of vulnerability. In terms of health outcomes, BUHS offered a rich range of health measures, including many traditional self-reported indicators as well as more objectively measured indicators gleaned from biomarker data. The individual questionnaires included basic characteristics such as age, education, religion, marital status, media exposure, duration of stay in slums, and employment status among others. It also covered general and specific health related questions, health behavioural information such as knowledge of AIDS and STDs, symptoms of STDs, mental health and smoking, alcohol and drug use, and criminal victimization. The detailed methodology of the survey including the data collection method, validation and reliability assessment were explained in the national report of the survey (NIPORT, 2008).

3.7 Conceptual and Analytical Frameworks

From the theories and empirical evidence of TC among youths and adults, ETS exposures, and IDU, the following conceptual and analytical frameworks can be constructed.

3.7.1 Conceptual Framework for TC among Youths

TC behaviour is influenced by three categories of factors. The first level is individual characteristics. The factors related to individuals are age, gender, education, ethnicity, knowledge, attitude and beliefs (Akers, 1998; Kimberly, 2003). The next level is immediate social environment. Friends, family members, peer groups, and neighbourhood are the influencing factors (Bandura, 1989; Catalano & Hawkins, 1996). The third level covers the broader social environment e.g., society, media, government policy, access to tobacco products and social norms and level of acceptance to TC (Hawkins & Weis, 1985; Kimberly, 2003). The framework is shown in **Figure 3.6**. It should be noted that the framework does not imply one level of factors have higher influence than the other.

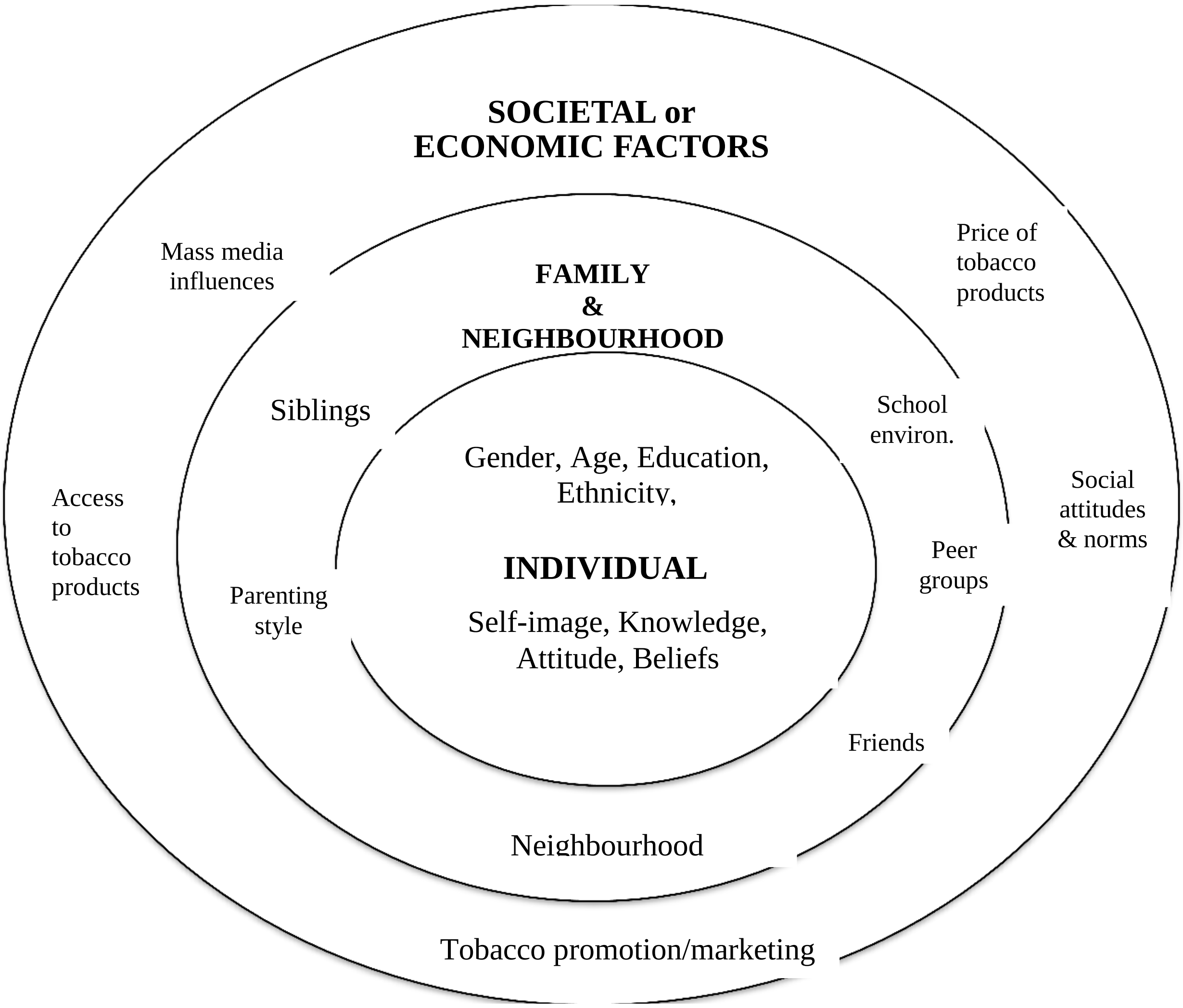

Figure 3.6: Conceptual Framework of TC among Youths,
Adopted from Akers (1998), Bandura (1989), Catalano & Hawkins (1996), Hawkins & Weis (1985), Kimberly (2003)

3.7.2 Conceptual Framework for ETS Exposure in Different Settings

ETS could cause the same health risks as with active smoking, but the level of risk exposure is lower than active smoking. Three different settings, namely, home (not including patios, balcony, garden etc.), indoor areas of public place (e.g., government buildings or offices, health-care facilities, restaurants, and public transports), and workplace are the main sources of ETS exposure (**Figure 3.7**). The framework shows that smoking by parents, other family members, relatives, guests, friends, colleagues, strangers and others contribute to ETS in at least one of the three settings.

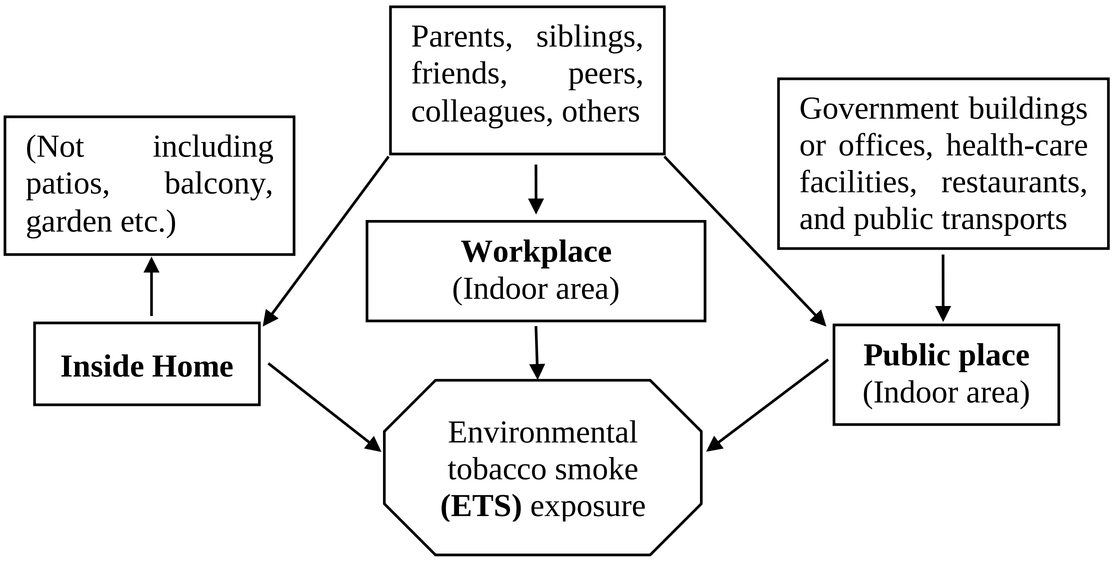

Figure 3.7: Conceptual Framework for ETS Exposure in Different Settings,
Adopted from (IIPS, 2011; LAIA, 1999; WHO, 2010)

3.7.3 Conceptual Framework for Factors Affecting TC, ETS and IDU

Figure 3.8 shows the association of TC, ETS and IDU with the influencing factors.

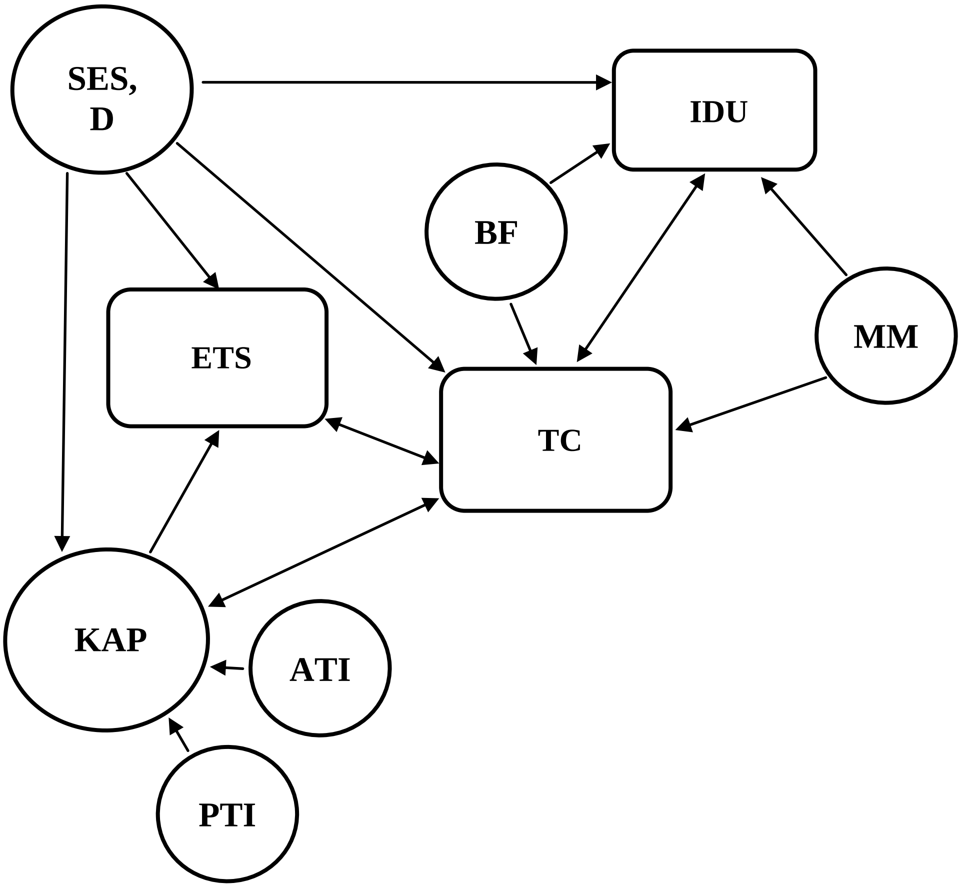

Figure 3.8: Conceptual Framework for Factors Affecting TC, ETS and IDU

Note: **TC**-tobacco consumption, **SES, D**-socio-economic status and demographic variables, **IDU**-illicit drug use, **MM**-mass media exposure, **ETS**-environmental tobacco smoke exposure, **KAP**-knowledge, attitude and perception about the consequences of TC, **ATI**-anti-tobacco information, **PTI**-pro-tobacco information, and **BF**-behavioural factors.

Socio-economic status and demographic variables have impact on TC, ETS and IDU. KAP towards the consequences of TC are also affected by these same variables. In addition, anti-and pro-tobacco information has influence on KAP. KAP in turns associated with TC behaviour and hence influence the sources of ETS. TC and IDU are both influenced by behavioural factors and exposure to mass media and interaction between TC and IDU is therefore expected. Through this framework it is clear that TC and KAP, TC and ETS, and TC and IDU are associated with each other.

3.7.4 Analytical Framework for TC among Adults

Figure 3.9 shows the analytical framework that is used for the analysis of TC behaviour (smoked and smokeless tobacco products) and its association with KAP of the consequences of harmful effects of tobacco.

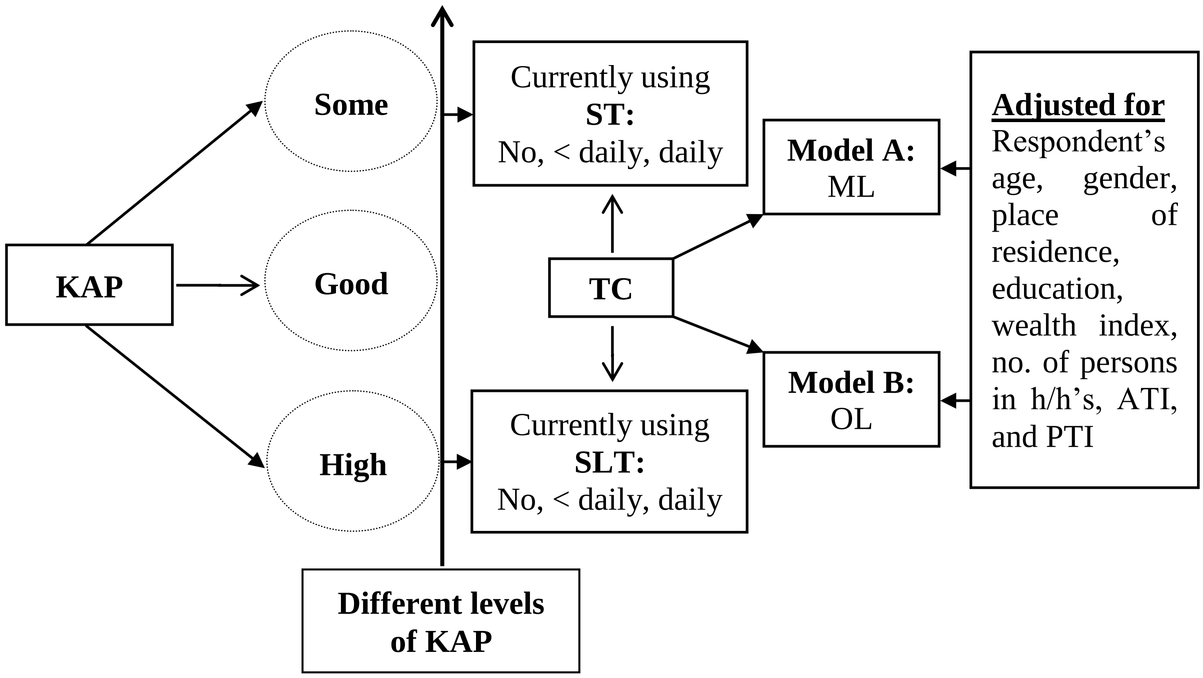

Figure 3.9: Analytical Framework for Association between KAP and TC

Note: KAP-knowledge, attitude and perception about the consequences of TC, **ST**-smoked tobacco, **SLT**-smokeless tobacco, **ML**-multinomial logistic, and **OL**-ordinal logistic.

This association was analysed by multinomial and ordinal logistic regressions separately. In these regressions, dependent variable KAP was constructed into three categories, i.e., some KAP, good KAP, and high KAP. The reference group is some KAP. When these categories were not ordered, the multinomial regressions were used. The ordinal regressions were applied when the three categories were ordered. All the regressions were adjusted for respondent’s age, gender, place of residence, education, wealth index, number of persons in households, ATI, and PTI as confounders.

For the classification and regression tree (CART) analysis on TC among adults, the dependent variable is average number of cigarettes and *bidis* smoked per day. Four dependent variables were constructed separately. They include those in the cigarette model with two-category (2CAT) and three-category (3CAT) dependent variables, and those in the *bidi* model with two-category (2CAT) and three-category (3CAT) dependent variables (**Figure 3.10**).

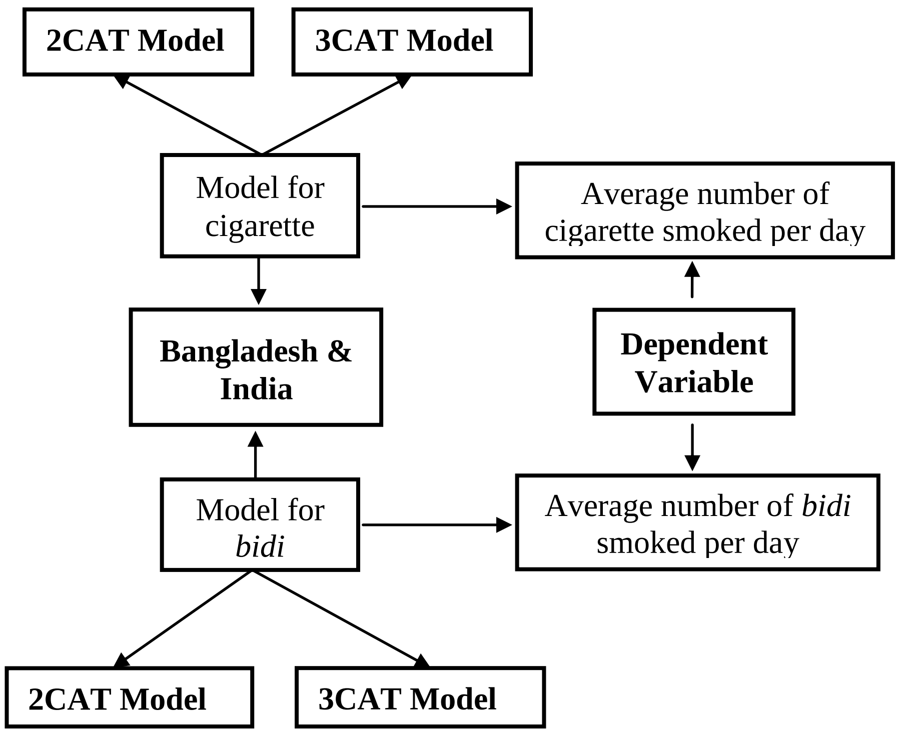

Figure 3.10: Analytical Framework for CART

The two-category variables were constructed using median number of cigarettes or *bidis* used per day as cut-off point. The three-categories were constructed using tertile as cut-off point. The analysis was performed separately for Bangladesh and India. Therefore, in total 8 dependent variables were constructed to characterize smoking patterns among adults in Bangladesh and India. The frameworks given in **Figures 3.9** and **3.10** are guidance to the analysis in **Chapter 4**.

3.7.5 Analytical Framework for ETS Exposure

For the analysis on ETS exposure, three different settings (home, workplace and public place) were considered. ETS exposure in these settings is the response variable.

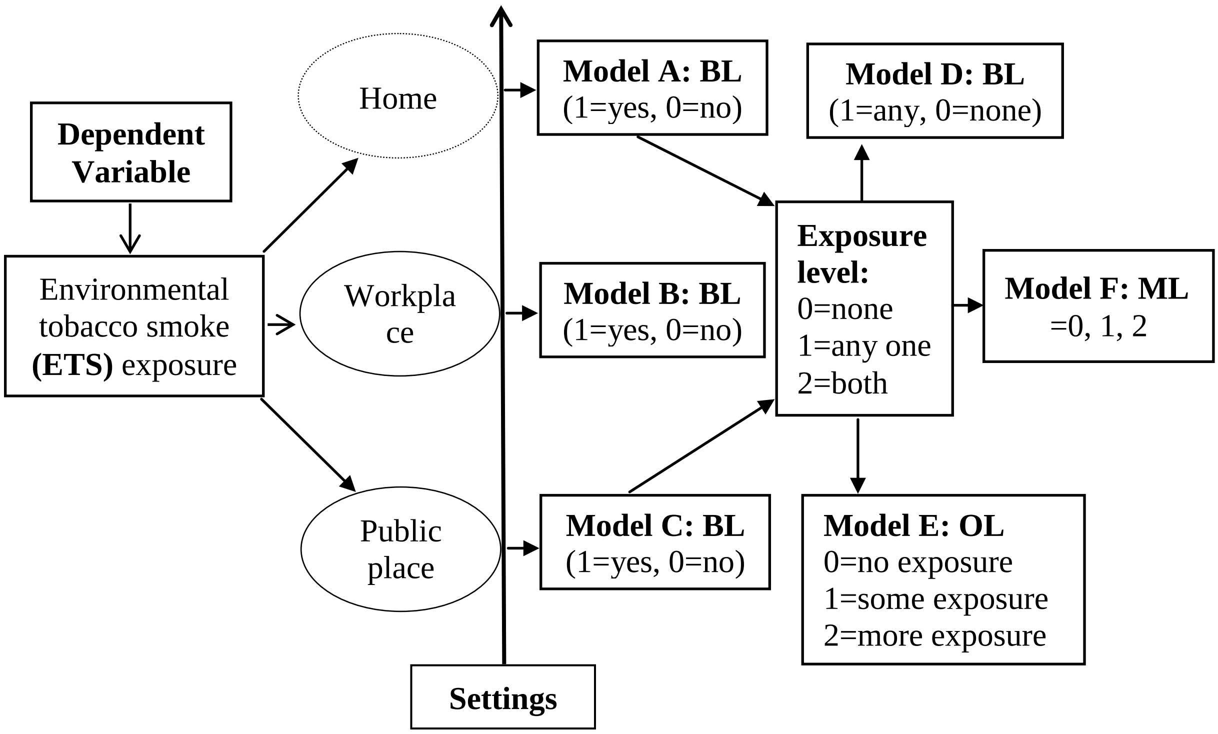

Figure 3.11: Analytical Framework for ETS Exposure

Note: **BL**-binary logistic, **ML**-multinomial logistic, **OL**-ordinal logistic.

The dependent variables in Model A (at home), Model B (at workplace) and Model C (at public place) have dichotomous outcomes (yes or no) and binary logistic (BL) regression was employed (**Figure 3.11**). A combined settings whether exposed to ETS at home or public place was formed. We considered the combination of these two settings only and did not include workplace because not all respondents are working. Based on the combined settings, Models D, E, and F were formulated. Model D was estimated using binary logistic regression where a value of 1 was assigned if exposed to ETS in any of these two settings, and 0 if no exposure. Model E examines the exposure in 3 levels, where the exposure levels were ordered (0=no exposure, 1=some exposure to ETS in any one setting, 2=more exposure when exposed to ETS in both settings), and ordinal logistic (OL) regression was formed. For Model F, the exposure levels (0, 1 and 2) were not ordered, and multinomial logistic (ML) regression was applied.

The association between TC (smoked and smokeless tobacco products) and ETS is examined by using binary logistic regressions. The dependent variables are whether exposed at home (Model A), workplace (Model B), public place (Model C), and combined settings (Model D).

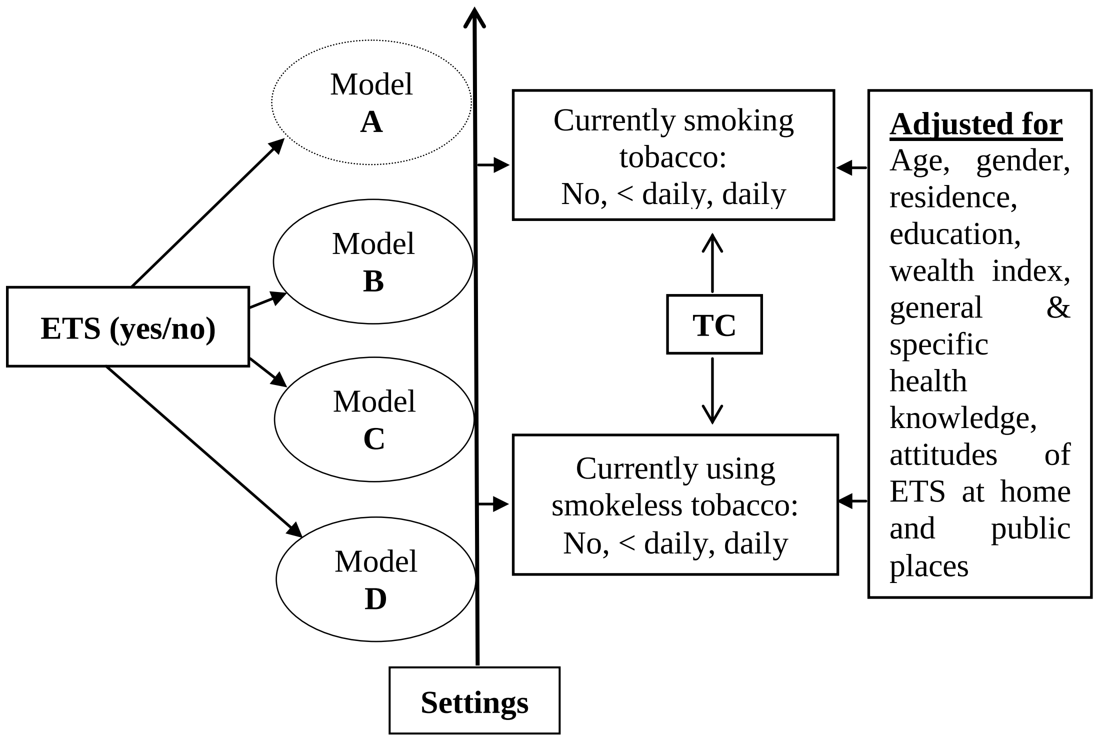

Figure 3.12: Analytical Framework for Association between ETS Exposure and TC

The regression were adjusted for age, gender, residence, education, wealth index, general & specific health knowledge, attitude towards ETS at home and public place as confounders (**Figure 3.12**). The TC variables in these models are the extent of current tobacco use, i.e., no smoking, smoking but not daily, and smoking daily. Both smoked and smokeless tobacco products were considered. The frameworks given in **Figures 3.11** and **3.12** are guidance to the analysis in **Chapter 5**.

3.7.6 Analytical Frameworks for TC and IDU

This study examines the association between TC and IDU for the general male population as well as the young male adults residing in urban slum areas in Bangladesh. For the general male population, the framework is given in **Figure 3.13**. Two categories of IDU were considered. The first category covers any form of illicit drugs (any IDU), and the other refers to only the main drugs (main IDU). IDU (any IDU and main IDU) is the response variable with dichotomous outcomes (drug user or not drug user). The association between TC and IDU (any and main) was estimated based on binary logistic regressions adjusted for age, education, residence, exposure to mass media, premarital sex, occupation, whether infected by STIs, and wealth index as confounders.

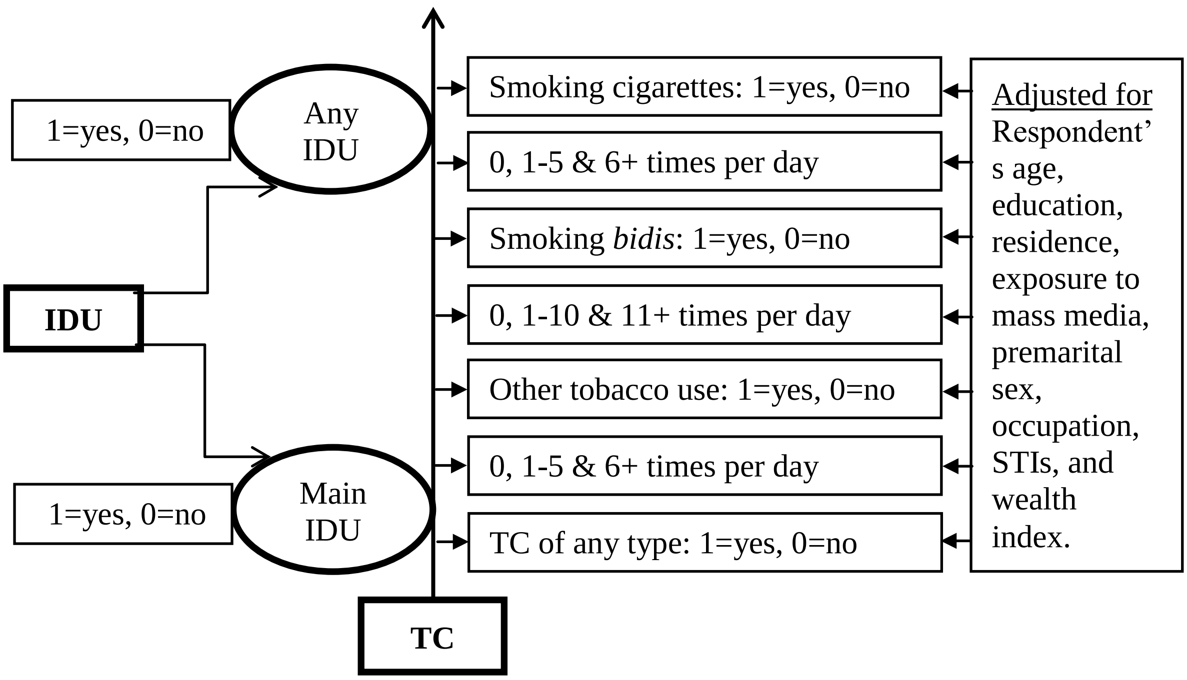

Figure 3.13: Analytical Framework for Association between IDU (Any and Main) and TC among General Male Population

The estimations were estimated separately for the two categories of IDU. Three categories of tobacco products were considered in the analysis, namely, cigarettes, *bidis*, and other products. For each of these categories, dichotomous variables were created where a value of 1 is assigned if the product is being used and 0 otherwise. To examine the impact of frequency of tobacco use, the TC variables were classified into three levels. For cigarettes and other products, these levels are 0, 1 to 5, and 6 or more times per day. For *bidis*, they are 0, 1 to 10, and 11 or more times per day. In addition, another category, namely, TC of any type was considered in the analysis. The dichotomous variable was created where a value of 1 is assigned if any products (cigarettes, *bidis* or other tobacco products) are being used and 0 otherwise.

A similar framework was applied for the case of urban slum male population but fewer variables were considered due to data limitations. IDU is the response variable with dichotomous outcomes (yes or no).

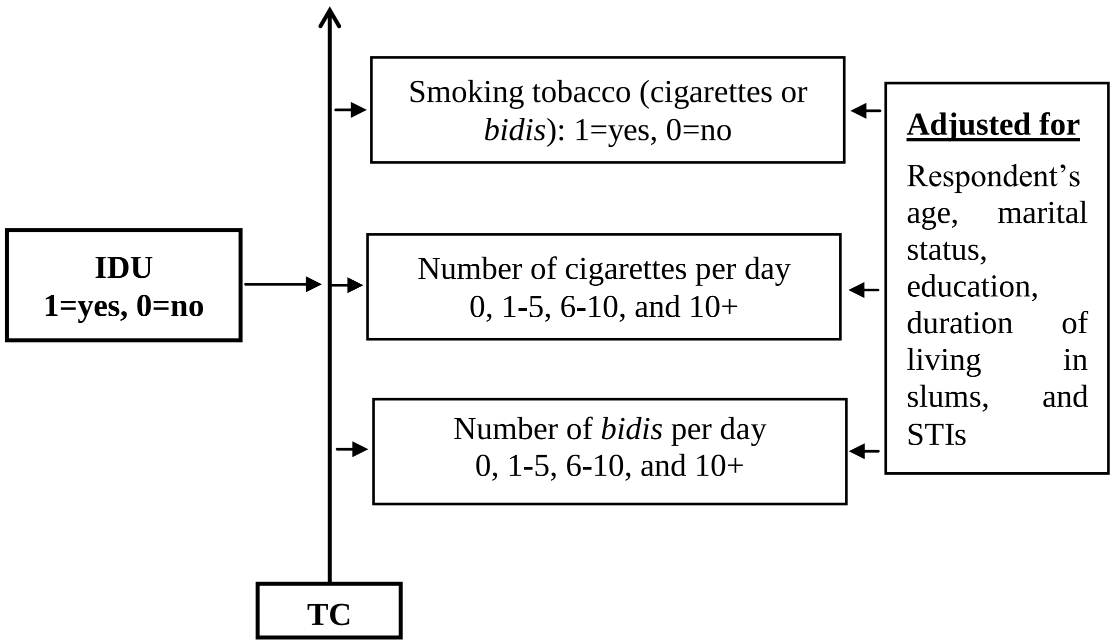

Figure 3.14: Analytical Framework for Association between IDU and TC among Males of Urban Slum Population

The association between TC and IDU was examined based on binary logistic regressions adjusted for age, marital status, education, duration of living in slums, and whether the respondents have symptoms of STIs as confounders (**Figure 3.14**). The analysis focused on the use of cigarettes and *bidis*. For these TC variables, dichotomous groups (user and non-user) were considered. The analysis also looks into account frequency of TC by grouping the number of cigarettes or *bidis* used per day into 4 categories (0, 1 to 5, 6 to 10, and 10 or more). These two **Figures (3.13** and **3.14)** are the frameworks for **Chapter 6**.

3.8 Tools and Techniques for Analysis

3.8.1 Regression Analysis

Descriptive statistics were computed to obtain the basic information about the sample of respondents in all the analytical chapters.

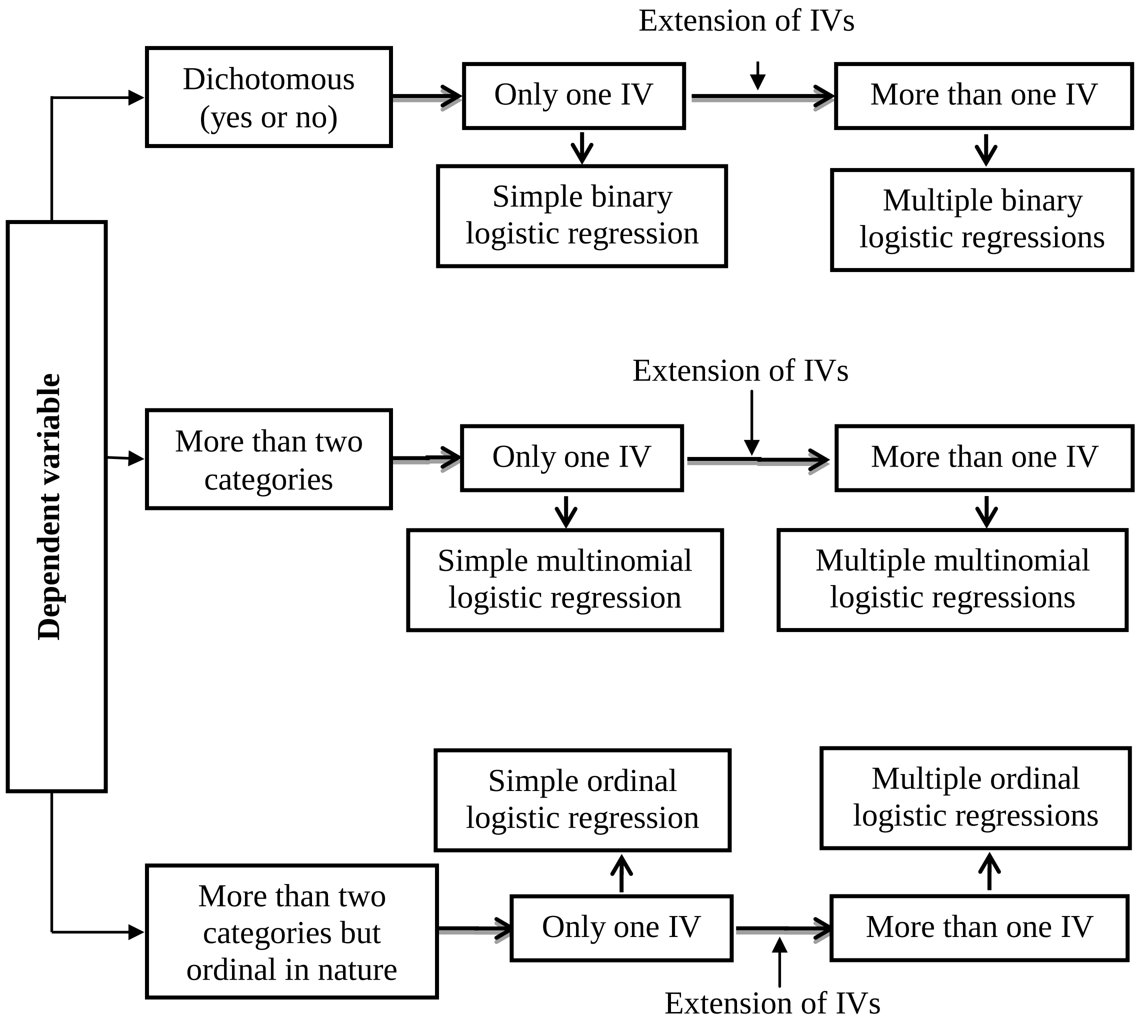

Figure 3.15: Schematic Presentation of Family of Logistic Regression

Note: IV-independent variable.

To test for significance of association between variables, the Chi-square tests were used. The null hypothesis of no relationship between the dependent variable and the determinant variable is rejected if the p-value of the Chi-square (χ^2) statistic is less than 5%. The relationships between variables were estimated using regressions. Logistic regression is useful when the response variable is categorical in nature. The family of logistic regressions used in different sections of this study is explained in **Figure 3.15**.

The logistic regression model for a dependent variable with binary outcome is given by:

$$\Pr(Y_i = 1) = \frac{\exp(X_i \beta)}{1 + \exp(X_i \beta)}$$

Where Y_i is a binary variable that takes a value of '1', X_i is independent variable, $i = 1, ..., k$ and $\beta_0, ..., \beta_k$ are unknown parameters.

The estimation form of the regression is the logistic transformation of the logistic function which can be expressed as

$$\ln\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \beta_1 X_1 + ... + \beta_k X_k \qquad (3.1)$$

The odds ratio (OR) in favour of $Y_i = 1$ together with its 95% confidence interval (CI) with respect to X_i indicates how many times is the group of interest more likely to be in the 'yes category of dependent variable' compared to the reference group. The regression was used to examine the association between two variables (e.g., tobacco consumption and illicit drug use) adjusted for other variables as confounders, where X_1 is the variable of interest and $X_2, ..., X_k$ are variables representing the confounders that affect Y_i. In this case, only the odds ratio in favour of $Y_i = 1$ computed for X_1 is of interest.

In ordinal logistic regression, the response variable is ordinal where the categories can be ordered. One way to take account of the ordering is the use of cumulative probabilities, cumulative odds and cumulative logits. Considering $k+1$ ordered categories, these quantities are defined by:

$$P(Y \leq i) = p_1 + \ldots + p_i$$
$$odds(Y \leq i) = \frac{P(Y \leq i)}{1 - P(Y \leq i)} = \frac{p_1 + \ldots + p_i}{p_{i+1} + \ldots + p_{k+1}}$$
$$\log it\,(Y \leq i) = \ln\left(\frac{P(Y \leq i)}{1 - P(Y \leq i)}\right), \quad i = 1, \ldots, k$$

The cumulative logistic model for ordinal response data is given by:

$$\log it\,(Y \leq i) = \alpha_i + \beta_{i1} X_1 + \ldots + \beta_{im} X_m\,, i = 1, \ldots, k \qquad (3.2)$$

The model has k equations and one logistic coefficient β_{ij} for each category or covariate combination. Hence, the general cumulative logistic regression model contains a large number of parameters. However, in some cases a more parsimonious model is possible. If the logistic coefficients do not depend on i, we have only one common parameter β_j for each covariate. Therefore, the cumulative odds are given by

$$odds(Y \leq i) = \exp\,(\alpha_i)\exp\,(\beta_1 X_1 + \ldots + \beta_m X_m), i = 1, \ldots, k$$

This means that the k odds for each cut-off category i, differ only with regard to the intercepts α_i, that is the odds are proportional.

The basic principle of multinomial logistic regression is similar to that of binary logistic regression, in that it is based on the probability of membership of each category of the dependent variable, say; the dependent variable is of $k+1$ categories. The regression compares the probability of being in each of k categories compared to a baseline or reference category. In a way we can say that we are fitting k separate binary logistic models, where we compare each category $1,2,\ldots,k$ to the baseline category. Therefore, multinomial logistic regression is basically an extension of binary logistic regression for nominal variables with more than two categories. The specification for multinomial logistic regression is:

$$\Pr(y_i = j) = \frac{\exp(x_i \beta_j)}{\sum_{j}^{J} \exp(x_i \beta_j)} \qquad (3.3)$$

where $\Pr(y_i = j)$ is the probability of belonging to group j, x_i is a vector of explanatory variables and β_j are the coefficients, which are estimated using maximum likelihood estimation.

3.8.2 Model Diagnostic Tests

(a) Goodness-of-fit Test

In binary logistic regression, Hosmer and Lemeshow (H-L) goodness of fit test tells how closely the observed and predicted probabilities match. The null hypothesis of "the model fits" will be rejected if the p-value is less than 0.05. For ordinal and multinomial logistic regressions, the test compares whether the model produces adequate accurate predictions compared to the null model (intercept only). Moreover, goodness-of-fit (measured by Pearson and Deviance statistics) also shows whether the model adequately fits the data. If the model fits well, the observed and expected cell counts will be very close, the value of the test statistic will be small and the null hypothesis cannot be rejected. It should be mentioned that if the categorical predictor has many levels or grouping, there may be cells with a small number of expected counts or many cells with zero frequencies. In that case these tests may not produce accurate or dependable goodness-of-fit test results. In such cases, it would be better to use the Pseudo R^2 (Cox & Snell, Nagelkerke, and McFadden) statistics to investigate to what extent the proposed model is an improvement over the null model and the overall classification accuracy (Agresti, 2007; Chan, 2004, 2005; Kwak & Clayton-Matthews, 2002).

(b) The Pseudo R^2

There are several R^2-like statistics that can be used to measure the strength of association between the dependent and predictor variables. They are not as useful as the R^2 coefficient in regression, since their interpretation is not straightforward (Hausman & McFadden, 1994). For logistic regressions, Pseudo R^2 shows the percentage of variation in the outcome variable that is explained by the logistic regression model.

(c) Overall Classification Accuracy

Ordinal regression does not have the classification table option. Therefore a cross-tabulation between the predicted categories and the actual groups is used to determine the model accuracy (Chan, 2005; O'Connell, 2005). The overall classification accuracy of models (binary, multinomial and ordinal logistic regressions) shows what percentages of the cases are correctly classified by the models and the better models will have higher percentages of correct classifications.

(d) Multicollinearity

A guide method for checking multicollinearity is to inspect the magnitude of the standard errors of the estimated parameters. Large standard errors (the tolerable value is 0.001-5.00) imply existence of multicollinearity and the model is not statistically stable. Variance inflation factor (VIF) that is more than 3 also shows the existence of multicollinearity. Multicollinearity can also be checked by using correlation matrix between the variables (Chan, 2004, 2005; Menard, 2002; Pampel, 2000).

(e) Test of Parallel Lines

In ordinal regressions, it is assumed that the relationships between independent variables and logits are same for all the logits. This means that the results are a set of parallel lines or planes for each category of the outcome variable. In the test of parallel lines, the model is not suitable if the p-value is less than 0.05. This unsuitability could be due to the use of wrong link function or wrong ordering of categories (Bender & Grouven, 1997; O'Connell, 2005). The model should be tested using the next appropriate link function (Cauchit) and reordering of the categories of the dependent variable. If a model fails to satisfy all the tests, it is recommended that the multinomial logistic regression is used, and ignoring the ordinal nature in the categories of the dependent variable.

3.8.3 Multivariate Analysis: Classification and Regression Tree (CART)

Classification and regression tree (CART), a data mining technique, is a predictive model that classifies the data into leaf and node divisions viewed as a tree. Each branch of the tree represents a variable for classification and the leaves of the tree branch out according to some splitting algorithms. Decision trees produce rules that are mutually exclusive and collectively exhaustive. The method categorizes data on each branch point without losing any of the data. The total number of observations in a parent node is equal to the sum of the number of observations contained in its two children nodes.

In CART, each group called a 'node' can be divided into two sub-groups termed as 'binary partitioning'. The original node is known as parent node and the resulting two groups or nodes are the child nodes. The term "recursive" means that the 'binary partitioning" process can be applied again and again. Therefore, each parent node can produce two child nodes and, in turn, each of these child nodes can be split again and again to form additional child nodes. Partitioning refers to the process where the dataset is split into sections or sub-groups.

The root node (node 0) includes all cases of the learning dataset and the tree building process starts at this point. The CART algorithm searches for the best predictor to divide the root node into two child nodes. To do so, the algorithm checks for all possible splitting predictors (termed as splitters) as well as all potential values of the predictor to be used to divide the node. For categorical variable, the number of potential splits increases with the number of levels of the categorical variable. For the best splitter, the algorithm seeks to maximize the average "purity" of the two child nodes. The most common splitting criterion or splitting function is 'Gini' and 'Twoing' which give similar results when the outcome variable is categorical in nature. Including the root node (node 0), each node is assigned a class called 'predicted outcome'. The node splitting process predicts class assignment in each node, and the process is recurrent for each child node and continues recursively until it is impossible to proceed further. Predicted class assignment is essential because it provides information on which node will end up being the terminal node after pruning. It depends on three factors namely, (a) distribution of classes of learning dataset in a particular node, (b) decision loss or cost matrix, and (c) fraction of subjects that end up in each node. This method of node class assignment ensures that the tree has a minimal expected average decision cost in which the probability of each outcome is equal to the assumed prior probabilities.

"Primary splitter" for each node is the variable that best splits the node, and maximizes the purity of resulting nodes. When "primary splitter" is missing for an individual observation, that observation is not discarded but, instead, "a surrogate splitting variable" is required. A surrogate splitter is a variable whose pattern within the dataset, relative to the outcome variable, is similar to the primary splitter. Therefore, the program uses the best available information in the face of missing values. In datasets of reasonable quality this allows all observations to be used. For handling missing data, CART has important advantages over other traditional multivariate regression modelling, where observations of the predictor variable which are missing are usually discarded.

If there is only one observation in each child node, all observations within the child node have similar distribution to that of the predictor variable with an external limit (depth option) stipulated by the user, the tree building process will stop. A major innovation of CART is the realization that there is no way during the tree-building process to know when to stop, and that different parts of the tree may require different depths. Therefore, the method of "cost-complexity" pruning is used to generate a sequence of simpler and simpler trees.

The optimal tree will fit the learning dataset with a high level of accuracy with "re-substitution cost" that generally greatly overestimates the performance of the tree on an independent set of data than any other trees. Cross validation is a method for validating a procedure for model building, which avoids the need for other dataset for validation. In cross validation, the learning dataset is randomly split into K sections, stratified based on the outcome variable and assures that a similar distribution of outcomes is present in each of the K subsets of data. From the K subsets, one subset is reserved to be used as an independent test dataset, while the remaining $K-1$ subsets are used as learning dataset. The entire model-building procedure is repeated K times, with a different subset of data reserved as the independent test dataset each time. Thus, K different models are produced, each of which can be tested against an independent subset of the data. Cross validation that measures the average performance of K models, is an excellent estimate of the performance of the original model. When cross validation is used in CART the entire tree building and pruning sequence is conducted K times. Thus, there are K sequences of trees produced. Based on their number of terminal nodes, the trees within the sequences are matched to produce an estimate of the performance of the tree in predicting outcomes for a new independent dataset, as a function of the number of terminal nodes. This process allows a data-based estimate for tree complexity which results in best performance with respect to an independent dataset.

To develop a CART for classification, each predictor is chosen based on how well it fits the records with different predictions. The entropy metric[5] is used to determine whether a split point for a given predictor is better than the others. Briefly, the CART algorithm splits the independent variable into two separate hyper-rectangular areas according to performance measures.

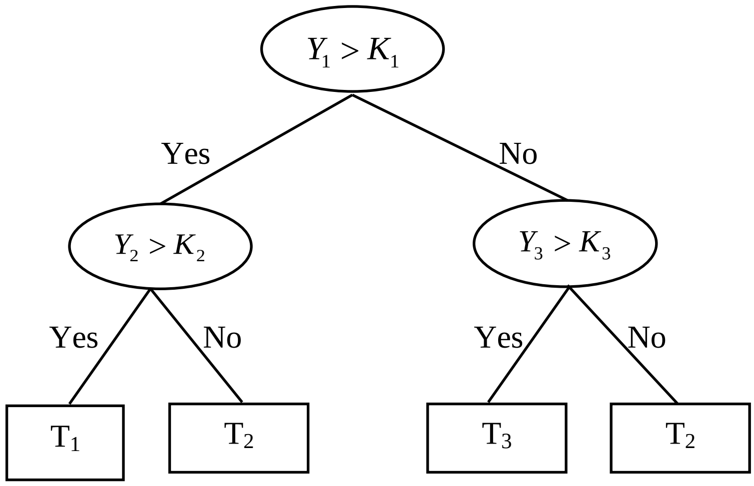

Figure 3.16: A Typical CART Model for Classification

Notes: Ovals are the intermediate nodes and rectangles are terminal nodes, K_1, K_2 *and* K_3 are splitting values of the variables Y_1, Y_2 *and* Y_3 respectively.

From the algorithmic point of view, CART has a forward stepwise technique that adds model terms and a backward technique for pruning, while selecting important variables that are useful in the model. The output of the models is a hierarchical structure that consists of a series of "if-then" rules to predict the outcome of the dependent variable. For example, at each intermediate node (ovals in **Figure 3.16**) of the tree, a condition is

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[5] Entropy or Gini Metric is a measure of disorder reduction caused by the splitting of data in a decision tree algorithm. Gini and the entropy metric are the most popular ways for selecting predictors in the CART decision tree algorithm. In brief, let (X, β, μ) be a probability space, and $T: X \rightarrow X$ a measure-preserving transformation. The entropy of T with respect to a finite measurable partition P is $h_\mu(T,P) = \lim \rightarrow H_\mu\left(V_{k=0}^{n-1} T^{-k} P\right)$ where H_μ is the entropy of a partition and V denotes the join of partitions. The above limit always exists, although it can be $+\infty$. The entropy of T is then defined as, $h_\mu(T) = \sup h_\mu(T,P)$ with the supremum taken all finite measurable partitions. Sometimes $h_\mu(T)$ is called the metric or measure theoretic entropy of T, to differentiate it from the topological entropy.

tested on the variables (e.g., $Y_1, Y_2, and\ Y_3$). The split then takes place according to whether the condition is satisfied. The observations that satisfy the condition are grouped in the left branch while the remaining grouped in the right branch. Based on the splitting values ($K_1, K_2, and\ K_3$) of the variables, every data point ends up in one of the nodes called terminal nodes ($T_1, T_2, and\ T_3$). The criteria for each terminal node by retreating up the tree to the top node can then be determined. For instance, the first terminal node (terminal node farthest to the left) retreats up to the left edge of the tree, yielding the following rule: ''If $Y_1 > K_1$ and $Y_2 > K_2$, then the observation will be classified as T_1 (first terminal node).'' Other terminal nodes in the tree can be interpreted similarly.

3.9 Software

The Statistical Package for Social Sciences (SPSS) version 20.0 and S-Plus 6.0 were used for computation of the results throughout the thesis.

CHAPTER 4: PREVALENCE, PATTERNS AND DETERMINANTS OF TOBACCO CONSUMPTION

4.1 Introduction

Tobacco consumption (TC) is a preventable public health problem. The prevalence of TC and its associated consequences in developed countries are declining or levelling off rapidly. However, TC of any form and the resulting death rates are still high in developing countries including South Asian region (WHO, 2009). The gap in tobacco related death rates between developing and developed countries is expected to increase over the next several decades (Samet & Wipfli, 2010).

The increase in youth TC in developing countries widens this gap further and the prevalence varies by country and gender (WHO, 2009). Notable theories and empirical evidence showed that socio-demographic and environmental conditions, parental and peer influence, and motivational and programmatic inclination as likely reasons of youth TC (Bandura, 1986; Kimberly, 2003; Kokkevi at al., 2007; Leatherdale et al., 2005b). Tobacco-related consequences on the youths are different from those on adults. Since youths have a longer period of smoking if they get addicted from the young age of tobacco initiation, and are seen as replacements for smokers who quit or die, they remain the targets of the tobacco industry (WHO, 2009).

Like other developing countries, adult TC is also high in South Asian region especially in Bangladesh and India (WHO, 2009). Various socio-economic factors were found to be associated with these TC (Palipudi et al., 2012; Schaap et al., 2008). Besides, the fact that the region is the largest producer and consumer of tobacco products is a special concern (WHO, 2009). Tobacco-related diseases, consequences and costs (direct and indirect) were enormous in Bangladesh and India (Palipudi et al., 2012; Zaman et al., 2007). In addition to social determinants, TC is greatly influenced by the level of knowledge of ill effects of tobacco products, individual attitude towards use of tobacco and perceptions about the social acceptance of TC (WHO, 2009).

The people of South Asian countries use diverse forms of tobacco products, namely, cigarettes, *bidis*, cigar, *hookah*, and smokeless tobacco (usually consumed orally or nasally, without burning or combustion) such as chewing tobacco (Eriksen, Mackay, & Ross, 2012). Therefore, the analysis of smoking patterns needs special attention to these diverse tobacco products. This chapter reports the empirical results along with discussions and cross-country comparisons to achieve the first objective of the study. **Section 4.1** provides a brief introduction; **Section 4.2** examines the issue of youth TC in Bangladesh, Nepal and Sri Lanka; **Section 4.3** explores the social determinants of TC and knowledge, attitude and perception (KAP) about the consequences of TC among adults in Bangladesh and India and finally, **Section 4.4** provides the analysis on the results of the classification and regression tree (CART) for characterizing smoking patterns of adults in Bangladesh and India.

4.2 Tobacco Consumption among Youths

The data for youth TC study of Bangladesh, Nepal and Sri Lanka were obtained from Global Youth Tobacco Survey (GYTS). A brief description of the methodology of the data collection, sampling procedure, questionnaires and relevant information on the survey was given in **Chapter 3,** Section 3.3.

The response variable is current tobacco use, and is defined as having used cigarettes, *bidis* or other smoked or smokeless tobacco product at least once during the past 30 days before the survey. The variable is coded “yes” or “1” if the respondent has used any of these tobacco products at least once and “no” or “0” if otherwise. To examine the influencing factors, several independent variables were selected based on the literature review in **Chapter 2,** Section 2.3.1 and the conceptual framework in

Chapter 3, Figure 3.6. The selected variables are: (i) background factors – age, sex and education grade, (ii) environmental factors – tobacco use behaviour of parents and friends, and whether they smoked at home or public places in the presence of respondent, (iii) motivating factors – free tobacco products from the vendors, advertisements and promotions in mass media and other places, and (iv) programmatic factors – whether taught in class about the danger of smoking and discussed smoking and health as part of a lesson. The detailed information regarding the dependent and independent variables and their coding for analysis are presented in **Appendix A1**.

4.2.1 Basic Information about Respondents

The descriptive information about the sample of study was obtained from frequency runs **(Table 4.1)**. The proportion of the respondents in each age category ranged from 21-43% for Bangladesh, 26-37% in Nepal and 23-39% in Sri Lanka. The proportion of female respondents was almost half for Sri Lanka, while the proportion was 54% for Nepal and 59% for Bangladesh. Some 55% of the Bangladeshi and 66% of the Nepalese respondents were in junior classes of grade seven and eight. For Sri Lanka, a higher proportion of the respondents (70.2%) were in grade nine and ten.

About 54% of the respondents from Bangladesh reported that at least one of their parents was a smoker. The proportion was slightly lower for Nepal (49%) and the lowest in Sri Lanka (30%). The incidence of TC among their friends was about 24% in Bangladesh and 27% in Nepal, but lowest in Sri Lanka (16%). About 35% of the youths in all the three countries reported to have experienced someone smoking in their home in their presence within seven days preceding the survey. Proportion of respondents who witnessed smoking at public places was 42.2% in Bangladesh, 47.4% in Nepal and 65.8% in Sri Lanka. Nepal had the highest proportion (17%) of youths who received free tobacco products from salesman. In contrast, this proportion was the lowest in Sri Lanka (3%).

Table 4.1: Basic Information of Respondents

Basic information [¶]	Bangladesh		Nepal		Sri Lanka	
	n	%	n	%	n	%
Age in years						
13	802	35.8	374	25.9	522	37.9
14	961	42.9	535	37.1	539	39.1
15	479	21.4	534	37.0	316	22.9
Mean age	13.86 years		14.1 years		13.85 years	
Gender						
Female	1301	59.2	776	53.8	691	50.2
Male	897	40.8	667	46.2	685	49.8
Educational grade						
Seventh (7 years of schooling)	584	26.1	461	32.0	-	-
Eighth (8 years of schooling)	644	28.7	494	34.3	395	29.8
Ninth (9 years of schooling)	581	25.9	331	23.0	520	39.1
Tenth (10 years of schooling)	433	19.3	156	10.8	414	31.1
Parental tobacco use						
No	1028	45.9	738	51.2	954	70.1
Yes	1210	54.1	705	48.8	406	29.9
Friends' tobacco use						
No	1711	76.3	1041	72.7	1144	84.4
Yes	531	23.7	392	27.3	211	15.6
Smoking at home *						
No	1463	65.3	927	64.7	874	64.6
1-4 days	385	17.2	273	19.0	380	28.1
5-7 days	392	17.5	234	16.3	100	7.4
Smoking in other places *						
No	1286	57.8	760	52.7	464	34.1
1-4 days	494	22.2	503	34.9	533	39.2
5-7 days	444	20.0	180	12.5	362	26.6
Offered free tobacco products by salesman						
No	1938	89.0	1180	83.0	1291	97.0
Yes	240	11.0	242	17.0	40	3.0
Ads. seen in hoarding, bus-stop, rail stations[a]						
None	593	26.5	220	15.3	438	32.6
A few	760	34.1	685	47.8	678	50.5
A lot	880	39.4	529	36.9	227	16.9
Taught in class about danger of TC						
No	1021	45.8	486	34.2	358	27.2
Yes	1211	54.2	937	65.8	958	72.8
Discussed TC & health as part of a lesson						
Never	1444	64.7	522	36.2	203	15.3
During the survey year	583	26.1	397	27.6	268	20.2
Preceding years of survey	206	9.2	520	36.2	858	64.6

[¶]Total (2242 youths for Bangladesh, 1444 for Nepal, and 1377 for Sri Lanka) does not always add up due to missing values; * in presence of youth in last 7 days before the survey; [a]detailed arein **Appendix A1**.

About 33% of the youths from Sri Lanka compared to 15.3% from Nepal never saw any advertisements in hoarding, bus-stop and railway stations. Majority of the Sri Lankan (73%) and Nepalese (66%) youths reported to have been taught in schools about the danger of smoking, and this proportion is the lowest among the youths from Bangladesh (54%). More than 60% of the Bangladeshi youths reported that issues on smoking and health were not discussed as part of school curricular. In contrast, only 36.2% of the Nepalese and 15.3% of the Sri Lankan respondents had reported the same.

4.2.2 Prevalence, Patterns and Determinants

The problem of youth TC seemed more serious in Nepal and Sri Lanka compared to Bangladesh, and more serious among the males in all the three countries (**Table 4.2**). Its prevalence rate was 6.9% (male 9.1%, female 5.1%) among the youths in Bangladesh, 9.4% (male 13.2%, female 5.3%) in Nepal and 9.1% (male 12.4%, female 5.8%) in Sri Lanka. The age when they first started smoking was 9.6, 10.24 and 8.61 years for the Bangladesh, Nepal, and Sri Lanka respectively. The Sri Lankan youths starts earlier than other two countries.

Table 4.2: Prevalence of Current* TC and Age of Tobacco Initiation

Prevalence & age of tobacco initiation	Bangladesh		Nepal		Sri Lanka	
Male & female	156	6.9	136	9.4	125	9.1
Male	85	9.1	101	13.2	85	12.4
Female	71	5.1	35	5.3	40	5.8
Average no. of cigarettes smoke per day	0.93		1.32		3.22	
Average no. of *bidis* smoke per day	1.62		0.75		-	
Average age (years) of tobacco initiation	9.6		10.24		8.61	

***Note:** Current TC refers to as having used cigarettes, bidis or other smoked or smokeless tobacco products at least once during the last 30 days before the survey.

TC included smoked and smokeless tobacco products. **Figure 4.1** shows the patterns of TC among the youths by gender and type of tobacco products. It is clear that in Bangladesh and Sri Lanka, the use of smokeless tobacco constituted a major part of total TC. In Bangladesh, smokeless tobacco use is slightly higher among the males (4.9%) than the females (4%). In Sri Lanka, the males consumed more than double (6.9%) smokeless tobacco products than the females (2.5%). In Sri Lanka, dual users (both smoked and smokeless tobacco products) also contributed to a noticeable proportion with more male users than female. However, in Nepal, TC was distributed almost equally (2.9 to 3.3%) among the three categories. The difference in proportion of male and female consumers was highest for Nepal for all these types of tobacco products compared to the other two countries. The proportion of male consumers was more than double or sometimes triple (dual users) of that of their female counterparts.

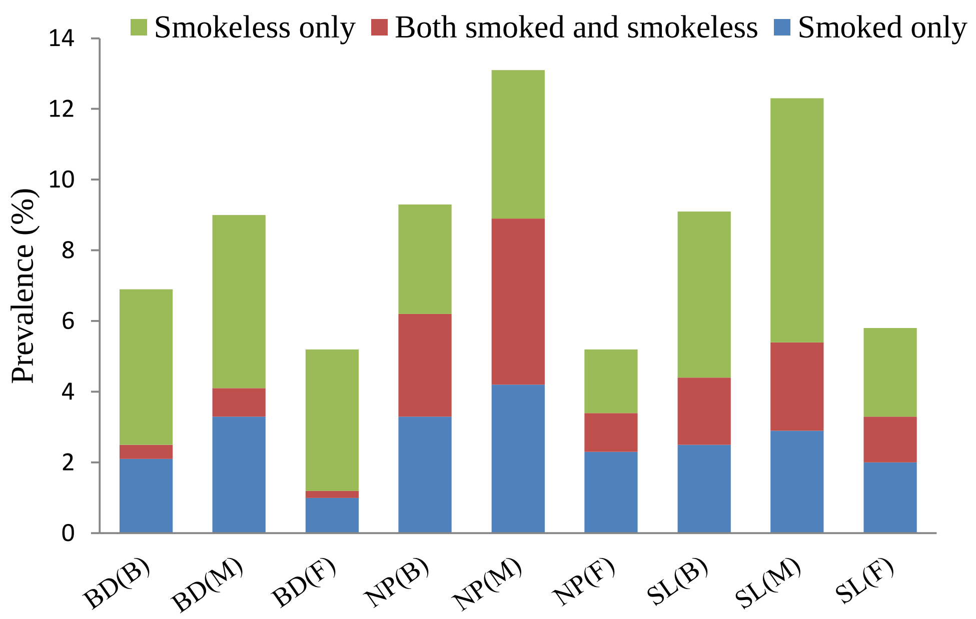

Figure 4.1: Patterns of TC among Youths by Gender and Type of Tobacco Products

Note: BD, NP and SL represent Bangladesh, Nepal and Sri Lanka. B represents both gender, M for male and F for female.

Bivariate cross tabulations of the response variable on the independent variables were generated using Chi-square test. The results showed that gender, smoking history of parents and friends, exposure to smoking at home and public places, and availability of free tobacco products from vendors were significantly ($p<0.001$) associated with TC in the three countries (**Table 4.3**). Respondents with parents or friends who were tobacco consumers and exposed to smoking at home or public places had a higher tendency to smoke. The smoking prevalence rate was also higher among those who were offered free tobacco products. Other factors, such as exposure to advertisements on tobacco products, and discussion of smoking hazards in school curricula were associated with youth TC in at least one of the three countries.

Table 4.3: Chi-Squared Analysis of Factors Associated with TC (%) among Youths

Factors	Bangladesh	Nepal	Sri Lanka
Age in years	χ^2=22.28 [a]	χ^2=14.49 [a]	χ^2=3.66
13	4.7	6.0	8.8
14	6.7	8.3	8.7
15	11.6	13.2	12.4
Gender	χ^2=13.59 [a]	χ^2=25.6 [a]	χ^2=16.87 [a]
Female	5.1	5.3	5.8
Male	9.1	13.2	12.4
Educational grade	χ^2=14.75 [a]	χ^2=3.10	χ^2=0.312
Seventh (7 years of school)	4.5	9.3	-
Eighth (8 years of school)	6.1	8.2	8.8
Ninth (9 years of school)	10.1	11.8	9.7
Tenth (10 years of school)	7.7	9.8	8.8
Parental tobacco use	χ^2=15.93 [a]	χ^2=8.2 [a]	χ^2=4.27 [a]
No	4.6	7.3	8.2
Yes	8.9	11.7	11.9
Friends' tobacco use	χ^2=70.34 [a]	χ^2=124.32 [a]	χ^2=58.76 [a]
No	4.5	4.1	6.6
Yes	15.2	23.5	24.2
Smoking at home *	χ^2=41.18 [a]	χ^2=51.27 [a]	χ^2=41.71 [a]
No	4.4	5.6	6.3
1-4 days	12.1	19.3	13.2
5-7 days	11.3	13.7	25.3
Smoking in other places *	χ^2=55.69 [a]	χ^2=67.9 [a]	χ^2=11.13 [a]
No	3.9	3.6	6.4
1-4 days	9.0	14.7	9.4
5-7 days	14.1	19.7	13.5
Offered free tobacco products by salesman	χ^2=53.45 [a]	χ^2=3.5 [a]	χ^2=31.0 [a]
No	5.6	9.1	8.4
Yes	18.5	14.5	35.1
Ads. seen in hoarding, bus-stop, rail stations	χ^2=18.3 [a]	χ^2=0.84	χ^2=13.19 [a]
None	4.9	7.9	8.3
A few	5.1	10.0	7.7
A lot	9.7	9.3	15.8
Taught in class about danger of TC	χ^2=5.14 [b]	χ^2=1.13	χ^2=3.40 [c]
No	8.2	10.7	12.0
Yes	5.8	8.9	8.5
Discussed TC & health as part of a lesson	χ^2=21.73 [a]	χ^2=3.45	χ^2=1.90
Never	5.6	11.4	10.7
During the survey year	7.5	8.9	11.4
Preceding survey years	14.5	8.2	8.8

* In presence of youths in last 7 days before the survey; [a] p<0.001; [b] p<0.01; [c] p<0.05 (p-values).

The Bangladeshi and Nepalese youths who were exposed to advertisements on tobacco products were more likely to be tobacco consumers. Discussion of the danger of smoking in school curricula had helped to deter smoking, at least in Bangladesh and Sri Lanka.

Multivariable binary logistic regressions were estimated for each country separately where the response variable takes a value of ‘1’ if the respondent is a tobacco user and ‘0’ if otherwise (details are in **Chapter 3**, Section 3.8). In the model diagnostic tests, Nagelkerke R^2 showed that the percentages of variation in the outcome variable (TC) explained by the models were 16%, 27% and 16% for Bangladesh, Nepal and Sri Lanka respectively. The P-values of Hosmer and Lemeshow (H-L) goodness of fit test for the three models were more than 5% level and showed that the model had good fit. In addition, the overall classification accuracy of the three models (Bangladesh, Nepal and Sri Lanka) showed that between 91-94% of the cases were correctly classified by the models. The check of multicollinearity from standard errors (SEs), variance inflation factor (VIF), and correlation matrix showed no serious multicollinearity among the selected independent variables (**Appendix A4**).

The results from the multivariable binary logistic regression analysis in **Table 4.4** showed that the likelihood of TC was about 1.5 (95% CI=0.90-2.64) times higher in Bangladesh among youth aged 15 years compared to those who were 13 years old. The corresponding odds ratio was 2.3 (95% CI=1.20-4.37) for Nepal and 2.8 (95% CI=1.05-7.30) for Sri Lanka. Significantly higher likelihood of TC was found among the males (OR=1.31 in Bangladesh, OR=1.77 in Nepal and OR=2.12 in Sri Lanka) with highest in Sri Lankan project. Parental TC did not show any significant effect on the tobacco use behaviour of the youths.

Table 4.4: Odds Ratio and 95% CI from Binary Logistic Regressions for Factors Influencing TC among Youths

Predictors	Bangladesh	Nepal	Sri Lanka
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age in years			
13[RC]	-	-	-
14	1.13 (0.69-1.86)	1.47(0.78-2.76)	0.96(0.45-2.04)
15	1.54 (0.90-2.64)	2.29** (1.20-4.3)	2.77** (1.05-7.3)
Gender			
Female[RC]	-	-	-
Male	1.31(0.89-1.95)	1.77**(1.10-2.87)	2.12***(1.29-3.5)
Educational grade			
Seventh[RC]	-	-	-
Eighth	1.02(0.57-1.83)	0.63(0.36-1.10)	-
Ninth	1.40(0.77-2.54)	1.35(0.76-2.39)	1.40(0.65-3.02)
Tenth	1.39(0.76-2.53)	1.25(0.65-2.32)	1.29(0.66-2.38)
Parental tobacco use			
No[RC]	-	-	-
Yes	1.04(0.68-1.60)	1.10(0.69-1.88)	1.05(0.69-1.61)
Friends' tobacco use			
No[RC]	-	-	-
Yes	1.94***(1.30-2.89)	4.10***(2.64-6.3)	2.34***(1.36-4.0)
Smoking at home #			
No[RC]	-	-	-
1-4 days	1.80**(1.09-2.96)	1.98**(1.17-3.35)	2.25***(1.31-3.8)
5-7 days	1.70** (1.02-2.81)	1.81** (1.08-2.8)	3.96*** (1.8-8.6)
Smoke other places #			
No[RC]	-	-	-
1-4 days	1.67*(0.98-2.85)	3.36***(1.9-5.87)	1.44(0.80-2.57)
5-7 days	2.67***(1.59-4.47)	5.22*** (2.7-9.8)	1.76* (1.05-2.88)
Offered free tobacco by salesman			
No[RC]	-	-	-
Yes	3.08***(1.97-4.83)	1.31(0.71-2.42)	2.57*(0.93-7.09)
Ads. seen in hoarding, bus stop, rail stations			
None[RC]	-	-	-
A few	0.90(0.51-1.59)	0.91(0.49-1.69)	0.89(0.51-1.53)
A lot	1.46 (0.87-2.45)	0.94(0.50-1.82)	1.61 (0.85-3.06)
Taught in class about danger of TC			
No[RC]	-	-	-
Yes	0.56***(0.38-0.84)	0.60*(0.41-0.89)	0.58**(0.35-0.94)
Discussed TC & health part of lesson			
Never[RC]	-	-	-
During survey year	0.79(0.47-1.56)	0.45***(0.3-0.78)	0.66*(0.41-0.99)
Preceding survey years	0.67**(0.43-0.92)	0.45*** (0.3-0.7)	0.67* (0.42-1.02)

*p<0.05; **p<0.01; ***p<0.001 (p-values); odds ratio (OR); confidence interval (CI); # in presence of youths in last 7 days before the survey.

However, friends' TC increased the likelihood of tobacco user among the respondents by at least two times (OR=1.9, CI=1.30-2.89 for Bangladesh, OR=4.1, CI=2.64-6.38 for Nepal and OR=2.3, CI=1.36-4.02 for Sri Lanka). The impact of influence from friends on smoking is the highest in Nepal.

Smoking at home and public places in the presence of the youths also appeared as a significant risk factor for TC. For instance, if the youths were exposed to smoking at home in the preceding seven days, the likelihood of them involved in TC was at least two times higher than the youths who did not have a similar exposure. This imitation behaviour was more common among the Sri Lankan youths compared to the other two countries. On the contrary, although exposure to smoking in public places increased the likelihood of TC in all three countries, its impact was higher among the youths in Bangladesh and Nepal. The provision of free tobacco products by vendors had influenced TC behaviour among the youths. For instance, TC was 3 times higher among the Bangladeshi youths and 2.6 times higher among the Sri Lankan youths when they received free tobacco products from the vendors. Teaching in class about the danger of smoking had reduced the likelihood of smoking to almost half for all the three countries. Similarly, discussions on smoking and health in school curriculum had also reduced the likelihood of TC.

4.2.3 Cross-country Comparison

The overall prevalence of youth TC in the three selected countries was below 10% with significantly higher rates among the males. A comparison can be made with the prevalence rate of other countries reported in WHO (2009). The rates were lower than those in other South Asian countries like Bhutan (male 18.3%, female 6.3%) and India (male 16.8%, female 9.4%), comparable to Pakistan (male 12.4%, female 7.5%), but higher than Maldives (male 8.5%, 3.4%). The incidence of youth TC in the three selected countries was higher than some neighbouring countries such as China (male

7.1%, female 3%), but lower than Myanmar (male 22.5%, female 8.2%) and Thailand (male 21.7%, female 8.4%). Consistent with TC among youths in other South Asian and neighbouring countries, this study showed significantly higher prevalence among males than females. The overall TC among female youths in the countries selected for this study was between 5-6%, but self-reporting in the survey and conservative social structure in these countries may lead to under-reporting of the actual situation. It should also be noted that the male-female differentials in TC prevalence rates in the selected three countries were much lower than that of some countries reported in WHO (2009), including Bhutan, India, Myanmar and Thailand. It is expected that in the near future TC among female youths will be higher in this region (WHO, 2009). This predicted trend on female TC may be due to the overall impact of globalization, urbanization, tobacco-related marketing efforts, and changing status of women from higher educational attainment and better employment opportunities (Al-Sadath et al., 2010; Sirirassamee et al., 2009). These findings are supported by the theory of triadic influence (Flay et al., 1999) and other studies (Rahman et al., 2011; Sirirassamee et al., 2009).

In contrast with other studies (Chassin et al., 2005; Sirirassamee et al., 2009), parental TC in the selected countries did not show any effect on their children's tobacco usage. However, in accordance with some studies (Akpinar et al., 2006; Leatherdale et al., 2005b; Lim et al., 2006; Rachiotis et al., 2010; Wakefield et al., 2000), the likelihood of TC increased significantly among youths who were exposed to smoking at home and public places. This experience has created health hazards. Such exposure impacted more on the Nepalese and Sri Lankan youths compared to their counterparts from Bangladesh.

Having seen friends using tobacco products increased the likelihood of TC among youths (Bandura, 1986; Oswal, 2012; Sirirassamee et al., 2009). In line with some empirical evidence in the literature and theories, this study showed that the risk of TC were 2 to 4 times higher due to such peer influence. This could be due to imitation, peer pressure or group characteristics. Peer influence had the largest impact on TC in Nepal compared to Bangladesh and Sri Lanka. Easy or sometimes free accessibility to tobacco products and lack of restrictions for sales to minors increased the possibility of TC among youths (Kotwal et al., 2005; Lim et al., 2006; Rudatsikira et al., 2008). Law enforcement, whether in or outside school compound, and tobacco control measures are essential (Gunasekara, 2008; WHO, 2008; WHO, 2009). Of the three countries, strict enforcement of law seemed to be most evident in Sri Lanka, which had the lowest percentage of those being offered free samples by salesman, and those who had seen tobacco advertisements on hoardings, bus stops and rail stations. In contrast, these incidents were highest in Nepal. On tobacco control measures, Sri Lanka also appeared to have done the most through education on the hazards of TC. Bangladesh, on the other hand, had lagged behind the two other countries in educating the youths on the adverse effects of TC in schools.

Consistent with other findings, this study showed that free tobacco products from the vendors had significant influence especially on the Bangladeshi and Sri Lankan youths. This may be related to other factors such as school environment (Leatherdale & Manske, 2005; Rahman et al., 2011), cultural norms (Rahman et al., 2011; Sirirassamee et al., 2009), socio-economic reasons (Al-Sadath et al., 2010; Leatherdale et al., 2005b) and psychological factors (Flay et al., 1999; Rudatsikira et al., 2008). Although free tobacco products were made available relatively easier in Nepal compared to the other two countries, the Nepalese youths were less affected by the same factor, perhaps due to different level of knowledge, attitude and awareness. For the same reasons, incorporation of health issues and hazards of smoking in school lessons had a higher positive impact on the Nepalese youths. Knowledge about the danger of addictive tobacco behaviour significantly reduced future TC (Kokkevi et al., 2007; Leatherdale et al., 2005b). This study found that class lessons on the danger of smoking and discussions of smoking and health as part of a lesson had influenced prevalence of tobacco usage among the youths in all three countries.

4.3 Tobacco Consumption among Adults

The data for adult TC to examine (a) determinants of TC, and (b) knowledge, attitude and perception (KAP) of the consequences of TC of Bangladesh and India were obtained from the Global Adult Tobacco Survey (GATS). The methodology of data collection, sampling procedure, questionnaires and relevant information were briefly discussed in **Chapter 3,** Section 3.4.

The response variable of TC is current tobacco use. The variable refers to smoking or use of any smokeless tobacco products within 30 days before the survey. The variable was coded "yes" or "1" if the respondent has used any of these tobacco products at least once in the last 30 days before the survey and "no" or "0" if otherwise. To measure KAP about the consequences of TC, 13 questions were asked in GATS Bangladesh and 5 questions were asked in GATS India. Therefore, scores ranging from 0-13 for Bangladesh and from 0-5 for India were used to categorize KAP into three levels (some KAP, good KAP and high KAP).

To examine the factors influencing TC among Bangladeshi and Indian adults, several independent variables such as respondent's age, gender, place of residence, education, and wealth index were considered. In addition to these socio-demographic variables, household members, anti-tobacco information (ATI) score and pro-tobacco information (PTI) score were used as predictors of KAP. It should be noted that to measure ATI score, 24 questions were asked in GATS Bangladesh (score ranges from 0-24) and 17 questions were asked in GATS India (score ranges from 0-17). Whereas, to measure PTI score, 63 questions were asked in GATS Bangladesh (score ranges from 0-63) and 54 questions were asked in GATS India (score ranges from 0-54). The variable selection was guided by the literature review in **Chapter 2,** Sections 2.3.2 & 2.3.3 and conceptual framework in **Chapter 3,** Figure 3.8. The detailed information regarding the response and independent variables and their coding for analysis are presented in **Appendix A2**.

4.3.1 Basic Information about Respondents

Descriptive information about the sample of study was obtained from frequency runs on the variables considered (**Table 4.5**). More than 40% of the adults in Bangladesh and India were in the age group of 25-44 years. The average age of the adults included in the survey for both countries was about 36 years. The male-female ratio was almost balance with slightly more females in Bangladesh (50.3% vs. 49.7%) than India (48.3% vs. 51.7%). About 43% of the adults in Bangladesh and 37% in India had household size of 4-5 members, and the average family size was 5 and 6 members respectively. The two countries were not highly urbanized. For example, about 74% adults in Bangladesh and 71% adults in India resided in rural areas. Majority of the respondents had no formal education (36% in Bangladesh and 31% in India). Only 8% of the adults in Bangladesh and 16% in India had completed higher education (college or university). About 42% of the adults in Bangladesh and 46% in India were from the lowest two quintiles of wealth index (poor category) whereas, 38% in Bangladesh and 30% in India were from the highest two quintiles (rich category).

The level of knowledge, attitude and perception (KAP) about the consequences of TC was satisfactory for both countries. More than 90% of the adults from Bangladesh and about 84% from India had good to high KAP, with an average score of 11.2 (out of 13) for Bangladesh and 3.76 (out of 5) for India.

Table 4.5: Proportion of Adults by Socio-economic and Health Knowledge Variables

Variables	**Bangladesh**	**India**
Age in years (mean ± SD)	35.84±15.96	35.96 ± 15.95
15-24	29.5	29.5
25-44	43.1	42.0
45-59	17.2	17.4
60 and above	10.2	11.1
Gender		
Female	50.3	48.3
Male	49.7	51.7
Household members (mean ± SD)	5.07± 2.39	6.06 ± 3.31
1-3	24.0	15.8
4-5	42.7	37.2
6-8	26.0	31.1
9 and above	7.2	15.9
Place of residence		
Urban	26.2	29.2
Rural	73.8	70.8
Educational attainment		
No formal education	36.0	31.2
< primary to primary completed (1-5 years)	27.7	23.9
< secondary to secondary completed (6-10 years)	28.3	28.6
Tertiary education (more than 10 years)	8.0	16.3
Wealth index (asset quintile)*		
Lowest (1st quintile)	18.7	27.6
Low (2nd quintile)	23.3	18.3
Middle (3rd quintile)	20.2	24.3
High (4th quintile)	22.8	15.6
Highest (5th quintile)	15.0	14.2
KAP (mean ± SD)	11.2± 2.52	3.76 ± 1.47
Some	9.5	16.2
Good	46.1	40.2
High	44.4	43.6
ATI score (mean ± SD)	2.96± 3.48	3.44 ± 3.69
0	31.1	27.2
1-3	36.9	35.1
4-6	17.9	18.1
7 and above	14.0	19.6
PTI score (mean ± SD)	2.81± 4.17	1.82 ± 3.97
0	39.6	65.4
1-3	34.3	18.8
4-6	13.7	6.6
7 and above	12.4	9.2

SD (standard deviation); KAP (knowledge, attitude and perception); ATI (anti-tobacco information); PTI (pro-tobacco information); * based on factor analysis (detaied in **Appendix A2**)

Anti-tobacco information (ATI) score showed that about 31% of the adults in Bangladesh and 27% of the adults in India had no such knowledge. Majority of the adults (37% in Bangladesh and 35% in India) had ATI score of 1-3 with an average score of 2.96 (out of 24) for Bangladesh and 3.44 (out of 17) for India. The proportion with ATI score of more than 7 and above was 14% and 20% among Bangladeshi and Indian adults respectively. Pro-tobacco information (PTI) score revealed that about 40% of the adults in Bangladesh and 65% in India had no such information. The average PTI score was 2.8 for Bangladesh (out of 63) and 1.8 for India (out of 54). Only 12% in Bangladesh and 9% in India had PTI score of more than 7 and above. The statistics showed that the adults in both countries had no or little knowledge on anti-tobacco and pro-tobacco information.

4.3.2 Patterns, Prevalence and Determinants

It was found that about 43% of the Bangladeshi and approximately 35% of Indian adults were currently consuming tobacco (either smoking cigarettes or *bidis* or using any smokeless tobacco). Among the current users, almost similar (about 20%) from both the countries were using smokeless tobacco only (**Table 4.6**). However, 16% and 9% adults from Bangladesh and India used smoked tobacco (either cigarettes or *bidis*) only, respectively, suggesting a higher prevalence of smokeless TC in both countries. Moreover, 7% of the adults in Bangladesh and 5% in India used both products (smoked and smokeless tobacco).

Table 4.6: Types and Patterns of TC among Adults

Status of TC*	Bangladesh	India
Never consumed	53.0	62.4
Former consumer	3.7	3.0
Current consumer	43.3	34.6
Patterns of TC		
Smoked products only	16.2	8.9
Smokeless products only	20.0	20.6
Both smoked and smokeless products	7.1	5.1
Sample size	9,629	69,296

* **Note:** Current TC refers to smoking or use of any smokeless tobacco products within 30 days before the survey

Prevalence of current TC among adults by selected socio-demographic characteristics in Bangladesh and India is presented in **Table 4.7**. The Chi-square test results showed that TC was significantly associated with all the variables. In both countries, the older age groups had higher prevalence of TC than the youngsters. For instance, among the adults from Bangladesh aged 60 and above, the prevalence of TC was more than 70%. This prevalence for India was about 50%. In contrast, the prevalence for adults aged 15-24 years was 17% and 19% in Bangladesh and India, respectively. Males were more likely to consume tobacco than female (58% vs. 29% in Bangladesh and 48% vs. 21% in India). The rural-urban TC differentials were also prominent (45% vs. 38% in Bangladesh and 39% vs. 25% in India).

Table 4.7: Prevalence of TC among Adults by Socio-demographic Characteristics

Socio-demographic variables*	**Bangladesh**	**India**
Age in years		
15-24	16.8	18.5
25-44	45.7	37.8
45-59	68.3	45.6
60 and above	70.7	49.7
Gender		
Female	28.5	20.9
Male	57.8	47.8
Place of residence		
Urban	38.3	25.4
Rural	44.9	38.5
Educational attainment		
No formal education	62.4	49.8
< primary to primary completed (1-5 years)	45.9	37.2
< secondary to secondary completed (6-10 years)	24.3	18.7
Tertiary education (more than 10 years)	25.7	19.3
Wealth index (asset quintile)**		
Lowest (1st quintile)	56.1	48.2
Low (2nd quintile)	46.9	38.7
Middle (3rd quintile)	42.4	31.8
High (4th quintile)	37.8	24.9
Highest (5th quintile)	27.9	16.7

*It should be noted that TC was significantly associated with all the independent variables ($p<0.05$) in the bivariate analysis based on Chi-square test; ** based on factor analysis (detaied in **Appendix A2**)

In both countries, the higher the education level, the lower the likelihood to be a tobacco user. For instance, among the adults in Bangladesh with no formal education, 62% were current tobacco users. However, for adults who completed higher education, only 26% were current tobacco users. About similar scenarios between TC and educational attainment were found for India. Like education, wealthiness had an inverse relationship with TC. For example, among the adults in the first wealthiness quintile (poorest) in Bangladesh, about 56% consumed tobacco compared to 28% among those from the fifth quintile (richest). Similarly, the prevalence of TC in India was 48% for the first quintile and 17% for the fifth quintile.

The multivariable binary logistic regression was estimated where the response variable takes a value of '1' if the respondent is a tobacco user and '0' otherwise (details are in **Chapter 3,** Section 3.8). The Nagelkerke R^2 shows the percentage of variation in TC that was explained by the models were 39% and 36% for Bangladesh and India respectively. The p-values of Hosmer and Lemeshow (H-L) goodness of fit test for the two models were more than 5%, hence no evidence to reject fitness of the model. In addition, the overall classification accuracy of the two models (Bangladesh and India) showed that 78-80% of the cases were correctly classified. The check for multicollinearity using standard errors (SEs), variance inflation factor (VIF) and correlation matrix did not find any serious multicollinearity among the selected independent variables (**Appendix A5**).

The results from the multivariable binary logistic regression analysis in **Table 4.8** showed that in both countries, age had significant ($p<0.001$) influence on the TC behavior among adults. For instance, adults aged 45-60 years and 60 years old and above in Bangladesh were 13 (95% CI=10.05-18.30) and 17 (95% CI=11.03-20.80) times more likelihood to consume any type of tobacco products than adults aged 15-24 years old. For India, adults 45 years and above had 4.5 times higher likelihood to consume tobacco products than the reference category. Significantly higher likelihood of TC was found among the males (OR=6.77 in Bangladesh, and OR=5.92 in India) compared to the females. In Bangladesh, urban-rural differentials were found to be insignificant. Whereas, in India urban-rural differentials were significant (p<0.001) with an OR of 1.21 (95% CI=1.0-1.35).

Table 4.8: Odds Ratio and 95% CI of Predictors of TC from Binary Logistic Regressions among Adults by Socio-demographic Characteristics

Variables or predictors	Bangladesh OR (95% CI)	India OR (95% CI)
Age in years		
15-24(RC)	-	-
25-44	4.94 (3.95-6.20)***	3.03 (2.7-3.35)***
45-59	13.20 (10.05-18.3)***	4.42 (3.9-5.10)***
60 and above	16.7 (11.03-20.8)***	4.63 (4.1-5.3)***
Gender		
Female(RC)	-	-
Male	6.77 (5.8-7.9)***	5.92 (5.5-6.5)***
Place of residence		
Urban(RC)	-	-
Rural	0.93 (0.78-1.1)	1.21 (1.0-1.35)***
Educational attainment		
Tertiary education(RC)(>10 years)	-	-
< Secondary to completed (6-10)	1.80 (1.50-2.10)	1.13 (.91-1.25)*
< Primary to P completed (1-5 years)	2.70 (1.90-4.26)***	1.80 (1.5-2.10)***
No formal education	4.90 (2.8-6.7)***	3.03 (2.6-3.5)***
Wealth index (asset quintile)		
5^{th} quintile(RC)	-	-
4^{th} quintile	1.35 (1.0-1.72)**	1.47 (1.3-1.65)***
3^{rd} quintile	1.46 (1.2-1.9)**	1.93 (1.78-2.2)***
2^{nd} quintile	1.71 (1.4-2.3)***	2.31 (2.1-2.7)***
1^{st} quintile	2.25 (1.8-3.01)***	2.98 (2.6-3.47)***

(RC) reference category; CI=confidence interval; OR=odds ratio; ***p<0.001; **p<0.01; *p<0.05.

In Bangladesh and India, educational attainment was significant (p<0.001) factor determining TC behaviour. The odds could be 4.9 (95% CI=2.8-6.7) and 2.7 (95% CI=1.90-4.20) times higher among Bangladeshi adults with no formal education and less than primary to completion of primary schooling, respectively, compared to the reference category of higher education. Slightly lower odds with similar patterns for both the categories compared to the reference category were also found among the Indian adults [3.03 (CI=2.6-3.5) and 1.8 (CI=1.5-2.10) respectively]. Like educational attainment, economic status had significant (p<0.001 to p<0.01)) influence on TC behaviour among the adults. Those who were poorer in both countries were more likely to consume tobacco products. The odds were higher among the Indian adults than the odds for the Bangladeshi adults. For instance, Indian adults from the first quintile (poorest) and second (poorer) quintile were 2.98 (CI=2.65-3.47) and 2.31 (2.10-2.7) times more likely to be tobacco users than the fifth (richest) quintile. The corresponding risks were found to be slightly lower (OR=2.25 in 1st quintile and OR=1.71 in 2nd quintile) for the Bangladeshi adults.

4.3.3 Knowledge, Attitude and Perception (KAP) and TC among Adults

The ordinal and multinomial logistic regression analyses were utilized to find out the factors influencing KAP of the consequences of TC. In addition, the association between TC and KAP were examined using these regressions adjusted for respondent's age, gender, place of residence, number of household members, education, wealth index, ATI and PTI as confounders (analytical framework is in **Chapter 3,** Figure 3.9). The detailed information on multivariable logistic regression is given in **Chapter 3,** Section 3.8.

(a) The Results for Bangladesh

A preliminary bivariate analysis was conducted to find association between the independent variables and TC. The variables that were significant in the bivariate analysis (Pearson Chi-square, Likelihood Ratio Test, and Linear by Linear test) were chosen based on the significance level of 0.05. This preliminary analysis allows selection of significant variables for multivariable analysis. From the standard errors (SEs), variance inflation factor (VIF), and correlation matrix, it is clear that there is no serious multicollinearity problem among the independent variables (**Appendix A6**).

The goodness of fit test showed that the model did not fit the data well (**Appendix A7**). This could be partly due to the inclusion of many categorical variables with many levels or grouping. However, the values of Pseudo R^2 (Cox and Snell=.14, Nagelkerke=.21, McFadden=.11 for ordinal logistic regression and Cox and Snell=.17, Nagelkerke=.25, McFadden=.13 for multinomial logistic regression) and classification accuracy (53.4% for ordinal and 55.7% for multinomial) showed the model is reasonably good model and acceptable. The ordinal regression assumed that the relationships between the independent variables and the logits are same for all the logits (**Appendix A7**). Here, a highly significant test statistics ($p<0.001$) suggests that separate parameters for each category would be more appropriate and thus current model may not be suitable. The model is again tested using another link function, Cauchit, but the test also did not support this model. Since the logit link function is widely used, this model was applied.

The results from the ordinal logistic regression given in **Table 4.9** showed that respondent's age, educational level (no formal education and completion of primary schooling), wealthiness (first quintile), family size (1-3 members), and anti-tobacco information (ATI) score were significantly ($p<0.001$) related to knowledge, attitude and perception (KAP) of the consequences of TC. It was also found that gender, place of residence, other categories of educational attainment (secondary to completion of secondary schooling), other wealth quintiles, and family size (4-5 members) were statistically significant at level between 0.001 to 0.05. For instance, the respondents who were 15-24, 25-44, and 45-59 years old were 1.3, 1.5 and 1.4 times more likely to have high KAP than respondents who have 60 or more years old. Males had better KAP than females and the urban residents also had better KAP than their rural counterparts. The corresponding likelihoods were 1.2 to 1.3 times higher. In the case of educational level, the respondents with better education background were more likely to have better KAP. Those with no formal education, less than primary to completion of primary schooling, and less than secondary to completion of secondary schooling were only 0.58, 0.75 and 0.85 times as likely as those with higher education (completed college or university or postgraduate degree) to have high levels of KAP.

Table 4.9: Ordinal Logistic Regression Results for KAP of the Consequences of TC, Bangladesh

Predictors	Estimate	95% CI	OR= Exp(estimate)
Age in years			
15-24	.216	.06-.37	1.25***
25-44	.372	.23-.51	1.45***
45-59	.343	.19-.50	1.40***
60+	-	-	-
Gender			
Male	.23	.07-.39	1.26**
Female	-	-	-
Place of residence			
Urban	.19	.05-.34	1.21*
Rural	-	-	-
Educational level			
No formal education	-.54	-.73-(-.35)	.58***
< Primary to P completed (1-5 years)	-.29	-.47-(-.11)	.75***
<Secondary to Second completed (6-10 years)	-.16	-.33-.01	.85*
Higher educatio	-	-	-
Wealth Index			
Lowest (1st quintile)	-.39	-.56-(-.22)	.68***
Low (2nd quintile)	-.18	-.33-(-.02)	.84**
Middle (3rd quintile)	-.06	-.21-.09	.94
High (4th quintile)	-.02	-.18-.13	.98**
Highest (5th quintile)	-	-	-
Number of persons in household			
1-3	.23	.06-.40	1.26***
4-5	.17	.00-.33	1.19*
6-8	.12	-.04-.28	1.13
9+	-	-	-
ATI score			
0	-.63	-.79-(-.47)	.53***
1-3	-.40	-.54-(-.27)	.67***
4-6	-.24	-.39-(-.10)	.79***
7+	-	-	-
PTI score			
0	-.08	-.24-.07	.92
1-3	.13	-.02-.27	1.14*
4-6	-.02	-.18-.14	.98
7+	-	-	-

OR=odds ratio; CI=confidence interval; *p<0.05; **p<0.01; ***p<0.001; link function: logit; ATI (anti-tobacco information); PTI (pro-tobacco information).

The level of KAP was higher among those who were wealthier. The respondents from the 1st and 2nd quintiles were only 0.68 and 0.84 times as likely to have high KAP compared to the respondents from the 5th quintile. The level of KAP was inversely related to household size. The respondents from household size of 1-3 members, and 4-5 members had 1.3 and 1.2 times higher likelihood of having high KAP than those from households with 9 or more family members. Those with higher ATI score tended to have higher level of KAP. The results showed that respondents with no ATI, score of 1-3, and 4-6 had likelihood of 0.53, 0.67 and 0.79 to have high KAP compared to the respondents with ATI score of 7 and above. Pro-tobacco information (PTI) score was not found to have any influence on KAP of the consequences of TC among Bangladeshi adults.

There are two parts in the multinomial logistic regression. The first part compares respondents who had "good KAP" to those who had "some KAP" while the second part compares those who had "high KAP" to those who had "some KAP". A positive coefficient, or log odds ratio larger than 1, indicates that the respondents in the related category have a higher probability than the reference group to be in the group with better KAP.

The odds of having good KAP were 1.4 and 1.3 times higher (with $p<.001$) among those who were 25-44 and 45-59 years old respectively than the reference category of 60 years old and above. Males had slightly higher likelihood (OR=1.13) of good KAP than their female counterparts. It was found that urban residents had significantly ($p<0.001$) higher likelihood (OR=1.31, 95% CI=1.08-1.59) of good KAP compared to those who resided in rural areas (**Table 4.10**). Education significantly ($p<0.001$ to $p<0.05$) influenced the KAP of the consequences of TC. For instance, the respondents with no formal education, some or completed primary schooling and some or completed secondary schooling were respectively 0.23, 0.32, and 0.70 times likely to have good KAP than the respondents with tertiary education. In the case of wealthiness, the respondents from the 1st quintile were 0.73 times as likely to have good KAP as the respondents from the 5th quintile. It was found that the respondents from small family

(1-5 members) had higher chances (more or less 1.2 times) of having good KAP than the respondents from large or extended family (9 or more members).

Table 4.10: Multinomial Logistic Regression Results for KAP of the Consequences of TC, Bangladesh

Predictors	Good vs. Some		High vs. Some	
	Estimate	OR (95% CI)	Estimate	OR (95% CI)
Age in years				
15-24	-.020	.98 (.75-1.27)	.127	1.14 (.87-1.49)
25-44	.355***	1.43 (1.14-1.78)	.570***	1.77 (1.40-2.24)
45-59	.272**	1.31 (1.02-1.68)	.486***	1.63 (1.26-2.11)
60+	-	-	-	-
Gender				
Male	.120	1.13 (.85-1.43)	.22*	1.25 (.92-1.72)
Female	-	-	-	-
Place of residence				
Urban	.270***	1.31 (1.08-1.59)	.35***	1.42 (1.12-1.75)
Rural	-	-	-	-
Educational level				
No formal education	-1.46***	.23 (.13-.42)	-1.75***	.17 (.10-.31)
< Primary to primary completed (1-6 years)	-1.16***	.32 (.18-.56)	-1.31***	.27 (.15-.48)
< Secondary to S completed (6-10 years)	-.36*	.70 (.39-1.25)	-.53*	.59 (.33-1.05)
Higher education	-	-	-	-
Wealth Index[a]				
Lowest (1st quintile)	-.31*	.73 (.55-1.03)	-.352**	.70 (.51-.98)
Low (2nd quintile)	.027	1.03 (.74-1.42)	-.068	.93 (.68-1.29)
Middle (3rd quintile)	.265***	1.30 (.95-1.80)	.271	1.31 (.94-1.83)
High (4th quintile)	.279*	1.32 (.96-1.83)	.427**	1.53 (1.11-2.16)
Highest (5th quintile)	-	-	-	-
No. of persons in h/h				
1-3	.219	1.24 (.90-1.72)	.438***	1.55 (1.12-2.15)
4-5	.218	1.24 (.91-1.70)	.361**	1.43 (1.04-1.97)
6-8	.132	1.14 (.84-1.54)	.248	1.28 (.94-1.74)
9+	-	-	-	-
ATI score				
0	-1.94***	.14 (.08-.25)	-2.22***	.11 (.06-.19)
1-3	-1.39***	.25 (.15-.42)	-1.70***	.18 (.11-.31)
4-6	-1.05***	.35 (.20-.61)	-1.26***	.29 (.17-.49)
7+	-	-	-	-
PTI score				
0	-.354*	.70 (.49-1.00)	-.344*	.71 (.50-1.02)
1-3	-.154	.86 (.60-1.22)	.005	1.0 (.70-1.43)
4-6	-.214	.81 (.55-1.19)	-.201	.82 (.55-1.21)
7+	-	-	-	-

OR=odds ratio; CI=confidence interval; the reference category is some KAP; *p<0.05; **p<0.01; ***p<0.001; ATI (anti-tobacco information); PTI (pro-tobacco information); [a]based on factor analysis (detaied in **Appendix A2**)

Anti-tobacco information (ATI) score significantly ($p<0.001$) influenced the KAP among the respondents. The respondents with no ATI, score of 1-3, and score of 4-6 were 0.14, 0.25 and 0.35 times likely to have good KAP than the respondents with score of 7 or more. It was found that the respondents with no pro-tobacco information (PTI) had 0.7 times likelihood ($p<0.05$) of having good KAP than the respondents with PTI score of 7 or more. The other categories of PTI did not show any significant influence on KAP.

The findings on comparison of high versus some level of KAP are similar to those comparing good versus some level of KAP, except that the likelihood of difference in the impact of significant factors on the KAP level is now larger. The odds of having high KAP were 1.8 and 1.6 times higher (with $p<.001$) among those were 25-44 and 45-59 years old respectively than the reference category of 60 years old and above (**Table 4.10**). Males were significantly ($p<0.05$) more likely to have high KAP (OR=1.3, CI=.92-1.72) than females. Urban residents had significantly ($p<0.001$) higher likelihood (OR=1.42, 95% CI=1.12-1.75) of high KAP than their rural counterparts. Education significantly ($p<0.05$) influenced the KAP of the consequences of TC. For instance, the respondents with no formal education, some to completion of primary schooling, and some or completion of secondary schooling had lower likelihood (OR is 0.17, 0.27, 0.59 respectively) of high KAP than those who had at least a university degree.

Where economic status is concerned, the respondents from the 1st quintile had lower chances ($p<0.01$) of high KAP than the respondents from the 5th quintile (OR=0.70). However, the respondents from the 4th quintiles had higher likelihood of having high KAP than the respondents from the 5th quintile (**Table 4.10**). It was found that the respondents from small family had higher likelihood of having high KAP than those from large or extended family. For example, those from family with 1-3 members, 4-5 members, and 6-8 members were 1.6, 1.4 and 1.3 times more likely to have high KAP compared to those with family size of 9 or more members. Anti-tobacco information score significantly (p<0.001) influenced the KAP among the respondents. The respondents having no ATI, score of 1-3, and score of 4-6 were 0.11, 0.18 and 0.29 times as likely to have high KAP as the respondents with score of 7 or more. The respondents with no pro-tobacco information score had lower likelihood (OR=0.71) of having high KAP than the respondents with PTI score of 7 or more.

The relationship between KAP and TC were estimated by logistic regressions that were adjusted for other variables as confounders (the model diagnostic results are close to those in **Appendix A7**). The results of the multinomial and ordinal regressions are given in **Table 4.11**. The ordinal logistic regression showed that the respondents who did not smoke at all (p<.001) or smoked less than once daily (p<.05) had 1.7 and 1.3 times higher likelihood of having a higher level of KAP compared to their counterparts who smoked daily. The findings are similar for smokeless tobacco (SLT) users. The respondents who did not use SLT products at all (p<.001) or used them less than once daily (p<.05) had 1.5 and 1.3 times higher likelihood of having a higher level of KAP compared to the daily users.

Table 4.11: Association of KAP and TC Adjusted for Confounding Factors, Estimated from Ordinal and Multinomial Logistic Regressions, Bangladesh

Predictors	**Multinomial**		**Ordinal**
	Good vs. Some	High vs. Some	Some, Good vs. High
	OR (95% CI)	OR (95% CI)	OR= Exp(estimate)
Current ST user			
Not at all	1.41** (.77-2.6)	2.16*** (1.7-2.74)	1.69***
Less than daily	1.30 (1.03-1.63)	1.54 (.82-2.90)	1.25*
Daily	-	-	-
Current SLT user			
Not at all	1.1 (.681.72)	1.36** (.85-2.19)	1.52***
Less than daily	1.04 (.87-1.24)	1.21 (1.01-1.45)	1.27*
Daily	-	-	-

OR=odds ratio; CI=confidence interval; reference category is high KAP for ordinal regression and some KAP for multinomial; *p<0.05; **p<0.01; ***p<0.001; ST (smoked tobacco); SLT (smokeless tobacco).

The results from the multinomial logistic regression (**Table 4.11**) suggested that the respondents who did not smoke at all ($p<.01$) or smoked less than once daily were 1.4 and 1.3 times more likely to have good KAP compared to those who smoked daily. The likelihood of having high level of KAP was 2.2 and 1.5 times higher than the daily smokers. For smokeless tobacco (SLT) users, the respondents who did not use SLT products at all ($p<.01$) or use less than once daily had 1.4 and 1.2 times higher likelihood of achieving a high level of KAP compared to the daily users of smokeless tobacco products.

(b) The Results for India

Bivariate analysis was conducted as in the case for Bangladesh. The results are in **Appendix A8**. No serious multicollinearity problem was detected for the multinomial and ordinal regressions. The results of the goodness of fit test showed that the model does not have a good fit (**Appendix A9**). The values of Pseudo R^2 (Cox and Snell=.18, Nagelkerke=.24, McFadden=.14 for ordinal regression and Cox and Snell=.20, Nagelkerke=.27, McFadden=.16 for multinomial regression) and classification accuracy (54.6% for the ordinal and 57.2% for the multinomial regression) showed that the model is reasonably acceptable considering the inclusion of many categorical variables with many levels or grouping in the model. The ordinal regression assumed that relationships between independent variables and the logits are same for all logits (**Appendix A9**). However, test statistic ($p<0.001$) suggests that separate parameters for each category would be more appropriate. The Cauchit link function was tested, but the model was also rejected. The logit link function was used given that it is the most commonly applied model.

The results from the ordinal logistic regression given in **Table 4.12** showed that the respondent's age (25-44 and 45-59 years), gender, educational level, wealthiness (1st and 2nd wealth quintiles), family size (1-3 members), anti-tobacco information (ATI) score, and pro-tobacco information (PTI) (score of '0') were significantly (p<0.001) related to knowledge, attitude and perception (KAP) of the consequences of TC.

Table 4.12: Ordinal Logistic Regression Results for KAP of Consequences of TC, India

Predictors	Estimate	95% CI	OR=exp(estimate)
Age in years			
15-24	.141	.10-.18	1.15*
25-44	.381	.34-.45	1.46***
45-59	.291	.22-.34	1.34***
60+	-	-	-
Gender			
Male	.22	.06-.36	1.25***
Female	-	-	-
Place of residence			
Urban	.21	.04-.34	1.23**
Rural	-	-	-
Educational level			
No formal education	-.689	-.74-(-.64)	.50***
< primary to primary school completed (1-5 years)	-.386	-.44-(-.34)	.68***
< secondary to secondary school completed (6-10 years)	-.137	-.18-(-.09)	.87***
Tertiary education (>10 years)	-	-	-
Wealth index			
Lowest (1st quintile)	-.37	-.55-(-.21)	.69***
Low (2nd quintile)	-.16	-.31-(-.01)	.85***
Middle (3rd quintile)	-.04	-.11-.08	.96*
High (4th quintile)	-.01	-.15-.12	.99*
Highest (5th quintile)	-	-	-
No. of persons in household			
1-3	.245	.09-.43	1.28***
4-5	.186	.03-.33	1.20**
6-8	.121	.08-.16	1.13*
9+	-	-	-
ATI score			
0	-1.287	-1.3-(-1.24)	.28***
1-3	-.708	-.75-(-.67)	.49***
4-6	-.456	-.50-(-.41)	.63***
7+	-	-	-
PTI score			
0	-.161	-.21-(-.11)	.85***
1-3	-.040	-.10-.02	.96
4-6	-.027	-.10-.04	.97
7+	-	-	-

OR=odds ratio; CI=confidence interval; *p<0.05; **p<0.01; ***p<0.001; link function: logit; ATI (anti-tobacco information); PTI (pro-tobacco information).

It was also found that the age group of 15-24 years, place of residence, 3rd and 4th wealth quintiles, and family size of (4-5 and 6-8 members) were statistically significant at the 0.001 to 0.05 level. The respondents in the age groups 15-24, 25-44 and 45-59 years old had 1.2, 1.5 and 1.3 times higher likelihood to have high KAP than those who were 60 or more years old. Males compared to the females and the urban residents compared to their rural counterparts were 1.3 and 1.2 times more likely to have higher KAP of the consequences of TC. In the case of educational level, those with no education, primary or secondary education had lower likelihood to have high KAP compared to the respondents with higher education (completed college, university or postgraduate degree). Respondents from the 1st and 2nd quintiles of wealth index were 0.69 and 0.85 times as likely to have high KAP compared to the respondents from the 5th quintile. Respondents with household size of 1-3 members and 4-5 members were 1.3 and 1.2 times more likely to have high KAP than those from households with 9 or more family members. The results on anti-tobacco information score showed that respondents with lower scores were less likely to have high KAP compared to those with higher scores. For PTI, the respondents with no PTI (zero score) had significantly ($p<0.001$; OR=.85) lower likelihood of high KAP than the respondents with PTI score of 7 and above.

The results for the estimated multinomial regression are reported in **Table 4.13**. The first part of the regression compares respondents who have "good KAP" to those who have "some KAP" and the second part compares those who have "high KAP" to those who have "some KAP".

The odds of having good KAP were 1.3, 1.4 and 1.2 times higher (with $p<.001$) among those who were 15-24, 25-44 and 45-59 years old respectively compared to the reference category of 60 years old and above. Males had slightly higher likelihood (OR=1.17) of good KAP than the females ($p<0.01$). Urban residents also had ($p<0.05$)

higher likelihood (OR=1.26, 95% CI=1.17-1.36) of good KAP than their rural counterparts (**Table 4.13**).

Table 4.13: Multinomial Logistic Regression Results for KAP of the Consequences of TC, India

Predictors	Good vs. Some		High vs. Some	
	Estimate	OR (95% CI)	Estimate	OR (95% CI)
Age in years				
15-24	.260***	1.30 (1.20-1.40)	.131***	1.14 (1.05-1.23)
25-44	.325***	1.38 (1.28-1.48)	.378***	1.46 (1.27-1.67)
45-59	.218***	1.24 (1.15-1.34)	.159***	1.17 (1.09-1.27)
60+	-	-	-	-
Gender				
Male	.153**	1.17 (1.10-1.26)	.198**	1.22 (1.05-1.42)
Female	-	-	-	-
Place of residence				
Urban	.233*	1.26 (1.17-1.36)	.276*	1.32 (1.24-1.41)
Rural	-	-	-	-
Educational level				
No formal education	-.882***	.41 (.37-.46)	-1.26***	.28 (.26-.31)
< Primary to primary completed (1-5 years)	-.602***	.55 (.49-.60)	-.87***	.42 (.38-.46)
< Secondary to S completed (6-10 years)	-.226***	.80 (.72-.88)	-.35***	.70 (.64-.78)
Tertiary edu (10+ year)	-	-	-	-
Wealth index				
Lowest (1st quintile)	-.323***	.72 (.69-.76)	-.381***	.68 (.62-.76)
Low (2nd quintile)	-.234**	.80 (.72-.89)	-.28**	.76 (.72-.82)
Middle (3rd quintile)	-.123*	.88 (.85-.94)	-.115*	.89 (.86-.96)
High (4th quintile)	.084	1.09 (1.03-1.15)	.05	1.05 (1.00-1.12)
Highest (5th quintile)	-	-	-	-
No. of persons in h/h				
1-3	.218**	1.24 (1.15-1.34)	.22**	1.24 (1.16-1.33)
4-5	.179*	1.20 (1.12-1.28)	.20*	1.22 (1.14-1.30)
6-8	.155	1.17 (1.10-1.24)	.20	1.22 (1.13-1.32)
9+	-	-	-	-
ATI score				
0	-1.36***	.26 (.23-.28)	-2.12***	.12 (.11-.13)
1-3	-.591***	.55 (.50-.61)	-1.27***	.28 (.26-.31)
4-6	-.247***	.78 (.70-.87)	-.727***	.48 (.44-.54)
7+	-	-	-	-
PTI score				
0	-.163***	.85 (.76-.94)	-2.62***	.77 (.69-.85)
1-3	.123**	1.13 (1.01-1.27)	.030	1.03 (.92-1.16)
4-6	.306***	1.36 (1.17-1.57)	.190**	1.21 (1.04-1.40)
7+	-	-	-	-

OR=odds ratio; CI=confidence interval; reference category is some KAP; *p<0.05; **p<0.01; ***p<0.001; ATI (anti-tobacco information); PTI (pro-tobacco information).

Education level significantly ($p<0.001$) influenced the KAP on the consequences of TC. For instance, respondents who had no formal education, some or completed primary schooling, and some or completed secondary schooling were respectively 0.41, 0.55 and 0.80 times as likely to good KAP as the respondents who completed tertiary education. In the case of economic status, the respondents from the lower quintiles had lower likelihood of having good KAP than the respondents from the 5^{th} quintile. It was found that the respondents from small families (1-5 members) had higher chances (more or less 1.2 times) of having good KAP than the respondents from large families (more than 9 members).

Anti-tobacco information score significantly ($p<0.001$) influenced the KAP among the respondents. The odds ratios in favor of having good KAP for respondents having no ATI, score of 1-3, and score of 4-6 were 0.26, 0.55 and 0.78, respectively in comparison to the respondents with ATI score of 7 or more. Respondents with no pro-tobacco information (PTI) had lower likelihood (OR=0.85) of having good KAP than the respondents with PTI score of 7 or more. However, those with PTI score of 4-6 had odds of good KAP that is significantly ($p<0.001$) more than one.

In the second part of the regression, the odds of having high KAP were 1.1, 1.5 and 1.2 times higher (with $p<.001$) among those from age groups of 15-24, 25-44 and 45-59 years old respectively than the reference category of 60 years old and above. The males had significantly ($p<0.01$) higher likelihood to have high KAP (OR=1.22, CI=1.05-1.42) than the females. It was found that the urban residents had ($p<0.05$) higher likelihood (OR=1.32, 95% CI=1.24-1.41) of high KAP than their rural counterparts. Education was a significant ($P<0.001$) variable affecting the KAP. The odds ratios for the respondents with no formal education, some or completed primary schooling, and some or completed secondary schooling are less than one (0.28, 0.42, and 0.70 respectively), suggesting those with less education were also less likely to have high KAP. Wealthiness was also positively related with the likelihood of achieving high KAP (**Table 4.13**). The respondents from household size of 1-8 members had about 1.2 times higher chances of having high KAP than the respondents from households with size of 9 or more members. Anti-tobacco information score significantly ($p<0.001$) influenced the KAP among the respondents. The respondents with no ATI, score of 1-3, and score of 4-6 were less likely (OR= 0.12, 0.28, 0.48 respectively) to have high KAP than the respondents with score of 7 or more. The results showed that the respondents with no pro-tobacco information (PTI) had lower likelihood (OR=0.77) of having high KAP than the respondents with PTI score of 7 or more. However, PTI score of 4-6 had significantly ($p<0.01$) increased the odds in favor of high KAP when compared to the reference category.

The logistic regressions relating to KAP and TC were estimated adjusting for other variables as confounders (results of model diagnostic are almost similar as in **Appendix A9**). The results of the multinomial and ordinal regressions are given in **Table 4.14**. The results for the ordinal logistic regression suggested that the respondents who did not smoke at all ($p<.001$) or smoked less than once daily ($p<.001$) were 1.6 and 1.3 times more likely to achieve the higher category of KAP compared to those who smoked daily. For smokeless tobacco (SLT) users the respondents who did not use SLT products at all ($p<.001$) or used less than once daily ($p<.01$) had 1.4 and 1.2 times higher likelihood of achieving a higher category of KAP compared to their counterparts who smoked daily. The results clearly indicated that those who smoked frequently were less likely to have good or high KAP.

In addition, the results from multinomial logistic regression showed that the respondents who did not smoke at all ($p<.001$) and smoked less than once daily had odds more than one (OR=1.3 and 1.1) in favor of good KAP compared to those who smoked daily. They were also 1.5 and 1.2 times more likely to high KAP than some

KAP compared to the daily smokers. For smokeless tobacco (SLT) users, the respondents who did not use SLT products at all ($p<.001$) had likelihood of 1.3 times to have good KAP and likelihood of 1.4 times to have high KAP than those who smoked daily.

Table 4.14: Association of KAP and TC Adjusted for Confounding Factors, Estimated from Ordinal and Multinomial Logistic Regressions, India

Predictors	Multinomial		Ordinal
	Good vs. Some	High vs. Some	Some, Good vs. high
	OR (95% CI)	OR (95% CI)	OR=Exp (estimate)
Currently ST user			
Not at all	1.3*** (1.2-1.4)	1.5*** (1.39-1.6)	1.58***
Less than daily	1.1 (.93-1.2)	1.2*** (1.05-1.37)	1.26***
Daily	-	-	-
Currently SLT user			
Not at all	1.3*** (1.2-1.3)	1.4*** (1.29-1.43)	1.43***
Less than daily	1.0 (.91-1.13)	1.1* (.99-1.24)	1.15**
Daily	-	-	-

OR=odds ratio; CI=confidence interval; reference category is high KAP for ordinal regression and some KAP for multinomial; *p<0.05; **p<0.01; ***p<0.001; ST (smoked tobacco); SLT (smokeless tobacco).

4.3.4 Cross-country Comparison

About 43% of the Bangladeshi and 35% of Indian adults were currently consuming some form of tobacco products (either smoking cigarettes or *bidis* or using any smokeless tobacco). Among the current users, almost similar proportion (about 20%) from both the countries used smokeless tobacco only. However, 16% and 9% adults from Bangladesh and India used smoked products (either cigarettes or *bidis*) only, respectively. Moreover, 7% adults in Bangladesh and 5% in India used both products (smoked and smokeless tobacco). In both countries, the older age groups were more likely to be tobacco users than the younger adults. Males were more likely to consume tobacco than females (58% vs. 29% in Bangladesh and 48% vs. 21% in India). The findings were consistent with some studies in developing countries such as Cambodia (male 48.0%, female 3.6%); China (60.8%, 4.2%); Malaysia (46.4%, 16.3%); Philippines (57.5%, 12.3%); Vietnam (49.4%, 2.3%); Indonesia (46.8%, 1.4%);

Myanmar (48.9%, 13.7%), and Thailand (36.6%, 1.6%) (Eriksen, Mackay, & Ross, 2012; WHO, 2009). In addition, the findings were also consistent with some South-Asian countries such as Maldives (37.4, 15.6%); Nepal (31.6%, 17.2%); Pakistan (32.4%, 5.7%); Sri Lanka (39.0%, 2.6%) (Eriksen, Mackay, & Ross, 2012; WHO, 2009). In line with other studies (Kabir et al., 2012; Kamal et al., 2010; Khan et al., 2009; Palipudi et al., 2012), the findings provide evidence that social factors were associated with TC behavior. For instance, the prevalence of TC was generally higher among the rural, less educated and low economic status groups. In general, the lack of education and wealth was correlated with increased TC.

This study found that age, gender, education, wealth status, place of residence, family size, and anti-tobacco information (ATI) score were significantly associated with knowledge, attitude and perception (KAP) of the consequences of TC in Bangladesh and India. The findings were rather consistent with other studies (Aryanpur et al., 2009; Lim et al., 2006; Manfredi et al., 1992; Oncken et al., 2005). In line with other studies (Spigner et al., 2005; WHO, 2009), TC was related with the level of knowledge of ill effects of tobacco products, individual attitude and perception about social acceptance. Knowledge and awareness of health risks and attitude towards smoking were associated with support smoking restrictions and quitting that was supported by (Abdullah et al., 2010; Chen et al., 2009; Lim et al., 2006; Mei et al., 2009). Consistent with (Hammond et al., 2006), the high level of knowledge was correlated with the educational attainment. Knowledge of diseases related to TC significantly influenced the behavior of tobacco use that was consistent in (Nsereko et al., 2008).

In South Asian countries, which are generally conservative societies, smoking was considered as unacceptable (Sreeramareddy et al., 2010). However, there was a slight increase in smoking rates among women due to their improved social status through education, employment and urbanization, while marketing of lighter cigarettes also had an impact (Edens et al., 2010). Previous studies showed that heavy smokers have positive attitude towards smoking compared to former smokers and non-smokers (Taylor et al., 1998). Some studies showed that knowledge and attitude differ according to smoking status, smokers had less knowledge and more positive attitude compared to non-smokers (Ma et al., 2003; Nabile et al., 2000). This chapter shows that those who did not smoke at all or smoked less than once daily had about 1.7 and 1.3 times higher likelihood to have better KAP compared to those who smoked daily in Bangladesh and India. Similar results were also found for the smokeless tobacco (SLT) users for both countries. Respondents who did not smoke at all or smoked less than once daily were more likely to have 'good KAP' and 'high KAP' compared to the daily smokers in Bangladesh. The results are the same for adults in India, and also for smokeless tobacco (SLT) users in both countries.

Consistent with other studies (Lim et al., 2006; Ma et al., 2005; Oncken et al., 2005; Yu et al., 2002), education level was strongly associated with knowledge and attitude scores, and both knowledge and attitude were associated with TC practices. Therefore, increasing knowledge through educating people about the harmful effects of tobacco and changing attitude and behaviors through counseling programs could be good interventions.

4.4 Smoking Patterns of Adults in Bangladesh and India: A Data Mining Technique

Further analyses on the patterns of TC among the adults in Bangladesh and India were conducted using the classification and regression tree (CART), a data mining technique. Here, the main purpose is to examine the characteristic of those who smoked daily. The data set employed is same as that used for analysis in **Section 4.3**.

The dependent variable for the CART model is "average number of cigarettes and *bidis* smoked per day". A total of four models were analysed for each country. Two models are for analysing cigarette smoking, and the other two for *bidi* smoking. For both of these tobacco products, the models were categorized into the 2 category model (2CAT) and 3 category model (3CAT) (details are in **Chapter 3,** Figure 3.10 as analytical framework). For Bangladesh, the range of usage was 1 to 60 cigarettes per day and 1 to 75 *bidis* per day. For India, the range of usage was 1 to 110 cigarettes per day and 1 to 125 *bidis* per day. Those who never smoked, or smoked but not every day in past 30 days prior to the survey were excluded because the main objective of this section is to understand the behaviour and characteristics of daily smokers using data mining technique. Furthermore, among different types of tobacco products, manufactured cigarettes and *bidis* were considered as these were the two most widely used tobacco products in both Bangladesh and India. Therefore, a total of 1,037 cigarette and 960 *bidi* smokers from Bangladesh and 2,290 cigarette and 5,716 *bidi* smokers from India were selected for the CART modelling (details are in **Table 4.15**).

Table 4.15: Dependent Variables for the CART Models for Cigarette and *Bidi* Usage

Bangladesh			**India**		
2CAT_Cigarette Model			**2CAT_Cigarette Model**		
Category	n	%	Category	n	%
1-7 Cigs per day	554	53.4	1-4 Cigs per day	1250	54.6
8+ Cigs per day	483	46.6	5+ Cigs per day	1040	45.4
3CAT_Cigarette Model			**3CAT_Cigarette Model**		
Category	n	%	Category	n	%
1-5 Cigs per day	423	40.8	1-3 Cigs per day	941	41.1
6-10 Cigs per day	399	38.5	4-6 Cigs per day	801	35.0
11+ Cigs per day	215	20.7	7+ Cigs per day	548	23.9
Total for Cigarette Model: 1,037			Total for Cigarette Model: 2,290		
2CAT_*Bidi* Model			**2CAT_*Bidi* Model**		
Category	n	%	Category	n	%
1-12 *Bidis* per day	520	54.2	1-10 *Bidis* per day	3252	56.9
13+ *Bidis* per day	440	45.8	11+ *Bidis* per day	2464	43.1
3CAT_*Bidi* Model			**3CAT_*Bidi* Model**		
Category	n	%	Category	n	%
1-8 *Bidis* per day	324	33.8	1-6 *Bidis* per day	2274	39.8
9-16 *Bidis* per day	319	33.2	7-12 *Bidis* per day	1502	26.3
17+ *Bidis* per day	317	33.0	13+ *Bidis* per day	1940	33.9
Total for *Bidi* Model: 960			Total for *Bidi* Model: 5,716		

*Cigs means cigarettes.

To compare the efficiency of CART models with other data mining techniques such as Chi-Square Automatic Interaction Detector (CHAID), Quick, Unbiased, and Efficient Statistical Tree (QUEST), Binary Logistic Regression (BLR), and Multinomial Logistic Regression (MLR), the dependent variable was also grouped into two categories and three categories for each country and both tobacco products. The details on the groupings are given in **Table 4.15**. The grouping for the 2-category models was guided by the median of the number of cigarettes or *bidis* smoked per day. The value is 7 cigarettes per day and 12 *bidis* per day for Bangladesh. For the 3-category models, the tertiles of the number of cigarettes or *bidis* smoked per day were used. For Bangladesh, the tertiles are 5 and 10 cigarettes per day, and 8 and 16 *bidis* per day. Whereas for India, the medians are 4 cigarettes per day and 10 *bidis* per day and the tertiles are 3 and 6 cigarettes per day, and 6 and 12 *bidis* per day. In addition, the cut-off points were also supported by the existing literature (Moon et al., 2012; Schane et al., 2010) and the GATS data structure.

Following the theory and literature on TC behaviour, and taking into consideration the nature of data for both country and the proposed CART technique, independent variables including gender, place of residence, highest level of education, wealth index, age when first started smoking cigarettes or *bidis,* smoking caused serious illnesses, advertisement of cigarettes or *bidis* at point of sale, and health warning labels in cigarettes or *bidis* packets were used to characterize the smoking behaviours of adults in Bangladesh and India. The details of the variables and their coding for analysis are presented in **Appendix A3**.

The importance of variables was evaluated from the sum of the improvements in all nodes or percentage scores in which the variable appears as a splitter. Surrogates were also included in the calculation which means that a variable that never splits a node may still be assigned a large importance score. From a range of variables in the dataset, the CART software provides the "variable importance scores." Variables that receives a 100% score (highest sum of improvements) indicates the most influential independent variable for predicting the dependent variable, followed by other variables based on their relative importance to the most important one. Any variables that do not make a significant contribution to the final model were excluded. The variable importance scores are reported in **Table 4.16** for all the 8 models. Age of TC initiation appeared to be the most important variable in all the four models for Bangladesh and the 3-category cigarette model for India. Gender was the most important variable in two models for India, and the second most important variable in two models for Bangladesh.

Table 4.16: Importance of Independent Variables for Predicting TC from CART

Predictor	**Bangladesh**				**India**			
	Cigarette Model		*Bidi* Model		Cigarette Model		*Bidi* Model	
	2CAT	3CAT	2CAT	3CAT	2CAT	3CAT	2CAT	3CAT
Age first started TC	**100%** (.013)	**100%** (.021)	**100%** (.014)	**100%** (.018)	47.6% (.008)	**100%** (.018)	43.0% (.007)	26.9% (.005)
Place of residence	62.2% (.008)	34.0% (.007)	1.9% (.000)	2.4% (.000)	20.9% (.004)	35.2% (.006)	0% (.000)	5.2% (.001)
Gender	5.9% (.001)	4.8% (.001)	87.9% (.012)	84.7% (.016)	29.0% (.005)	24.1% (.004)	**100%** (.016)	**100%** (.017)
Smoking caused illnesses	14.4% (.002)	7.1% (.001)	16.6% (.002)	9.8% (.002)	12.4% (.002)	15.7% (.003)	4.0% (.001)	1.0% (.000)
Cig ads. at point of sale	75.9% (.010)	37.5% (.008)	NA	NA	8.7% (.002)	11.9% (.002)	NA	NA
Bidi ads. at point of sale	NA	NA	45.0% (.006)	2.9% (.001)	NA	NA	8.3% (.001)	12.4% (.002)
Health warning in cigs packs	40.9% (.005)	4.9% (.001)	NA	NA	4.1% (.001)	16.7% (.003)	NA	NA
Health warning in *bidi* packs	NA	NA	18.1% (.002)	4.5% (.001)	NA	NA	6.9% (.001)	13.0% (.002)
Education	27.8% (.004)	48.7% (.010)	1.2% (.000)	71.4% (.013)	15.1% (.003)	40.8% (.007)	23.2% (.004)	18.9% (.003)
Wealth index	39.2% (.005)	21.6% (.005)	52.7% (.007)	16.1% (.003)	**100%** (.018)	68.3% (.012)	4.6% (.001)	2.6% (.000)

NA=not applicable; % and values in parentheses indicate normalized importance and improvement of splitters, respectively. The scores in bold indicate the most important variable.

4.4.1 Model Summary and Efficiency of CART Model

The Chi-square test for categorical and F-test for continuous independent variables were run for Bangladesh and India separately. It was found that the categorical independent variables selected through the CART algorithm for each country was significantly (p<0.10) associated with the response variable. While for the continuous independent variables' age when first started smoking was found to be significant (p<0.05) for both countries.

Table 4.17: Model Summary of CART

Specification & result	**Bangladesh**				**India**			
	Cigarette Model		*Bidi* Model		Cigarette Model		*Bidi* Model	
	2CAT	3CAT	2CAT	3CAT	2CAT	3CAT	2CAT	3CAT
Minimum cases in parent node*	60	80	50	70	70	135	150	170
Minimum cases in child node*	20	40	20	25	30	75	100	130
Total no. of nodes	21	19	17	19	21	21	17	19
No. of terminal nodes	11	10	9	10	11	11	9	10
The tree depth is 5								

The model summary table provides some broad information on the models (**Table 4.17**). The specification provides information on whether CART is the chosen algorithm, dependent and independent variables, validations, maximum tree depth, minimum number of cases in parent nodes and minimum number of cases in child nodes. The results of the analysis display information on all the parent, child and terminal nodes, while showing the number of observations in each category of the dependent variable for every node, depth of the tree (number of levels below the root note), and independent variables included in the final model.

To build the CART model, the number of cases in the parent and child nodes was determined based on classification accuracy (overall and percentage in the specific classes) and other diagnostic results such as index chart, gain chart, and risk estimates.

The smaller the number of cases in the parent and child nodes, the higher the classification accuracy of the model but this will enlarge the size of the tree, and make interpretations difficult. On average, the algorithm runs about 20-30 iterations to determine the optimal number of cases in parent and child nodes and to satisfy the diagnostic tests for all models. In addition to selecting small number of cases in the parent and child nodes for a good model, the predictive ability of the data mining model was also evaluated by their classification accuracy through a cross-validation technique. In the present study, ten-fold cross validation was used to estimate the true classification rate. To be specific, the algorithm divided the data set into 10 groups. In each of 10 iterations, nine groups were used for training (constructing) the model and the one remaining group was used for testing the classification accuracy of the constructed model. This process was repeated nine more times with the alteration of the testing groups to obtain the classification rates of each testing set. The final classification results from the 10 different testing groups were then averaged to obtain the cross-validation error rates of the decision tree model.

The constructed 2CAT cigarette model classified approximately 62.1% and 63.1% of the smokers accurately for Bangladesh and India respectively (**Table 4.18**). For the 2CAT *bidi* models, the accurate classification was slightly lower than the 2CAT cigarette models. Accurate classification accounted 57.9% and 59.1% for Bangladesh and India respectively. For the 3CAT cigarette and *bidi* models, the classification accuracy dropped with an increased misclassification rate. For instance, the 3CAT cigarette and *bidi* models for Bangladesh and India had accuracy between 45% to 47% only. It was apparent from the models with different categories (2CAT vs. 3CAT), increasing the number of categories in the dependent variable might reduce the classification accuracy of the model and increase the misclassification errors. This might depend on the nature of the data and the problem investigated.

Table 4.18: Classification Accuracy (%) of Different Models for Predicting Response Variable

Models#	Bangladesh				India			
	Cigarette Model		*Bidi* Model		Cigarette Model		*Bidi* Model	
	2CAT	3CAT	2CAT	3CAT	2CAT	3CAT	2CAT	3CAT
CART	**62.1** (.422)	**46.6** (.614)	**57.9** (.424)	**45.4** (.616)	**63.1** (.386)	**47.1** (.583)	**59.1** (.407)	**46.7** (.567)
CHAID	58.8 (.457)	44.4 (.592)	54.3 (.471)	42.9 (.611)	59.2 (.437)	43.9 (.555)	57.1 (.428)	43.7 (.575)
QUEST	54.4 (.462)	37.1 (.640)	54.3 (.435)	37.6 (.627)	57.6 (.431)	39.3 (.610)	56.0 (.416)	40.9 (.608)
BLR	56.5	-	55.8	-	55.7	-	56.4	-
MLR	-	43.1	-	41.3	-	40.7	-	42.9

#**CART** (Classification and Regression Tree); **CHAID** (*Chi*-squared Automatic Interaction Detector); **QUEST** (Quick, Unbiased, Efficient Statistical Tree); **BLR** (Binary Logistic Regression); **MLR** (Multinomial Logistic Regression); risk estimate of cross-validation are in parentheses. The scores in bold indicate the highest classification accuracy for particular model.

The classification accuracy (goodness-of-fit) of 10-fold cross validation was computed for CART and other decision tree algorithms such as CHAID and QUEST. It should be mentioned that the same training and testing data for calculating cross-validated errors were used. The results showed that the CART models (2CAT and 3CAT) for cigarettes and *bidis* yielded higher classification accuracy than the CHAID and QUEST models (**Table 4.18**) for Bangladesh and India. In addition, the classification accuracy of 10-fold cross validation for the 2CAT CART and BLR models was compared, and the 3CAT CART models was also compared to the MLR models. These comparisons were made for cigarette and *bidi* smokers in Bangladesh and India separately. It was apparent that the 2CAT CART model yielded higher classification accuracy (**Table 4.18**) than the BLR model (62.1% vs. 56.5% for the cigarette model and 57.9% vs. 55.8% for the *bidi* model for Bangladesh, and 63.1% vs. 55.7% for the cigarette model and 59.1% vs. 56.4% for the *bidi* model for India). Although the classification accuracy was low due to more categories, the results also revealed that the 3CAT CART model yielded higher classification accuracy than the MLR model (46.6% vs. 43.1% for the cigarette model and 45.4% vs. 41.3% for the *bidi* model for Bangladesh, and 47.1% vs. 40.7% for the cigarette model and 46.7% vs.

42.9% for the *bidi* model for India). The above findings demonstrated that the logistic regressions, whether binary or multinomial had lower classification accuracy and therefore is a less suitable approach for classifying TC in the current data set that has a mixture of categorical and continuous independent variables. The CART model is the best in terms of classification accuracy.

4.4.2 Results and Interpretation

The CART algorithm builds a tree model to classify the "average number of cigarettes and *bidis* smoked per day" using some attributes as predictors. **Figures 4.2-4.5** and **Figures 4.6-4.9** present the results of the CART models for Bangladesh and India respectively.

(a) The Results for Bangladesh

In the 2CAT cigarette model, the total number of nodes is 21 of which 11 are terminal nodes (the nodes that did not split to further nodes). The overall classification accuracy is 62.1%, demonstrating that the constructed decision tree model correctly classifies more than 62% of the cases. In the root node (node 0), about 53% used 1-7 cigarettes daily and 47% used more than 8 cigarettes per day. This node was divided based on the best splitter. Among the independent variables, age when first started smoking is the most influential variable (best splitter) with normalized importance of 100%. The smokers who started smoking at age less than or equal to 14 years branched the left child node (node 1) and all the other cases branched to the right (**Figure 4.2**). Node 1 is the parent node and is partitioned by wealth index (with normalized importance of 39.2%) to form two child nodes (node 3 and node 4). There is no further division in node 3 and node 4. These two nodes are terminal nodes and the following rule is created: if the respondents started smoking at age less than or equal to 14 years old and were from a rich family, about 48% smoked 8 or more cigarettes per day. If they were from a poor or middle income family, about 78% smoked 8 or more cigarettes per day.

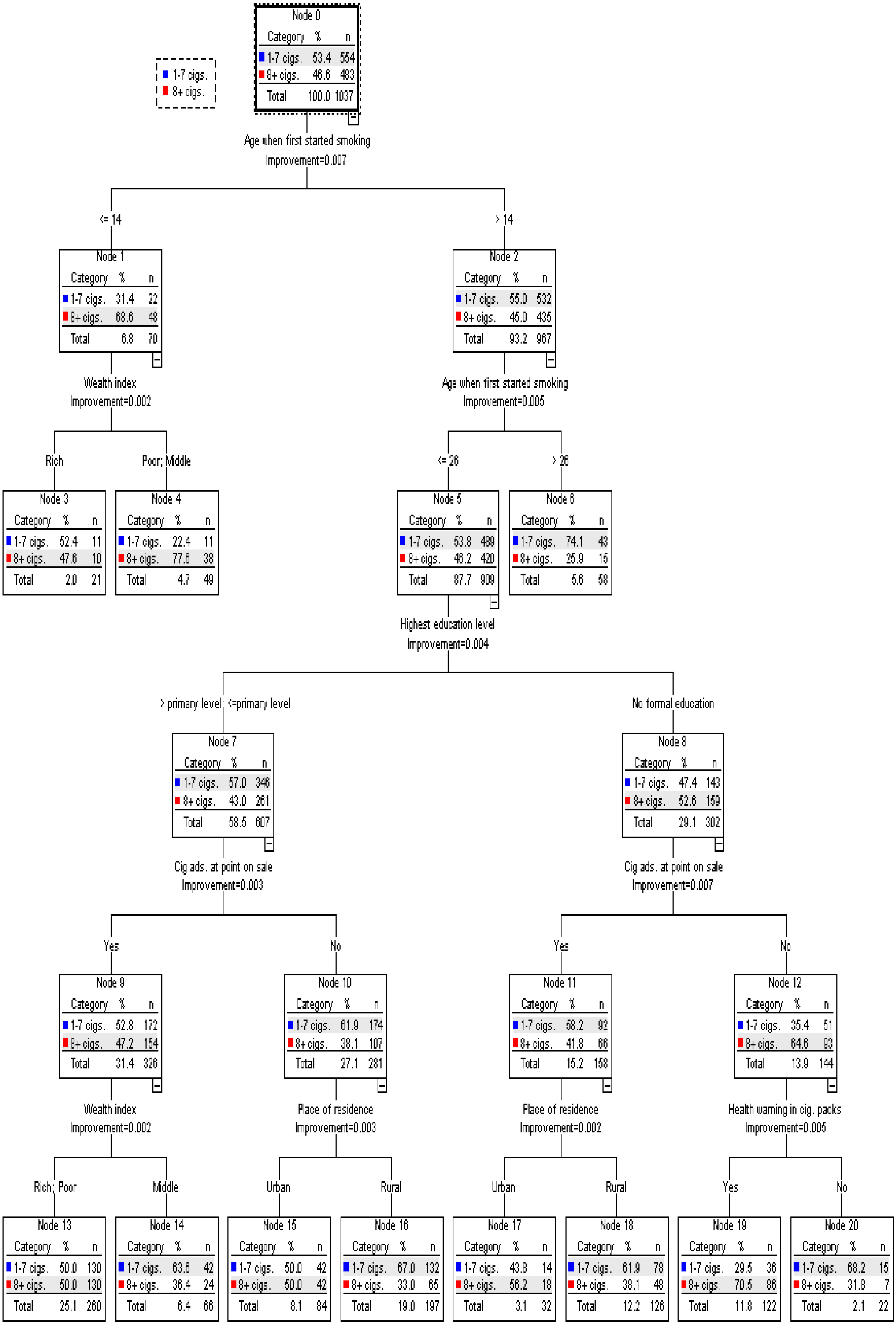

Figure 4.2: The CART Model for Classifying Average Number of Cigarettes Smoked (2CAT) Per Day, Bangladesh

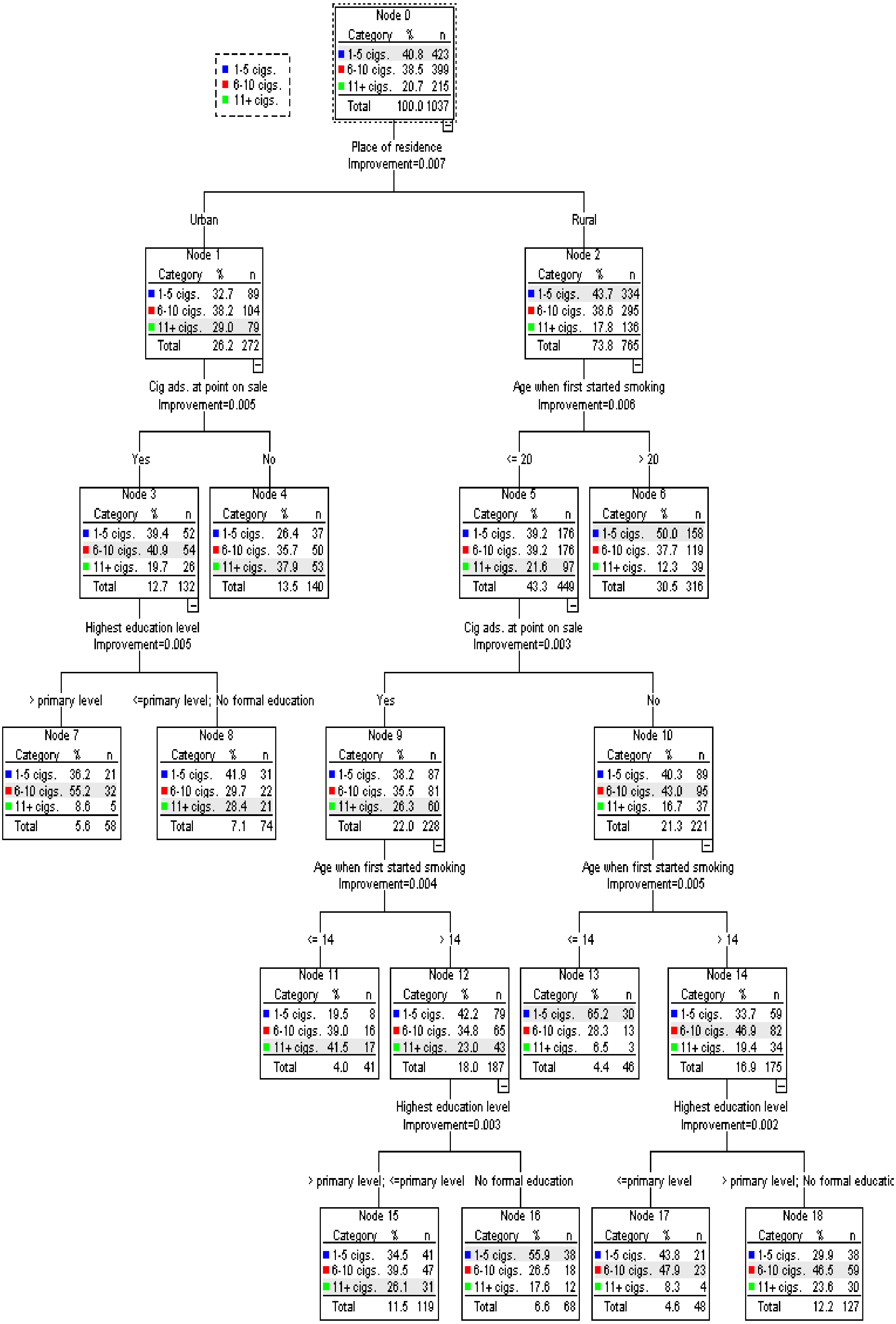

Figure 4.3: The CART Model for Classifying Average Number of Cigarettes Smoked (3CAT) Per Day, Bangladesh

Similarly, node 2 is the parent node and again divided by age when first started smoking with an improvement of 0.005, and formed two child nodes (node 5 and node 6). The respondents who started smoking at age less than or equal to 26 years were categorized in the left child node (node 5) and all other instances were in the right node (node 6). Since there is no further division in node 6, it is a terminal node. The rule is that if the respondents started smoking at age more than 26 years old, 74.1% used 1-7 cigarettes per day.

For the cases that started smoking at age more than 14 years old but less than or equal to 26 years, the next influential variables (splitters) are education level with improvement of 0.004, cigarette advertisements at point of sale (with improvement of 0.003 and 0.007), wealth index (improvement of 0.002), place of residence (improvement of 0.003 and 0.002), and health warning on cigarette packets (improvement of 0.005). It is interesting to discover that among the respondents who started smoking between the age of 14 to 26 years, had no formal education, seen cigarette advertisements at point of sale and resided in the urban area, 56.2% smoked 8 or more cigarettes per day (node 17). However, 61.9% smoked 1-7 cigarettes per day if they resided in the rural area (node 18). Smoking is thus more prevalent in urban areas. This pattern is also true among those who started smoking at the same age group, seen cigarette advertisements at point of sale, but with education (node 15 and 16). However, the proportion of heavy smokers was lower when compared to the group without formal education.

In the 3CAT cigarette model (**Figure 4.3**), the total number of nodes is 19 of which 10 are terminal nodes. The overall classification accuracy is only 46.6%. In the root node (node 0), about 40.8% smoked 1-5 cigarettes per day, 38.5% smoked 6-10 cigarettes per day and the remaining 20.7% smoked more than 11 cigarettes per day. Like the 2CAT model, age when first started smoking is the most important variable with normalized importance of 100%. The first splitter is place of residence with improvement of 0.007 which partitioned the root node into two child nodes (node 1 and node 2). Node 1 is now the parent node and is divided by the splitter of cigarette advertisements at point of sale (improvement of 0.005) to form two child nodes (node 3 and node 4). Node 4 is the terminal node. If the respondents were from urban area and had not seen cigarette advertisements at point of sale, 37.9% of them smoked 11 or more cigarettes per day. If the respondents had seen cigarette advertisements at point of sale (node 3), the next splitter is the highest education level (improvement of 0.005) which resulted in two nodes (node 7 and node 8). Since no further splits occurred in node 7 and 8, they are the terminal nodes. The following rule is developed: if the respondents were from urban area, seen cigarette advertisements at point of sale, and they have more than primary education, 55.2% of them smoked 6-10 cigarettes per day whereas, 28.4% smoked 11 or more cigarettes per day if they had less than or up to primary education. This shows that those with less education are more likely to consume more cigarettes.

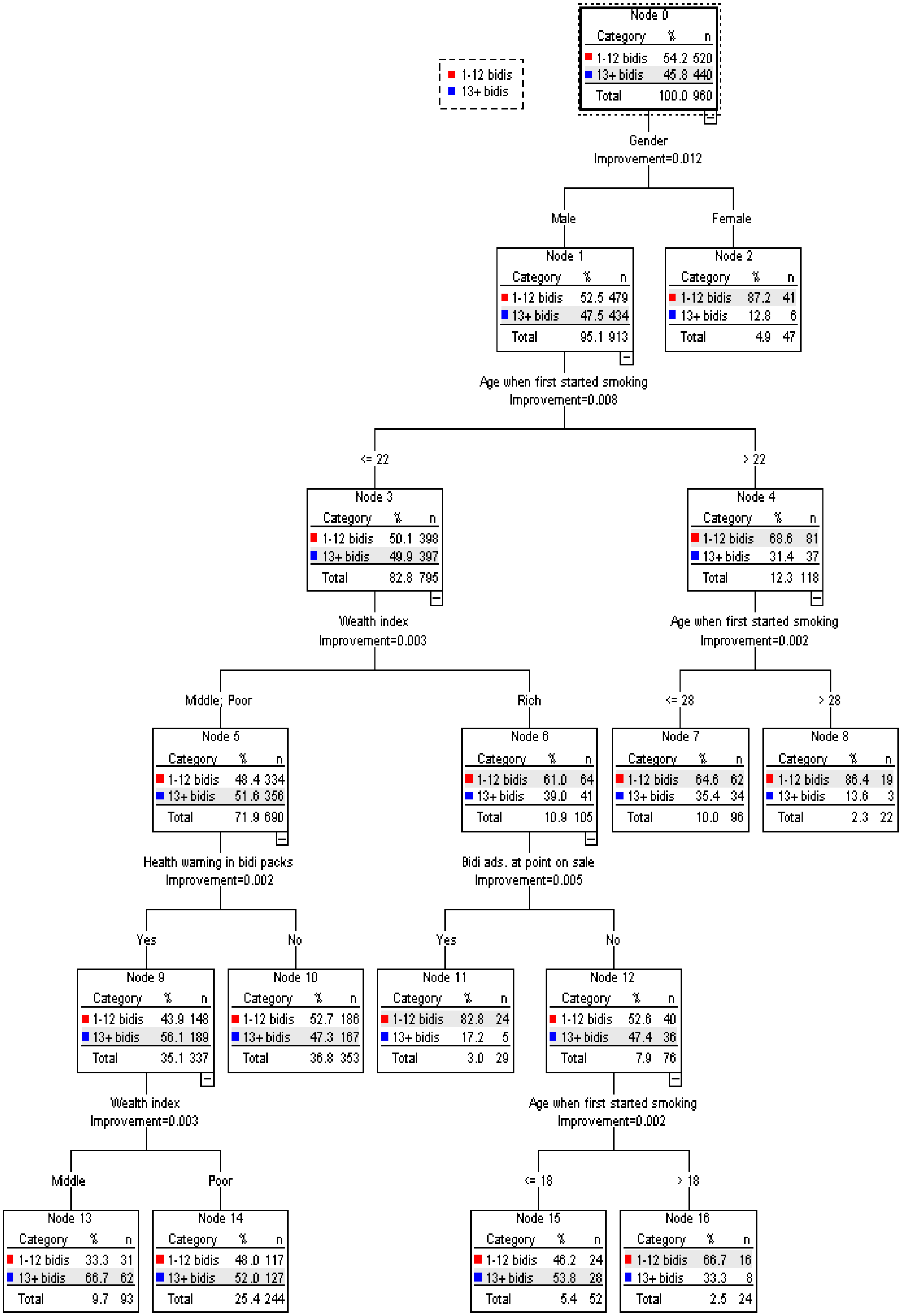

Figure 4.4: The CART Model for Classifying Average Number of *Bidi*s Smoked (2CAT) Per Day, Bangladesh

Like the cigarette models for Bangladesh, age when first started smoking was found to be the most influential variable for classifying the average number of *bidis* smoked per day in the 2CAT and 3CAT *bidi* models with normalized importance of 100% for both cases. However, gender was the first splitter with improvement of 0.012 and 0.016 for the 2CAT and 3CAT *bidi* models respectively. The 2CAT *bidi* model (**Figure 4.4**) accurately classified about 58% of the cases. The following rule is established: Among the male respondents who started smoking at age less than or equal to 22 years old, and have seen health warning on *bidi* packets, and from middle income family, 66.7% smoked 13 or mode *bidis* per day (node 13). However, if they were from poor family, about 52% smoked the same number of *bidis* per day (node 14). Terminal nodes 7 and 8 suggest that among the males who started smoking at age 28 years or less, they are more likely to be heavy *bidi* smokers compared to those who started smoking *bidis* at as older age. This is from the observation that 13.6% of those who started smoking after age 28 years old used 13 or more *bidis* daily compared to 35.4% among those who started smoking at younger age.

The 3CAT *bidi* model (**Figure 4.5**) accurately classified only 45.4% of the cases. Among the respondents who started smoking at age 16 or less, had some education (primary level or less), and are male, 54.5% smoked 17 or more *bidis* per day (node 15). However, if they started smoking between 17 to 18 years old, about 41% smoked the same number of *bidis* per day (node 16). Among the males who initiated TC at younger age, terminal nodes 17 and 18 indicated that those with less education are more likely to be heavy smokers. Another interesting pattern discovered from both models is that, only 4.9% of the smokers are female and majority of them 87.2 smoked 1-12 *bidis* per day (**Figure 4.4**) and 78.7% smoked 1-8 *bidis* per day (**Figure 4.5**). As smoking prevalence is low among females, the node did not branch out further.

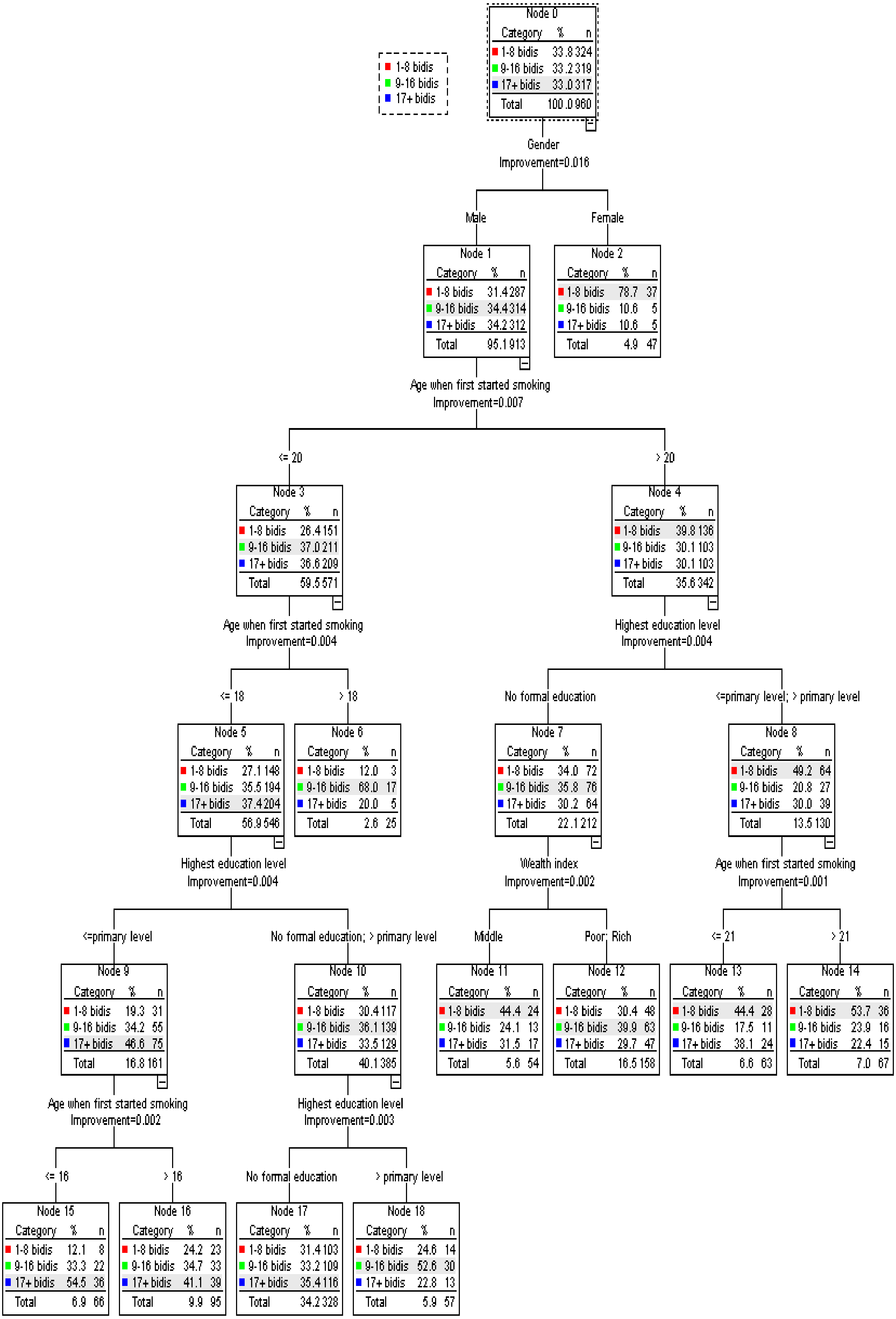

Figure 4.5: The CART Model for Classifying Average Number of *Bidis* Smoked (3CAT) Per Day, Bangladesh

(b) The Results for India

The total number of nodes and terminal nodes for the 2CAT cigarette model (**Figure 4.6**) for India is 21 and 11 respectively, with an overall classification accuracy of 63.1%. The median value of the number of cigarettes smoked per day for the Indian smokers is lower compared to that for the Bangladeshi smokers. The root node (node 0) showed that about 54.6% smoked 1-4 cigarettes daily and 45.4% used more than 5 cigarettes per day. This node was partitioned based on the best splitter. Among the independent variables, wealth index is the most influential variable with normalized importance of 100%. Besides, the wealth index is the first splitter and partitioned the root node into two child nodes (node 1 and node 2) with improvement score of 0.014. These two child nodes became the parent nodes at the next level. Node 1 is now split by wealth index again to produce two child nodes (node 3 and node 4). They are clearly the terminal nodes as no further branching was found. The following rule is established: In India, if the respondents were from poor family, 54.6% smoked 5 or more cigarettes per day (node 3). Among those from middle income family, 56.8% smoked 1-4 cigarettes per day (node 4). On the other hand, the respondents from rich family (node 2) were partitioned by age when first started smoking with improvement (of 0.004) and threshold point of 17.5 years.

The respondents who started smoking at age 17.5 years or less branched left and formed node 5, while those who started smoking at age 17.5 years or older formed other node 6. Nodes 5 and 6 are now two parent nodes and are ready for splitting by other important variables with different classification rules. Among the smokers from rich family but rural background, and started smoking at age 17.5 years or youngers, and had not seen cigarette advertisements at point of sale but know information on serious illnesses caused by smoking, 86.8% smoked 1-4 cigarettes per day (node 15).

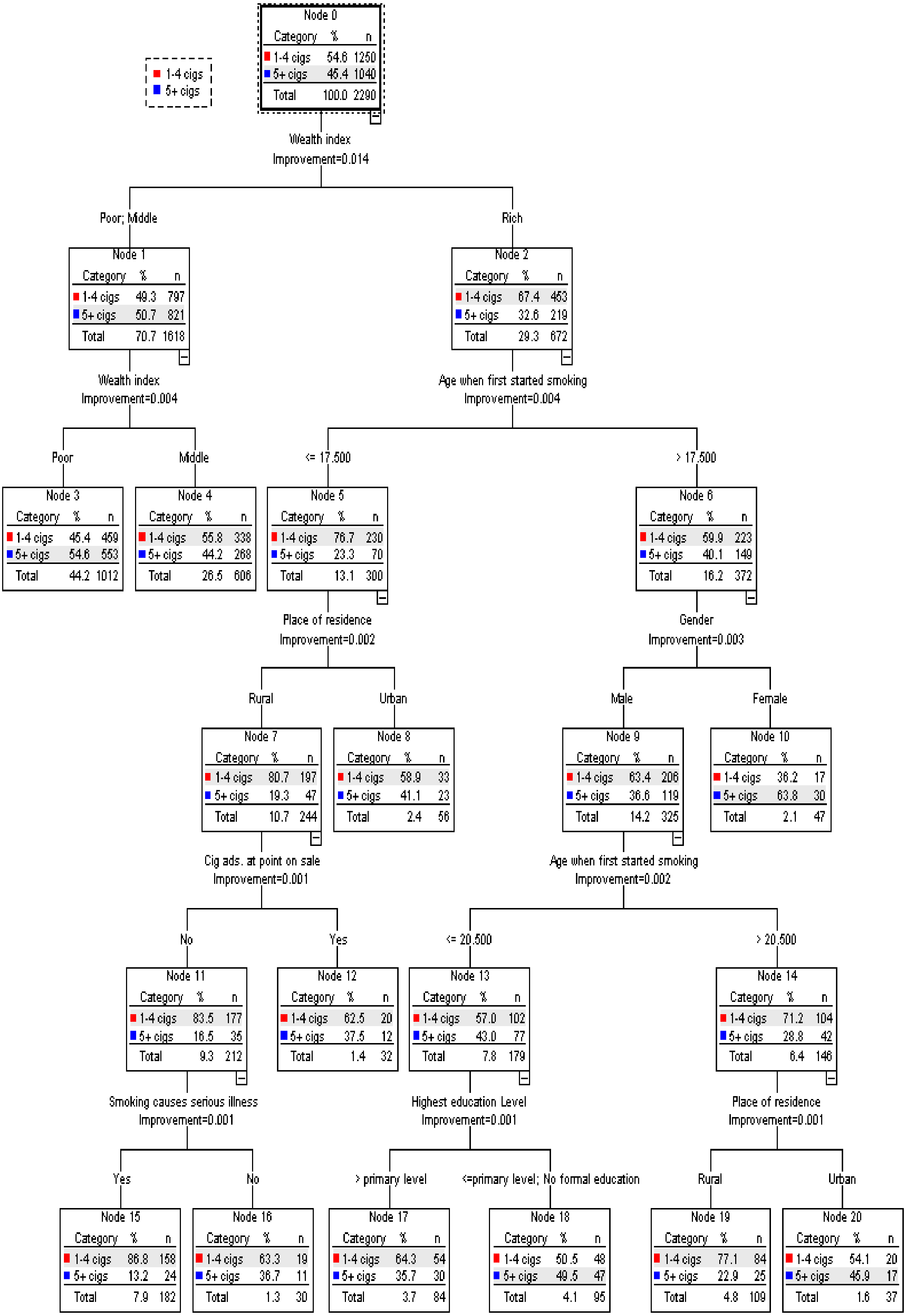

Figure 4.6: The CART Model for Classifying Average Number of Cigarettes Smoked (2CAT) Per Day, India

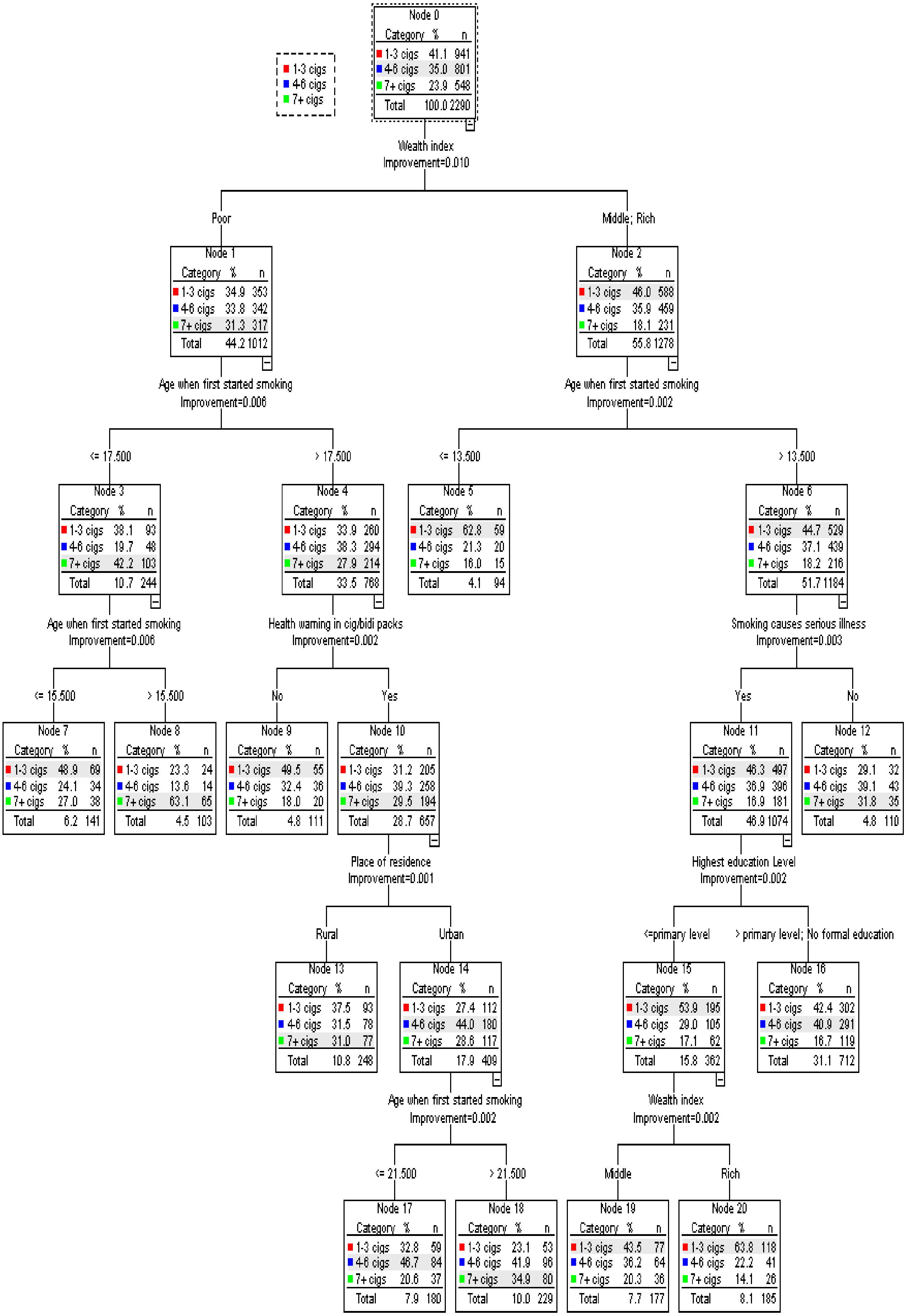

Figure 4.7: The CART Model for Classifying Average Number of Cigarettes Smoked (3CAT) Per Day, India

On the other hand, 63.3% smoked 1-4 cigarettes per day (node 16) if they do not know the serious illnesses caused by smoking. Among the smokers, those who were aware of danger of smoking were more likely to smoke less compared to those who had no such awareness. Another interesting pattern is as follows. Among the male smokers from rich family who started smoking at age between 17.5 to 20.5 years, and have higher than primary school education, 36.7% smoked 5 or more cigarettes per day (node 17). However, 49.5% smoked 5 or more cigarettes per day (node 18) if they had no formal education or up to primary school level education. Smoking is more prevalent among those with less education.

The 3CAT cigarette model for India has 21 nodes in total and 11 terminal nodes, with overall classification accuracy of 47.1% (**Figure 4.7**). The TC categories are 41.1% that smoked 1-3 cigarettes per day, 35% that smoked 4-6 cigarettes per day and 23.9% that smoked more than 7 cigarettes per day (node 0). In this model, age when first started smoking is the most influential variable with normalized importance of 100%. The first splitter is wealth index with improvement of 0.010. It partitioned the root node into two child nodes with respondents from poor family (node 1) and those from rich family (node 2). Node 1 was split by age when first started smoking with the threshold of 17.5 years. The respondents who started smoking at age 17.5 years or less branched into left node (node 3) and those who started smoking at older age branched into the right node (node 4). These two child nodes (node 3 and node 4) became the parent nodes and went through further split. Node 3 was split by age when first started smoking with the threshold of 15.5 years into node 7 and node 8. Nodes 7 and 8 are the terminal nodes. Among the respondents from poor family, and started smoking at age 15.5 years or less, 48.9% smoked 1-3 cigarettes per day (node 7). If they started smoking at age older than 15.5 years, but less than 17.5 years, 63.1% smoked 7 or more cigarettes per day (node 8). On the other hand, the respondents who started smoking at age more than 17.5 years (node 4) were partitioned by whether they were aware of health warning on cigarette and *bidi* packets with improvement of 0.002 and produced two child nodes (node 9 and node 10). Node 9 is a terminal node. It showed that the respondents from poor family who started smoking at age more than 17.5 years and not aware of health warning on cigarette and *bidi* packets, 49.5% smoked 1-3 cigarettes per day (node 9). Another terminal node, node 19 showed that among the respondents from middle income family, started smoking at age older than 13.5 years, aware that smoking will cause serious illnesses, and had primary school level education or less, 43.5% smoked 1-3 cigarettes per day (node 19). On the contrary, 63.8% smoked 1-3 cigarettes if they were from rich family (node 20). The results suggest that the smokers from poorer family were more likely to smoke more cigarettes daily.

The 2CAT *bidi* model had 17 nodes in total and 9 terminal nodes, with overall classification accuracy of 59.1%. The 3CAT *bidi* model has 19 nodes in total and 10 terminal nodes with overall classification accuracy of 46.7%. Gender is the most influential independent variables with normalized importance of 100% for both models. Gender is the first splitter with improvement of 0.016 for the 2CAT model (**Figure 4.8**) and improvement of 0.017 for the 3CAT model (**Figure 4.9**). It is apparent for both the models node 2 is the terminal node. Node 2 from the 2CAT model showed that among the female respondents 81.3% smoked 1-10 *bidis* per day (**Figure 4.8**). Node 2 from the 3CAT model showed that 72.2% of the female smokers smoked 1-6 *bidis* per day (**Figure 4.9**).

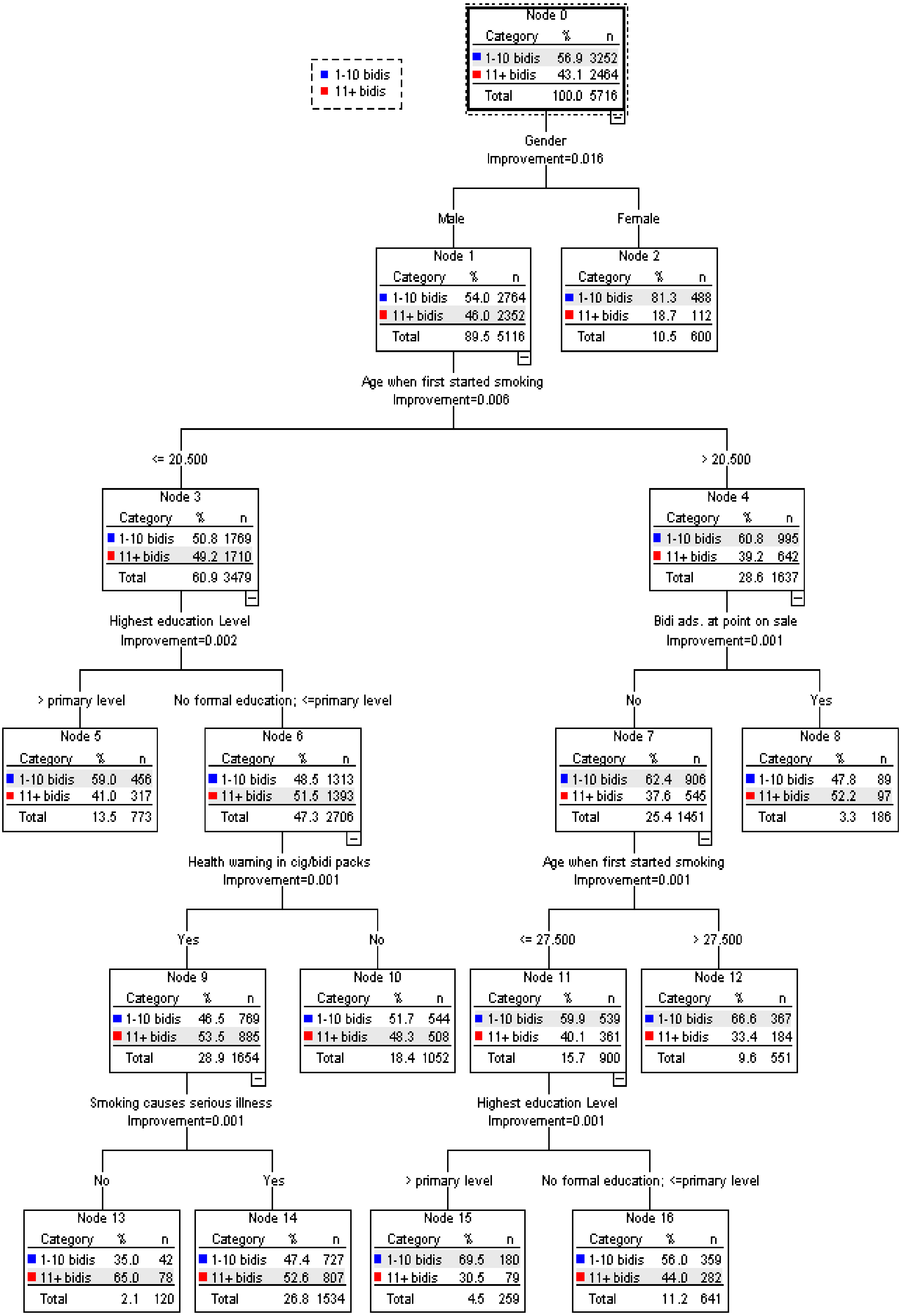

Figure 4.8: The CART Model for Classifying Average Number of *Bidis* Smoked (2CAT) Per Day, India

For both the *bidi* models, node 1 is represented by the male smokers only and is partitioned by age when first started smoking with the threshold of 20.5 years and 21.5 years respectively, for the 2CAT and 3CAT models. The following rules are obtained. For the 2CAT model (**Figure 4.8**), the decision tree results indicated that among the male smokers who started smoking at age 20.5 years or less, and had education of at least primary schooling, 59% smoked 1-10 *bidis* per day (node 5). If they had no formal education or their education is up to primary level, and not seen health warning on *bidi* packets, 48.3% smoked 11 or more *bidis* per day (node 10). It can be explored that if the respondents had seen health warnings on *bidi* packets, but were not aware that smoking will cause serious illnesses, 65% of them smoked 11 or more *bidis* per day (node 13). If they were aware of the danger of smoking, 52.6% smoked 11 or more *bidis* per day (node 14). The results suggest that awareness of smoking hazard will reduce TC.

From the 3CAT model (**Figure 4.9**), it is apparent that among male respondents who started smoking at age 21.5 years or less, and had seen *bidi* advertisements at point of sale, 46.1% smoked 13+ *bidis* per day (node 6). However, if the respondents had not seen any advertisements at point of sale (node 5), they were partitioned based on the highest education level (improvement of 0.001), place of residence (improvement of 0.001), and health warnings on *bidi* packets (improvement of 0.002). A few observations can be made from the terminal nodes. Among the male respondents who were from the rural areas, with education of primary schooling and above, had not seen *bidis* advertisements at point of sale and started smoking at age 21.5 years or less, 42.5% of them smoked 1-6 *bidis* per day (node 13). However, if they resided in the urban areas, 37.6% smoked 7-12 *bidis* per day (node 14). Similarly, if they had no formal education or attained primary schooling or less and had seen health warnings on *bidi* packets 43.8% smoked 13 or more *bidis* per day (node 15). If they had not seen the health warnings, 31% smoked 7-12 *bidis* per day (node 16).

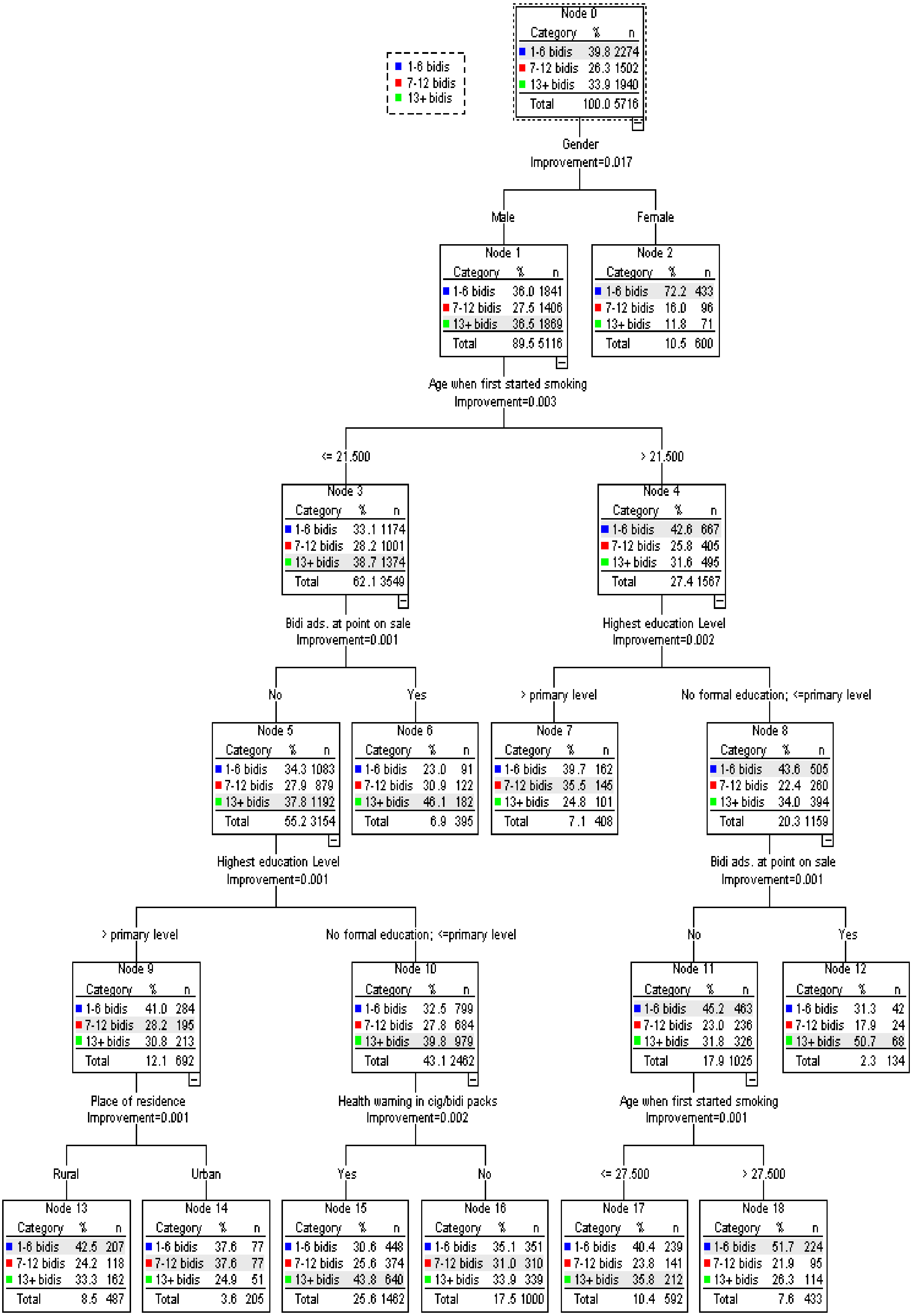

Figure 4.9: The CART Model for Classifying Average Number of *Bidis* Smoked (3CAT) Per Day, India

4.4.3 Discussion

Classification and regression tree (CART) was used to characterize "average number of cigarettes and *bidis* smoked per day" among adults aged 15 years and above in Bangladesh and India. Several possible predictors were inserted into the CART system but the procedure automatically excluded the variables that did not make any significant contribution to the final model for classifying the response variable. The 2CAT and 3CAT cigarette and *bidi* models were constructed for Bangladesh and India. The 2CAT cigarette models classified approximately 62.1% and 63.1% of the smokers accurately for Bangladesh and India respectively. Accurate classification for the 2CAT *bidi* models was slightly lower than the 2CAT cigarette models, where the former accounted 57.9% and 59.1% for Bangladesh and India respectively. For the 3CAT cigarette and *bidi* models, the classification accuracy is even lower. For instance, the 3CAT cigarette and *bidi* models for Bangladesh and India had an accuracy of 45% to 47% only. It was apparent from the 2CAT and 3CAT models, an increase in the number of categories in the dependent variable might reduce the classification accuracy and increase the misclassification errors. However, this might depend on the nature of the data and the problem investigated.

The classification accuracy was computed for CART and other decision tree algorithms such as CHAID and QUEST. The results showed that the CART models (2CAT and 3CAT) for cigarettes and *bidis* yielded higher classification accuracy than the CHAID and QUEST models for both Bangladesh and India. In addition, the classification accuracy of the 2CAT CART and BLR models was compared, and the 3CAT CART models were also compared to the MLR models. These comparisons were made for cigarette and *bidi* smokers in Bangladesh and India separately. It was apparent that the 2CAT CART model yielded higher classification accuracy than the BLR model (62.1% vs. 56.5% for the cigarette model and 57.9% vs. 55.8% for the *bidi* model for

Bangladesh, and 63.1% vs. 55.7% for the cigarette model and 59.1% vs. 56.4% for the *bidi* model for India). Although the classification accuracy was low due to more categories, the results also revealed that the 3CAT CART model yielded higher classification accuracy than the MLR model (46.6% vs. 43.1% for the cigarette model and 45.4% vs. 41.3% for the *bidi* model for Bangladesh, and 47.1% vs. 40.7% for the cigarette model and 46.7% vs. 42.9% for the *bidi* model for India).

The above findings demonstrated that the logistic regressions, whether binary or multinomial had lower classification accuracy and therefore is a less suitable approach for classifying TC in the current data set that has a mixture of categorical and continuous independent variables. Both CART and logistic regression models can efficiently handle the nonlinear relationship between the independent and dependent variables. The choice between the two techniques may depend upon the nature of data and no consensus exists about which of them is better. The results showing that the CART model is the best in terms of classification accuracy were also supported by the findings reported in other studies (Moon et al., 2012; Ruben & Canlas Jr, 2009; Soni, et al., 2011; Srinivas et al., 2010).

Consistent with other findings (Daeppen et al., 2000; Dunham, 2003; Giskes et al., 2005; Moon et al., 2012; Ruben & Canlas Jr, 2009; Soni, et al., 2011; Srinivas et al., 2010), CART is appropriate because it defines groups that are consistent in their attributes but which vary in terms of the dependent variable and the results are presented graphically. Therefore, CART was found easy to understand compared to the other techniques. It was found that CART can solve problem which may be difficult or impossible to solve using traditional multivariate techniques. In contrast with the logistic regression and other techniques (Giskes et al., 2005; Moon et al., 2012), CART is inherently non-parametric and no assumptions are made regarding the underlying distribution of the predictor variables, automatic 'machine learning' and less input is needed for analysis.

4.5 Concluding Remarks

The overall prevalence of youth TC in Bangladesh, Nepal and Sri Lanka was below 10% with significantly higher rates among the males. The TC among female youths in the countries selected for this study was between 5-6%, but self-reporting in the survey and the conservative social structure in these countries may lead to under-reporting of the actual situation. It is expected that in the near future TC among female youths will be higher in this region. This expected trend of female TC may be due to the overall impact of globalization, urbanization, tobacco-related marketing efforts, and the changing status of women from higher educational attainment and better employment opportunities. Several demographic, socio-economic, environmental, and programmatic factors significantly influenced TC behaviour among youths in this region. Therefore, an understanding of the factors influencing youth TC provides helpful insights for the formulation of tobacco control policies in the South Asian region and the lessons learnt can be considered by other developing nations as input for their policy options.

Like TC among youths, about 43% of the Bangladeshi and 35% of Indian adults were currently consuming some form of tobacco products (either cigarettes or *bidis* or any smokeless tobacco products). Males were more likely to smoke tobacco products. However, smokeless tobacco products were relatively more popular among females in Bangladesh and India. The findings provide evidence that socio-economic and demographic factors were associated with TC behaviours among adults. Along with these factors, availability of anti-tobacco and pro-tobacco information was also significantly associated with knowledge, attitude and perception (KAP) of the consequences of TC, which in turns was related to TC behaviours among adults.

Knowledge and awareness of health risks and attitude towards smoking were associated with support for smoking restrictions and quitting. Knowledge of diseases related to TC significantly influenced the behaviour of tobacco use. Education level was strongly associated with knowledge and attitude scores, and both knowledge and attitude had significant impact on TC practices. Therefore, increasing knowledge through education about the harmful effects of tobacco and changing attitude and behaviors through counseling programs could be good interventions for tobacco use control. Further analyses on the patterns of TC among the adults in Bangladesh and India were conducted using the classification and regression tree (CART) to examine the behaviour of those who smoked daily. It was found that CART has enormous advantages over other traditional multivariate techniques, and it provided higher classification accuracy. Therefore, CART can be used as a suitable alternative to traditional techniques for characterising smoking patterns among daily smokers.

CHAPTER 5: PREVALENCE, PATTERNS AND DETERMINANTS OF ENVIRONMENTAL TOBACCO SMOKE EXPOSURE AMONG ADULTS

5.1 Introduction

Smoked tobacco products especially cigarettes or *bidis* are the principal source of exposure of nonsmokers or smokers to tobacco smoke. Environmental tobacco smoke (ETS) is the combination of mainstream and side stream smoke (Eriksen, Mackay, & Ross, 2012; First, 1985). Tobacco smoke contains more than 3,000 different chemicals, including irritant gases, carcinogens and fine particles. Nonsmokers or smokers who live or work with a smoker generally have the greatest exposure to ETS. Although ETS in public places appears to be an irritation, it usually contributes only a small amount to personal ETS exposure (WHO, 2009). ETS has been established as a causal risk factor for a number of health problems for children, youths, and adults (Boffetta et al., 2000; CEPA, 2005; Filippini et al., 2002; Krajinovic et al., 2000; Sasco & Vainio, 1999; WHO, 2009). In addition to a large and growing health burden, ETS exposure also imposes economic burdens on individuals and countries, both in terms of the costs of direct health care as well as indirect costs from reduced productivity (WHO, 2009). The literature showed that socio-economic and demographic factors as well as the KAP (knowledge, attitude and perception) towards ETS significantly influenced the exposure level to ETS (Abdullah et al., 2011; Bolte et al., 2009; Chen et al., 2009; Hyland et al., 2009; Liu et al., 2008; Mak et al., 2008; Mei et al., 2009; Öberg et al., 2011; Rachiotis et al., 2010; Rudatsikira et al., 2008; Sims et al., 2010).

While the health hazard of ETS is easier to prevent than tobacco smoking, it has received far less attention than the latter. ETS control can only be effective with a better understanding of the prevalence, patterns and predictors of ETS exposure. Using nationally representative data of Bangladesh and India where smoking prevalence is high, this chapter examines the prevalence, patterns and determinants of ETS exposure at home, workplace, public places and the combined settings of home and public places among Bangladeshi and Indian adults. **Section 5.2** describes the data sources, variables and methods of analysis. **Section 5.3** presents the prevalence of ETS exposure using diamond-shaped equiponderant graphs. **Section 5.4** and **Section 5.5** present the results on factors associated with ETS exposure in different settings for Bangladesh and India, respectively. Finally, **Section 5.6** compares the findings between the two countries and also with past studies as concluding remarks.

5.2 Data, Variables and Methods of Analysis

The data for the analysis in this chapter were obtained from the Global Adult Tobacco Survey (GATS) of Bangladesh and India. The data set is same as that used for analysis in **Section 4.3** on TC for the Bangladeshi and Indian adults. ETS exposure in different settings such as at home, at workplace and at public places was considered as the response variable. Exposure to ETS at other places was excluded from the analysis due to small number of cases for Bangladesh and no information was collected in GATS India. To examine the influencing factors of ETS exposure in different settings, several independent variables, namely, age, gender, number of persons in household, place of residence, level of highest education, wealth index, general and specific health knowledge about ETS exposure, attitude towards ETS at home and workplaces, and perception of smoking restrictions at some places were considered. It should be noted that the inclusion of these variables were guided by the literature in **Chapter 2,** Section 2.3.4 and the conceptual frameworks in **Chapter 3** (Figures 3.7 and 3.8). In addition, the detailed information on the dependent and independent variables and their coding for analysis are given in **Appendix B1**.

Frequency runs were generated to compute the descriptive information of the sample for Bangladesh and India. Bivariate analyses using cross tabulations were performed to obtain the prevalence of ETS in different settings for various categories of the selected variables and to identify significant determinants using the Pearson's Chi-square (χ^2) test. Diamond-shaped equiponderant graphs were used to present the prevalence of ETS in different settings by age group and gender for both countries. In addition, multivariable binary logistic regressions for three settings (at home, at workplace and at public places) were estimated separately with ETS exposure as the response variable (yes=1 and no=0). These were designated as Models A, B and C. Combined settings were also considered by examining ETS exposure at home (yes=1 and no=0) or public places (yes=1 and no=0) (details are in **Chapter 3,** Figure 3.11 as analytical framework). In combined settings, exposure to ETS at workplace was not included because not all respondents are working. The binary logistic regression (Model D) was estimated where the response variable was set at '1' if the respondent was exposed to ETS in any of the two settings, and '0' if otherwise. Another response variable was created by considering the number of settings that the respondent had experienced ETS exposure (none, one only, or two). When this variable is ranked, the ordinal regression (Model E) was estimated. Model F was estimated using multinomial regression, when ranking of the variable is not considered. Besides, to differentiate the exposure level among smokers and non-smokers, the association between TC and ETS adjusting for other variables as confounders was also examined (analytical framework is in **Chapter 3**, Figure 3.12). The detailed information about the multivariable binary, ordinal and multinomial logistic regressions are given in **Chapter 3**, Section 3.8.

5.3 ETS Exposure among Bangladeshi and Indian Adults

The basic characteristics namely, demographic and socio-economic background of the respondents of Bangladesh and India are explained in **Chapter 4,** Table 4.5. The diamond-shaped equiponderant graphs were plotted to show the overall prevalence and the prevalence rates of ETS exposure in different settings by age groups and gender. The plot projects three-dimensional bar graphs in two dimensions, whereby the third dimension is replaced with a polygon whose area and the middle vertical and horizontal lengths represent the prevalence (%) of ETS exposure (**Figure 5.1** and **Figure 5.2**).

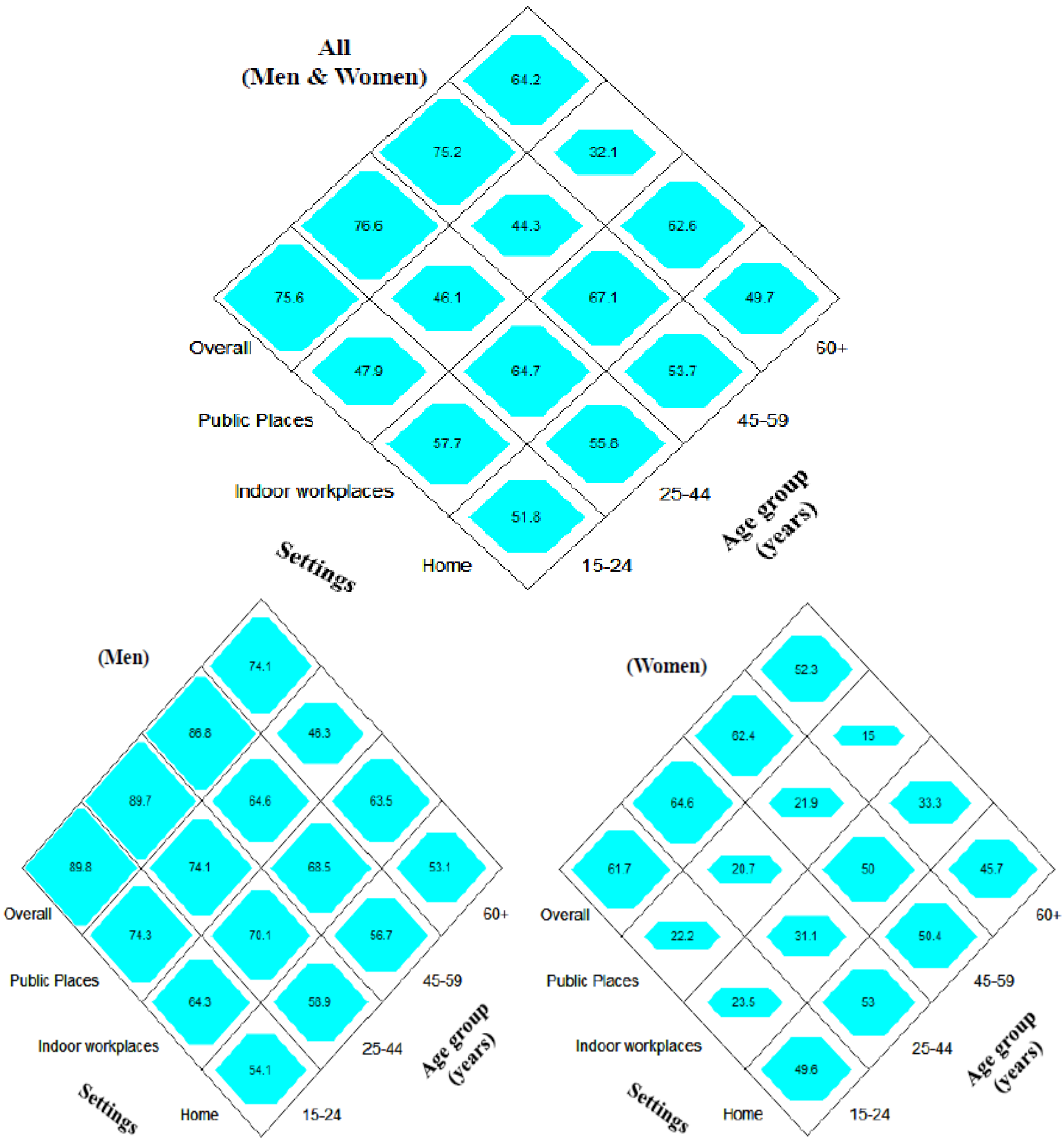

Figure 5.1: Prevalence (%) of ETS Exposure among Men, Women and Both by Age Group and Different Settings, Bangladesh

In Bangladesh, adults aged 25-44 years were more exposed to ETS (76.5%) than the other age groups when all the settings were considered. This age group had also a higher level of exposure at home (55.6%) than the other groups. However, adults aged 15-24 years and aged 45-59 years old were more exposed to ETS at public places (47.9%) and workplaces (67.1%), respectively, than the other groups. It was found that the adults aged 60 years and above had lower ETS exposure than the other groups in all the three settings. The sex differentials in exposure level showed the remarkably higher among the males compared to the females in all settings. However, the gaps in exposure level between the males and females were relatively narrower for home ETS (**Figure 5.1**).

Figure 5.2: Prevalence (%) of ETS Exposure among Men, Women and Both by Age Group and Different Settings, India

In India, adults in the age group 25-44 years old had higher ETS exposure (66.6%) than the other age groups in all the settings combined together. However, adults aged 15-24 years were more exposed to ETS at public places (31.7%) than the other age groups. It was found that adults aged 60 years and above had slightly higher exposure to ETS at indoor workplaces (35.8%) and at home (52.4%) than the other age groups. However, the gaps between the different age groups for these two settings are not very big. Like Bangladesh, the sex differentials in exposure level were remarkably high. The males had higher exposure to ETS than females in all settings except home. Except for females in the age group 45-59 years who had higher home ETS exposure, the females in other age groups had almost similar exposure to ETS at home as their male counterparts (**Figure 5.2**).

5.4 The Results for Bangladesh

5.4.1 Factors Associated with ETS Exposure in Different Settings

Table 5.1 shows the prevalence of ETS exposure in different settings (at home, at workplace, at public places and combined settings of home or public places) by socio-demographic factors, health knowledge, and perception and attitudes about smoking. In this bivariate analysis, age, gender, educational level, general and specific health knowledge on ETS, attitude towards ETS at home were significantly ($p<0.001$) associated with ETS exposure at home, at workplace and at public places. Besides, place of residence and wealth index were also found to be significant ($p<0.001$ to $p<0.05$) for all three settings. Perceptions to smoking restrictions at places such as workplaces, restaurants and universities had significant ($p<0.001$) impact on ETS exposure at home and at public places only but not at workplaces.

Table 5.1: Chi-Squared Analysis of ETS by Settings and Predictors, Bangladesh

Predictors	Model A	Model B	Model C	Model D
Age in years	χ^2=18.3 [a]	χ^2=17.90 [a]	χ^2=77.13 [a]	χ^2=57.83 [a]
15-24	51.8	57.7	47.9	74.0
25-44	55.8	64.7	46.1	74.7
45-59	53.7	67.1	44.3	73.4
60+	49.7	62.6	32.1	62.9
Gender	χ^2=29.15 [a]	χ^2=122.78 [a]	χ^2=2268.1 [a]	χ^2=611.0 [a]
Male	56.4	67.8	69.3	84.4
Female	50.9	30.5	20.8	61.9
No. of persons in H/H	χ^2=43.82 [a]			
1-2 persons	47.7			
3-4 persons	51.1	-	-	-
5-9 persons	55.8			
10 or more persons	62.4			
Place of residence	χ^2=143.89 [a]	χ^2=9.97 [a]	χ^2=4.7 [c]	χ^2=29.96 [a]
Urban	43.4	58.8	46.4	68.9
Rural	57.3	66.0	44.4	74.5
Educational level	χ^2=344.5 [a]	χ^2=59.0 [a]	χ^2=164.9 [a]	χ^2=26.7 [a]
No formal education	62.9	71.1	38.7	74.9
< primary (1-4 years)	59.2	70.5	47.2	75.8
Primary comple (5 years)	50.8	66.7	40.8	69.7
< secondary (6-9 years)	47.9	64.2	46.9	70.1
Secondar & above (10+)	36.0	49.4	58.0	72.9
Wealth index*	χ^2=345.5 [a]	χ^2=12.6 [c]	χ^2=63.4 [a]	χ^2=37.2 [a]
Lowest (1st quintile)	66.3	66.1	37.9	76.7
Low (2nd quintile)	58.8	67.6	42.7	73.9
Middle (3rd quintile)	53.3	62.2	47.0	73.3
High (4th quintile)	50.4	63.1	48.4	72.8
Highest (5th quintile)	35.1	59.0	49.0	67.3
GHK on ETS exposure	χ^2=39.4 [a]	χ^2=17.2 [a]	χ^2=214.9 [a]	χ^2=3.7 [c]
Yes	52.8	62.6	46.9	73.3
No	65.7	85.7	16.8	69.8
Specific HK on ETS	χ^2=50.4 [a]	χ^2=15.7 [a]	χ^2=410.8 [a]	χ^2=27.9 [a]
No knowledge	63.1	72.8	20.5	68.9
Some knowledge	53.4	53.8	36.2	68.7
Good knowledge	52.1	63.2	50.3	74.4
Attitude of ETS (home)	χ^2=3870 [a]	χ^2=31.4 [a]	χ^2=15.5 [a]	χ^2=1544 [a]
Smoking allowed	93.9	67.8	42.4	96.2
Not allowed	18.4	57.3	47.0	53.4
No rules/policy	68.3	71.1	44.1	80.7
Attitude of ETS (WP)		χ^2=684.4 [a]		
Smoking allowed		89.4		
Not allowed	-	21.9	-	-
No rules/policy		75.6		
Perception of SR at SP	χ^2=51.4 [a]	χ^2=4.38	χ^2=53.7 [a]	χ^2=17.32 [a]
No support	62.5	100.0	9.6	63.1
Moderate support	73.0	73.2	47.7	81.8
Strong support	52.9	62.6	45.2	72.9

H/H=household; GHK=general health knowledge; WP=workplace; SP=some places; [a] $p<0.001$; [b] $p<0.01$; [c] $p<0.05$; Model A-ETS at home; Model B-ETS at workplace; Model C-ETS at public places; Model D-ETS at home or public places. *based on factor analysis (detaied in **Appendix A2**)

Number of persons in the household and attitude about ETS were statistically significant at ($p<0.001$) in Models A and B. General health knowledge on ETS was found to be significant at $p<0.05$ for Model D. Males were more likely to be exposed to ETS at home, workplaces and public places than females. The gender differential is the smallest for ETS at home. Those from large family had higher exposure to ETS at home. While those with lower educational attainment had higher exposure to ETS at home and workplaces, those with higher educational attainment were more likely to be exposed to ETS at public places. While the poorer respondents and those with no or some specific health knowledge on ETS had higher ETS exposure at home and workplaces. Those wealthier and had good specific health knowledge on ETS were more likely to be exposed to ETS at public places. Those who supported smoking restrictions were less likely to be exposed to home or workplace ETS and they were mostly exposed to ETS at public places.

The model diagnostic tests in multivariable binary logistic regressions are in **Appendix B2**. The Nagelkerke R^2 shows the percentage of variation in ETS exposure explained by the logistic regression models (58% for Model A, 52% for Model B, 37% for Model C and 41% for Model D). In Hosmer and Lemeshow (H-L) goodness-of-fit test, the null hypothesis of "the model fits" was not rejected for Models A and B, but rejected for Models C and D. The overall classification accuracy of the model showed that more than 80% of the cases were correctly classified by Model A, Model B and Model D but slightly lower (about 75%) by Model C. Moreover, from the check of multicollinearity by different techniques, it is clear that there is no serious problem of multicollinearity among the independent variables **Appendix B2**.

The variables which were found statistically significant in the bivariate analysis (at $p<0.05$) were included in the Models A, B and C (see in **Table 5.2)** and Model D (see **Table 5.3**). For Model A, the results showed that adults aged 45-59 and 60+ years old had significantly (OR=0.76, 95% CI=0.63-0.91; OR=0.54, 95% CI=0.44-0.67) lower chance of being exposed to ETS at home compared to the reference category of 15-24 years old. For Model B, it was apparent that adults aged 25-44 years old were 1.44 times more likely to be exposed to ETS at workplaces than the reference category of 15-24 years old. Those aged 45 and above had lower likelihood to ETS exposure at workplaces. The respondents from the older age groups also had lower likelihood of being exposed to ETS at public places compared to those younger. The females were only half as likely to be exposed to ETS at home compared to the males and the likelihood of them being exposed to ETS at workplaces and public places was even lower.

Larger household size significantly ($0.001<p<0.05$) increase the chance to be exposed to home ETS. For example, the likelihoods were 1.2, 1.5 and 2.4 times higher to be exposed to ETS at home if the household have 3-4, 5-9, and 10 or more persons, respectively, compared to the reference category of 1-2 persons. The respondents from the rural areas were 1.35 times more likely to be exposed to ETS at home compared to the urban residents. Exposure to ETS at workplace and public places did not show significant difference between the urban and rural residents. While the likelihood of being exposed to ETS at home and workplace dropped with better educational attainment, the likelihood of being exposed to ETS at public places increased for the same group of respondents. The respondents who were wealthier had significantly lower chance to be exposed to ETS at home, but the chances of them exposed to ETS at workplace and public places were higher. For example, the respondents from the high (OR=0.75, 95% CI=0.63-0.90) and highest (OR=0.63, 95% CI=0.50-0.78) wealth quintiles had significantly ($p<0.001$) less likelihood to be exposed to ETS at home compared to those from the lower wealth quintiles.

Table 5.2: OR and 95% CI (BLRs) of Predictors of ETS by Settings, Bangladesh

Predictors	Model A OR (95% CI)	Model B OR (95% CI)	Model C OR (95% CI)
Age in years			
15-24	-	-	-
25-44	1.04 (.91-1.19)	1.44*** (1.06-1.9)	1.00 (.89-1.13)
45-59	.76*** (.63-.91)	.91 (.61-1.35)	.84** (.72-.97)
60+	.54*** (.44-.67)	.65 (.37-1.13)	.43*** (.35-.51)
Gender			
Male	-	-	-
Female	.44*** (.39-.49)	.27*** (.18-.39)	.12*** (.10-.13)
No of persons in H/H			
1-2 persons	-		
3-4 persons	1.22* (.99-1.50)	-	-
5-9 persons	1.53*** (1.25-1.8)		
10 or more persons	2.38*** (1.73-3.2)		
Place of residence			
Urban	-	-	-
Rural	1.35*** (1.18-1.5)	1.11 (.85-1.46)	1.04 (.93-1.16)
Educational level			
No formal education	-	-	-
< primary (1-4 years)	1.02 (.86-1.21)	1.17 (.75-1.80)	1.07 (.92-1.24)
Prim comple (5 years)	.70*** (.59-.83)	1.12 (.68-1.84)	.97 (.82-1.15)
< secondar (4-9 years)	.60*** (.50-.72)	.94 (.62-1.45)	1.05 (.91-1.23)
Second & abo (10 Y)	.51*** (.42-.63)	.56** (.36-.88)	1.3*** (1.1-1.5)
Wealth index[a]			
Lowest (1st quintile)	-	-	-
Low (2nd quintile)	.84* (.70-.99)	1.16 (.70-1.93)	1.00 (.86-1.16)
Middle (3rd quintile)	.81** (.68-.98)	1.27 (.76-2.10)	1.18* (1.0-1.38)
High (4th quintile)	.75** (.63-.90)	1.47 (.88-2.46)	1.20** (1.1-1.4)
Highest (5th quintile)	.63*** (.50-.78)	1.90** (1.08-3.34)	1.22** (1.0-1.4)
GHK on ETS			
Yes	-	-	-
No	1.26 (.92-1.73)	2.67* (.72-9.99)	.65*** (.47-.89)
Specific HK on ETS			
No knowledge	-	-	-
Some knowledge	.78* (.59-1.03)	.64 (.27-1.50)	1.25* (.97-1.62)
Good knowledge	.65** (.53-.76)	.54 (.44-.67)	1.64*** (1.3-2.)
Attitude ETS home			
Smoking allowed	-	-	-
Not allowed	.01*** (.01-.02)	.81 (.56-1.18)	.85** (.75-.96)
No rules/policy	.13*** (.11-.16)	.93 (.62-1.34)	.96 (.84-1.08)
Attitude ETS (WP)			
Smoking allowed		-	
Not allowed	-	.04*** (.02-.05)	-
No rules/policy		.34*** (.24-.49)	
Perception SR at SP			
No support	-		-
Moderate support	.90 (.75-1.07)	-	3.6*** (1.6-7.7)
Strong support	.73* (.43-1.24)		4.9*** (2.4-10)

H/H=household; GHK=general health knowledge; HK=health knowledge; WP=workplace, SP=some places; *p<0.05; **p<0.01; ***p<0.001. [a] based on factor analysis (detaied in **Appendix A2**)

Those in the highest wealth quintile had 1.9 times higher likelihood to be exposed to ETS at workplaces than those in the lowest quintile (**Table 5.2**).

General and specific health knowledge on ETS had significantly influenced exposure to ETS at home and workplaces. For instance, the respondents with no general health knowledge on ETS had 1.3 times higher likelihood to be exposed to ETS at home and 2.7 times for ETS at workplace. In addition, those with some knowledge (OR=0.78, CI=0.59-1.03) and good knowledge (OR=0.65, CI=0.74-1.19) had lower chance to be exposed to ETS at home compared with those with no knowledge of ETS. Those with some knowledge (OR=0.64, CI=0.27-1.50) and good knowledge (OR=0.54, CI=0.44-0.67) had lower chance to be exposed to ETS at workplaces compared with those of no knowledge. Attitude about ETS at home significantly ($p<0.001$) lowered the exposure level. It was apparent that chances to be exposed to ETS were lower if smoking was not allowed at home. Attitude about ETS significantly ($p<0.001$) lowered the exposure to ETS at workplaces. If smoking was not allowed at workplaces, the likelihood of being exposed to workplace ETS was close to zero. Perception about ETS also influenced exposure level at home. For example, those who expressed moderate (OR=0.90, CI=0.75-1.07) and strong support (OR=0.73, CI=0.43-1.24) of smoking restrictions in some places had lowered the likelihood to be exposed to ETS at home and these group of respondents were more likely to be exposed to ETS at public places.

Model D examines the combined settings, either being exposed to ETS at home or public places, or at both places. The results showed that the adults aged 45-59 and 60+ years old had significantly lower chance (OR=0.80, 95% CI=0.67-0.96; OR=0.40, 95% CI=0.33-0.49) of ETS exposure compared to the reference category of 15-24 years old (**Table 5.3**). The odds ratio for the females to be exposed to ETS was as low as 0.18. Respondents from the rural area were 1.13 times more likely than the urban residents to be exposed to ETS. The respondents who completed primary schooling or less than secondary schooling had lower chance of ETS exposure than those without education. Wealthiness did not show any significant effects on ETS exposure.

Table 5.3: Odds Ratio and 95% CI (BLRs) of Predictors of ETS by Combined Settings, Bangladesh

Predictors	Model D OR (95% CI)
Age in years	
15-24	-
25-44	.99 (.86-1.13)
45-59	.80** (.67-.96)
60+	.40*** (.33-.49)
Gender	
Male	-
Female	.18*** (.16-.20)
Place of residence	
Urban	-
Rural	1.13* (.99-1.29)
Educational level	
No formal education	-
Less than primary (1-4 years)	1.02 (.86-1.22)
Primary completed (5 years)	.75*** (.62-.90)
Less than secondary (6-9 years)	.83** (.70-.98)
Secondary & above (10+ years)	1.00 (.83-1.25)
Wealth index	
Lowest (1st quintile)	-
Low (2nd quintile)	.88 (.74-1.05)
Middle (3rd quintile)	.97 (.81-1.17)
High (4th quintile)	1.03 (.86-1.24)
Highest (5th quintile)	1.00 (.80-1.24)
GHK on ETS exposure	
Yes	-
No	1.20 (.88-1.70)
Specific HK on ETS	
No knowledge	-
Some knowledge	1.03 (.79-1.34)
Good knowledge	1.29** (1.0-1.6)
Attitude about ETS (at home)	
Smoking allowed	-
Not allowed	.03*** (.02-.04)
No rules/policy	.14*** (.12-.18)
Perception of SR at SP	
No support	-
Moderate support	1.03 (.55-1.90)
Strong support	1.09 (.66-1.83)

GHK=general health knowledge; HK=health knowledge; SR=smoking restrictions; SP=some places; OR=odds ratio; CI=confidence interval; *p<0.05; **p<0.01; ***p<0.001; Model D-ETS at home or public places.

General health knowledge on ETS had some impact. For instance, the respondents with no general knowledge on ETS had likelihood of 1.2 times higher to be exposed to ETS. In addition, the respondents with good knowledge of ETS were 1.3 times more likely to be exposed to ETS in combined settings, mainly due to ETS at public places as found earlier. Attitude about ETS at home significantly ($p<0.001$) lowered the exposure level in combined settings. If smoking was not allowed at home, the odds ratio of ETS exposure was close to zero. In the combined settings, perceptions of smoking restrictions at some places did not show any differences in impacts on ETS exposure.

Model E was estimated using the ordinal logistic regression for the combined settings of exposure to ETS at either home or public places. Although the goodness-of-fit test showed that the model did not fit the data well, the values of Pseudo R^2 (Cox and Snell=0.38, Nagelkerke=0.43, and McFadden=0.24) and classification accuracy (63.4%) suggested that the model is reasonably acceptable, considering the large dataset, and the inclusion of many independent or categorical variables with many levels or grouping **Appendix B3**. The ordinal regression assumed that the relationships between independent variables and the logits are same for all the logits (link function Logit is widely used). Here, a highly significant test statistic ($p<0.001$) means that separate parameters for each category would be more appropriate. The model was again tested using the next appropriate link function (Cauchit). Since all the tests failed to satisfy the requirements for a good model, the multinomial logistic regression which ignores the ordinal nature in the categories of ETS exposure is a better alternative.

Bivariate analyses provided supportive information for designing the ordinal regression model. The variables that were significantly related to ETS exposure in the bivariate analysis were chosen based on the significance level of $p<0.001$ (**Appendix B3**). These variables are age, gender, place of residence, specific health knowledge about ETS, and attitude on ETS exposure at home (**Table 5.4**). The respondents who were 15-24, 25-44, and 45-59 years old had likelihoods which were 2.3, 2.4 and 1.8 times higher to be exposed to ETS than the respondents who were 60 or more years old. The results suggested that the younger age groups were more exposed to ETS at home or public places.

Table 5.4: Parameter Estimates for Ordinal Logistic Regression, Bangladesh

Factors	Estimate	95% CI	OR=Exp(estimate)
Age in years			
15-24	.83***	.67-.99	2.29
25-44	.87***	.72-1.01	2.38
45-59	.57***	.42-.75	1.80
60+	-	-	-
Gender			
Male	2.00***	1.90-2.09	7.39
Female	-	-	-
Place of residence			
Urban	-.16***	-.26- (-.06)	0.85
Rural	-	-	-
Educational level			
No formal education	.13	-.03-.29	1.14
Less than primary (1-4 years)	.18**	.01-.34	1.19
Primary completed (5 years)	-.14	-.31-.03	0.87
Less than secondary (6-9 years)	-.02	-.16-.13	0.98
Secondary & above (10+ years)	-	-	-
Wealth index			
Lowest (1st quintile)	.05	-.12-.22	1.05
Low (2nd quintile)	-.02	-.18-.14	0.98
Middle (3rd quintile)	.05	-.10-.21	1.05
High (4th quintile)	.11	-.03-.26	1.12
Highest (5th quintile)	-	-	-
GHK on ETS exposure			
Yes	0.08	-.16-.31	1.08
No	-	-	-
Specific HK on ETS			
No knowledge	-.27***	-.45-(-.09)	0.76
Some knowledge	-.27***	-.41-(-.14)	0.76
Good knowledge	-	-	-
Attitude about ETS (at home)			
Smoking allowed	.83***	.72-.94	2.29
Not allowed	-1.76***	-1.86-(-1.65)	0.17
No rules/policy	-	-	-
Perception of SR at SP			
No support	-.41	-.83-.01	0.66
Moderate support	-.11	-.35-.13	0.90
Strong support	-	-	-

GHK=general health knowledge; HK=health knowledge; SR=smoking restrictions; SP=some places; OR=odds ratio; CI=confidence interval; *p<0.05; **p<0.01; ***p<0.001; link function: logit.

Males compared to females had a higher probability (about 7.4 times) to be exposed to a higher level of ETS. The urban residents had a lower probability of being exposed to a higher level of ETS compared with the rural residents. The respondents with lower educational attainment were more likely to be exposed to ETS in more settings. Wealth index and general health knowledge about ETS did not show any significant influences on the number of settings the respondents were exposed to. It was found that the respondents who had smoking allowed at home were 2.3 times more likely to be exposed to ETS in more settings. However, respondents whose home did not allow smoking had lower chance to be exposed to ETS in multiple settings.

Next, the multinomial logistic regression for Model F is considered. The goodness-of-fit test did not reject the null hypothesis. However, the values of Pseudo R^2 (Cox and Snell=0.40, Nagelkerke=0.45, and McFadden=0.25) and classification accuracy (65.2%) showed that the model was statistically acceptable (**Appendix B4**). The variables that were significant at $p<0.05$ in the bivariate analysis (Likelihood Ratio Test) were chosen for the model (**Appendix B4**). There are two parts to the estimation results of the multinomial logistic regression reported in **Table 5.5**. First part compares respondents who had some exposure of ETS to those who have no ETS exposure at all and the second part compares those who have more exposure of ETS to those who have no such exposure.

The odds of exposure to some ETS compared to no exposure at all were 2.21, 2.15, and 1.86 times higher (with $p<0.001$) among those who were 15-24, 25-44, and 45-59 years old respectively than the reference category of 60 or more years old. Similar pattern was also found for the odds of more to no ETS exposure, where the younger age groups were more likely to be exposed to ETS.

Table 5.5: Parameter Estimates for Multinomial Logistic Regression, Bangladesh

Predictors	Some vs. No exposure		More vs. No exposure	
	Estimate	OR (95% CI)	Estimate	OR (95% CI)
Age in years				
15-24	.79	2.2*** (1.8-2.7)	1.36	3.9*** (2.95-5.1)
25-44	.76	2.2*** (1.8-2.6)	1.40	4.1*** (3.16-5.3)
45-59	.62	1.9*** (1.5-2.3)	0.96	2.6*** (1.97-3.4)
60+	-	-	-	-
Gender				
Male	1.32	3.7*** (3.3-4.2)	3.32	27.6*** (23.-32)
Female	-	-	-	-
Place of residence				
Urban	-.09	.92 (.81-1.04)	-.29	.75*** (.63-.88)
Rural	-	-	-	-
Educational level				
No formal education	-.10	.91 (.74-1.11)	.25	1.28* (.98-1.67)
< primary (1-4 years)	-.09	.92 (.73-1.13)	.34	1.41** (1.07-1.8)
Pri completed (5 years)	-.34	.71*** (.57-.88)	-.22	.80 (.60-1.07)
< secondary (6-9 years)	-.27	.76*** (.63-.92)	.03	1.03 (.81-1.31)
Second & above (10+)	-	-	-	-
Wealth index				
Lowest (1st quintile)	-.03	.98 (.78-1.21)	.11	1.12 (.84-1.50)
Low (2nd quintile)	-.15	.86 (.71-1.06)	-.03	.97 (.74-1.28)
Middle (3rd quintile)	-.06	.94 (.77-1.15)	.12	1.13 (.87-1.47)
High (4th quintile)	-.008	.99 (.83-1.19)	.22	1.25* (.98-1.60)
Highest (5th quintile)	-	-	-	-
GHK on ETS				
Yes	-.16	.86 (.64-1.16)	.29	1.34 (.86-2.07)
No	-	-	-	-
Specific HK on ETS				
No knowledge	-.19	.82* (.66-1.04)	-.46	.63*** (.46-.87)
Some knowledge	-.18	.84** (.70-1.00)	-.48	.62*** (.49-.78)
Good knowledge	-	-	-	-
Attitude ETS at home				
Smoking allowed	1.88	6.5*** (5.2-8.3)	2.26	9.6*** (7.4-12.3)
Not allowed	-1.42	.24*** (.21-.28)	-2.63	0.07*** (.06-.09)
No rules/policy	-	-	-	-
Perceptions SR at SP				
No support	-.01	.99 (.60-1.63)	-1.21	.30*** (.12-.73)
Moderate support	-.08	.93 (.64-1.34)	-.17	.84 (.55-1.28)
Strong support	-	-	-	-

GHK=general health knowledge; HK=health knowledge; SR=smoking restrictions; SP=some places; OR=odds ratio; CI=confidence interval; the reference category is not exposed; *p<0.05; **p<0.01; ***p<0.001.

Males had significantly (p<0.001) higher likelihood (OR=3.7, CI=3.30-4.22) of being exposed to some ETS and more ETS (OR=28, CI=23-32) than their female counterparts. It was found that the respondents with education of primary schooling or less than secondary schooling had significantly (p<0.001) lower likelihood of being exposed to some ETS compared to respondents with at least secondary school education. Those with less education were most likely to be exposed to more ETS. The odds of more exposure to ETS against no exposure for the urban residents were lower (OR=0.75, CI=0.63-0.88) than that of the rural residents. The wealth index did not show significant difference on the ETS exposure of the respondents. The impact of general health knowledge on ETS was also not significant. For specific health knowledge about ETS, respondents with no knowledge and some knowledge were less likely to indicate that they were exposed to some or more ETS compared to the respondents with good knowledge. Economic status had no significant impact when combined settings of ETS exposure were considered. When smoking was allowed at home, the likelihood of being exposed to some ETS was 6.5 times higher, and the likelihood of being exposed to more ETS was 9.6 times higher (**Table 5.5**).

5.4.2 Association between ETS Exposure and TC

The logistic regressions adjusted for other variables as confounders were estimated to examine the association between TC and ETS exposure in different settings (**Table 5.6**). The confounders are age, gender, residence, education, wealth index, general and specific health knowledge about ETS, attitude of ETS at home and public places. In Model A, the respondents who smoked daily and less than daily revealed 2.8 and 1.5 times higher likelihood of exposure to ETS at home compared with the reference category of no tobacco smoking. In addition, respondents who used any smokeless tobacco product daily (OR=1.90, CI=1.40-2.55) and less than daily (OR=1.31, CI=1.13-1.50) were significantly ($p<0.001$) more likely to be exposed to ETS at home than the non-users. In Model B, it was found that daily use of smoked tobacco products (OR=1.32, CI=0.98-1.79) and smokeless tobacco products (OR=1.40, CI=.99-1.98) led to significantly higher likelihood of being exposed to ETS at workplaces. Model C showed that the respondents who smoked daily and less than daily revealed 1.5 and 1.2 times higher likelihood of ETS exposure at public places. Besides, the respondents who used any smokeless tobacco products daily or less than daily had 1.4 times (p<0.001) higher likelihood of ETS exposure at public places compared to the non-users.

Table 5.6: Odds Ratio and 95% CI (BLRs) for Association between ETS Exposure and TC, Bangladesh

Tobacco consumption	ETS exposures in different settings			
	Model A	**Model B**	**Model C**	**Model D**
	AOR (CI)	AOR (CI)	AOR (CI)	AOR (CI)
Use of TS				
No	-	-	-	-
< Daily use	1.5** (1.4-1.9)	1.2 (0.9-1.5)	1.2** (.89-1.4)	1.3*** (.9-2.)
Daily use	2.8*** (2.4-3.3)	1.3* (.9-1.8)	1.5*** (1.-1.7)	1.8*** (2-3)
Use of SLT				
No	-	-	-	-
< Daily use	1.3*** (1.1-1.5)	1.24 (.9-1.5)	1.4*** (1-1.5)	1.5*** (1.3-2)
Daily use	1.9*** (1.4-2.5)	1.4* (.9-1.9)	1.4*** (1-1.8)	1.6*** (1-2.2)

AOR=adjusted odds ratio; CI=confidence interval; *p<0.05; **p<0.01; ***p<0.001; "<daily" means do not use daily; (TS=smoked tobacco and SLT=smokeless tobacco); Model A-ETS at home; Model B-ETS at workplace; Model C-ETS at public places; Model D-ETS at home or public places.

In Model D, the respondents who smoked daily (OR=1.8, CI=1.46-2.17) and less than daily (OR=1.3, CI=.98-1.80) had odds ratio more than one for exposure to ETS at combined settings. Moreover, it was revealed that the use of smokeless tobacco daily or less than daily caused the likelihood to be 1.5 times higher of being exposed to ETS at either home or public places.

5.5 The Results for India

5.5.1 Factors Associated with ETS Exposure in Different Settings

Table 5.7 provides the results of the bivariate analysis to show the prevalence of ETS exposure in different settings by socio-demographic factors, health knowledge, and perception and attitude about smoking. Gender, place of residence, educational level, wealth index, and general and specific health knowledge on ETS were significantly (p<0.001) associated with ETS exposure in Model A, Model B and Model C.

Table 5.7: Chi-Squared Analysis of ETS by Settings and Predictors, India

Predictors	ETS Exposure in Different Settings			
	Model A	Model B	Model C	Model D
Age in years	χ^2=9.55 [c]	χ^2=19.73 [a]	χ^2=478.4 [a]	χ^2=141.9 [a]
15-24	39.3	29.8	31.7	56.8
25-44	39.2	32.8	29.8	56.2
45-59	39.7	31.7	26.6	54.0
60+	39.6	35.8	20.0	50.0
Gender	χ^2=13.9 [a]	χ^2=148.9 [a]	χ^2=4442.9 [a]	χ^2=1427.2 [a]
Male	40.0	34.2	39.0	61.8
Female	38.7	21.7	17.7	48.4
No of persons in H/H	χ^2=770.1 [a]	-	-	-
1-2 persons	35.2			
3-4 persons	32.9			
5-9 persons	41.3			
10 or more persons	47.7			
Place of residence	χ^2=1534.8 [a]	χ^2=61.9 [a]	χ^2=108.9 [a]	χ^2=504.5 [a]
Urban	28.8	28.8	31.3	49.2
Rural	43.7	34.9	27.6	57.9
Educational level	χ^2=2607.9 [a]	χ^2=430.0 [a]	χ^2=1574.9 [a]	χ^2=285.4 [a]
No formal education	48.3	44.0	20.2	57.1
< primary (1-4 years)	44.5	42.1	27.8	58.6
Pri complete (5 years)	43.0	39.6	30.8	58.3
< seconda (6-9 years)	38.3	34.7	31.1	55.2
Second & above (10+)	26.2	24.3	36.4	50.8
Wealth index	χ^2=2360.98 [a]	χ^2=176.8 [a]	χ^2=615.4 [a]	χ^2=696.9 [a]
Lowest (1st quintile)	22.6	24.3	31.2	44.7
Low (2nd quintile)	33.6	31.9	33.8	54.2
Middle (3rd quintile)	39.2	33.1	31.0	56.4
High (4th quintile)	44.1	36.5	28.7	58.7
Highest (5th quintile)	48.0	39.8	22.8	58.3
GHK on ETS	χ^2=162.3 [a]	χ^2=75.6 [a]	χ^2=1060.2 [a]	χ^2=45.47 [a]
Yes	38.3	30.9	31.1	55.9
No	44.2	41.6	17.2	52.7
Specific HK on ETS	χ^2=97.62 [a]	χ^2=89.93 [a]	χ^2=808.7 [a]	χ^2=44.8 [a]
No knowledge	43.7	43.2	18.4	52.9
Some knowledge	38.8	33.3	27.9	54.9
Good knowledge	38.5	29.5	32.5	56.4
Attitude ETS (home)	χ^2=3525.8 [a]	χ^2=642.7 [a]	-	χ^2=7876.6 [a]
Smoking allowed	84.6	48.8		89.0
Not allowed	12.8	25.2		35.6
No rules/policy	51.8	39.1		64.5
Attitude ETS (WP)	-	χ^2=2609.2 [a]	-	-
Smoking allowed		63.1		
Not allowed		15.9		
No rules/policy		38.3		

H/H=household; GHK=general health knowledge; HK=health knowledge; WP=workplace; [a] p<0.001; [b] p<0.01; [c] p<0.05; Model A-ETS at home; Model B-ETS at workplace; Model C-ETS at public places; Model D-ETS at home or public places.

Attitude about ETS at home used in Model A and Model B were found to be significant ($p<0.001$). Besides, age in years were significantly associated with ETS exposure ($0.001<p<0.05$) in all three settings. The number of persons in the household and attitude about ETS at workplaces that were only used in Model A and Model B, respectively, were statistically significant ($p<0.001$). All the variables used in Model D were significantly related to ETS exposure ($p<0.001$) at home or public places. While those from older age groups were more exposed to ETS at home, those younger had a higher tendency to be exposed to ETS at public places. In all settings, the males had higher exposure to ETS than the females, although the differential is smaller for ETS at home. Household size was directly related to ETS exposure. While ETS exposure at home and workplaces was higher in the rural areas, ETS in public places was more prevalent in the urban areas. Those with better educational attainment were less likely to be exposed to ETS at home and workplaces, but were more likely to be exposed to ETS at public places. The patterns of ETS exposure by wealthiness for India were rather different from the patterns for Bangladesh. Those wealthier had higher ETS exposure at home and workplaces, but lower at public places. General and specific health knowledge on ETS helped to reduce exposure to ETS at home and workplaces, but not at public places. Similarly, ETS exposure at home and workplaces was also reduced through support for banning of smoking at home and workplaces.

The model diagnostic tests for the multivariable binary logistic regressions are in **Appendix B5**. Nagelkerke R^2 shows that the percentage of variation in ETS exposure explained by the logistic regression models was 56% for Model A, 30% for Model B, 17% for Model C and 40% of Model D. Hosmer and Lemeshow (H-L) goodness-of-fit test failed to show that the models had good fit. On the contrary, the overall classification accuracy of models showed that more than 80% of cases were correctly classified by Model A, and about 75% were correctly classified by Model B. whereas, classification accuracy of Model C and D were roughly 71%. The check of multicollinearity by different techniques suggested no serious multicollinearity problem among the independent variables (**Appendix B5**). The variables which were found to be statistically significant in the bivariate analysis ($p<0.05$) were included in the binary logistic regression models (Model A, Model B, Model C) in **Table 5.8** and Model D in **Table 5.9**.

The results showed that adults aged 25-44, 45-59 and 60+ years old had significantly lower chance of being exposed to ETS at home and public places compared to the reference category of 15-24 years old. On the other hand, those younger respondents had a higher tendency to be exposed to ETS at public places. The females were less likely to be exposed to ETS in all three settings than the males. The females had the highest exposure to ETS at home, followed by workplaces, and lastly public places. The higher the number of persons in a household, higher the chance to be exposed ETS at home. For example, the likelihoods were 1.2, 1.5 and 1.9 times higher if the household size was 3-4, 5-9, and 10 or more persons compared to the reference category of 1-2 persons. The respondents from the rural areas have significantly ($p<0.001$) higher exposure of ETS at home than the urban residents. Place of residence did not have any significant impact on exposure to ETS at workplaces and public places. The level of education had significant impact on ETS exposure. Those with better education level were less likely to be exposed to home and workplace ETS, but they had a higher tendency to be exposed to public place ETS, compared to the respondents with lower educational attainment (**Table 5.8**). The respondents who were in the second to fifth wealthiness quintiles had 1.3 times higher likelihood of being exposed to ETS at home compared to those from the first quintile. On the other hand, those who were wealthier had lower likelihood of being exposed to ETS at workplaces or public places.

Table 5.8: OR and 95% CI (BLRs) of Predictors of ETS by Settings, India

Predictors	Model A	Model B	Model C
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age in years			
15-24	-	-	-
25-44	.89*** (.85-.94)	1.19*** (1.1-1.3)	.96* (.93-1.00)
45-59	.91*** (.85-.96)	1.08 (.95-1.23)	.83*** (.79-.87)
60+	.86*** (.80-.93)	1.06 (.88-1.29)	.63*** (.59-.67)
Gender			
Male	-	-	-
Female	.75*** (.72-.78)	.45*** (.40-.51)	.34*** (.33-.36)
No. of persons in H/H			
1-2 persons	-		
3-4 persons	1.19*** (1.09-1.3)	-	-
5-9 persons	1.49*** (1.37-1.6)		
10 or more persons	1.92*** (1.74-2.1)		
Place of residence			
Urban	-	-	-
Rural	1.08*** (1.0-1.14)	1.01 (.42-1.10)	1.00 (.96-1.04)
Educational level			
No formal education	-	-	-
< primary (1-4 years)	.90*** (.84-.96)	.93 (.79-1.10)	1.03 (.98-1.10)
Pri completed (5 years)	.84*** (.79-.90)	.89 (.76-1.05)	1.10*** (1.-1.17)
< secondar (6-9 years)	.77*** (.72-.82)	.77*** (.67-.90)	1.01 (.96-1.07)
Second & above (10+)	.61*** (.57-.65)	.64*** (.55-.73)	1.16*** (1.1-1.2)
Wealth index			
Lowest (1st quintile)	-	-	-
Low (2nd quintile)	1.24*** (1.15-1.3)	1.12* (.99-1.26)	1.13*** (1.1-1.9)
Middle (3rd quintile)	1.35*** (1.26-1.5)	1.01 (.90-1.14)	1.07* (1.01-1.13)
High (4th quintile)	1.28*** (1.18-1.4)	.97 (.84-1.12)	.98 (.92-1.04)
Highest (5th quintile)	1.30*** (1.20-1.4)	.91 (.78-1.06)	.76*** (.72-.81)
GHK on ETS			
Yes	-	-	-
No	1.04 (.99-1.10)	1.2*** (1.07-1.4)	.58*** (.55-.61)
Specific HK on ETS			
No knowledge	-	-	-
Some knowledge	1.13*** (1.06-1.2)	.90 (.77-1.05)	1.22*** (1.2-1.3)
Good knowledge	1.25*** (1.18-1.3)	.87* (.74-1.01)	1.43*** (1.4-1.5)
Attitude of ETS home			
Smoking allowed	-	-	
Not allowed	.03*** (.02-.04)	.60*** (.55-.67)	-
No rules/policy	.19*** (.18-.20)	.83** (.73-.94)	
Attitude of ETS (WP)			
Smoking allowed		-	
Not allowed	-	.13*** (.12-.15)	-
No rules/policy		.37*** (.33-.41)	

H/H=household; GHK=general health knowledge; HK=health knowledge; WP=workplace; OR=odds ratio; CI=confidence interval; *p<0.05; **p<0.01; ***p<0.001; Model A-ETS at home; Model B-ETS at workplace; Model C-ETS at public places.

In India, general health knowledge on ETS did not show any significant influence on exposure to ETS at home. However, specific health knowledge about smoking significantly ($p<0.001$) influenced exposure to ETS at home. For instance, those with some knowledge (OR=1.13, CI=1.06-1.20) and good knowledge (OR=1.25, CI=1.18-1.34) have higher likelihood to be exposed to ETS at home compared with those of no specific knowledge. General and specific health knowledge on ETS had impact on the exposure to ETS at workplaces. Those with no general knowledge on ETS had 1.2 times higher likelihood ($p<0.001$) to be exposed at workplaces. In addition, people with some knowledge (OR=0.90, CI=0.77-1.05) and good knowledge (OR=0.87, CI=0.74-1.01) had lower chance to be exposed to ETS at workplaces compared to those with no knowledge. General and specific health knowledge on ETS exposure also significantly ($p<0.001$) influenced exposure in public places. For example, the respondents with general health knowledge on ETS exposure had higher chance to be exposed to ETS at public places than the respondents without health knowledge. Moreover, people with some knowledge (OR=1.22) and good knowledge (OR=1.43) about ETS exposure had significantly higher likelihood of being exposed to ETS at public places (**Table 5.8**). Attitude about ETS at home significantly ($P<0.001$) lowered the exposure level. It was apparent that the chance of being exposed to home ETS was almost zero if smoking was not allowed at home. Attitude about ETS at home had also lowered the likelihood of exposure to ETS at workplaces. If smoking not allowed at home, it would also reduce chances of exposure to ETS at workplaces. Smilarly, attitude about ETS at workplaces significantly ($p<0.001$) lowered the exposure level. The odds ratio of being exposed to ETS at workplaces was 0.13 if smoking was not allowed at workplaces.

For Model D (combined settings, either exposed to ETS at home or public places or at both places), the results showed that as age increased, the likelihood of exposure to

ETS at home or public places reduces (**Table 5.9**). The females had significantly ($p<0.001$) lower likelihood (OR=.46, CI=.44-.47) of ETS exposure than the males. The respondents from the rural areas had higher ETS exposure ($p<0.05$) than the urban residents. Better educational attainment had helped to reduce significantly the exposure to ETS. Those who were poorer had higher likelihood of being exposed to ETS compared to those wealthier.

Table 5.9: Odds Ratio and 95% CI (BLRs) of Predictors of ETS by Combined Settings, India

Predictors	**Model D** **OR (95% CI)**
Age in years	
15-24	-
25-44	.94*** (.90-.98)
45-59	.82*** (.78-.87)
60+	.69*** (.65-.74)
Gender	
Male	-
Female	.46*** (.44-.47)
Place of residence	
Urban	-
Rural	1.04* (1.00-1.09)
Educational level	
No formal education	-
< primary (1-4 years)	.95* (.89-1.00)
Primary completed (5 years)	.92** (.86-.98)
Less than secondary (6-9 years)	.84*** (.79-.89)
Secondary & above (10+ years)	.81*** (.77-.89)
Wealth index	
Lowest (1^{st} quintile)	-
Low (2^{nd} quintile)	1.18*** (1.1-1.25)
Middle (3^{rd} quintile)	1.17*** (1.1-1.24)
High (4^{th} quintile)	1.06* (1.00-1.13)
Highest (5^{th} quintile)	.93** (.87-.99)
GHK on ETS exposure	
Yes	-
No	.79*** (.76-.83)
Specific HK on ETS	
No knowledge	-
Some knowledge	1.18*** (1.1-1.25)
Good knowledge	1.29*** (1.22-1.4)
Attitude about ETS (at home)	
Smoking allowed	-
Not allowed	.06*** (.05-.09)
No rules/policy	.19*** (.18-.21)

GHK=general health knowledge; HK=health knowledge; OR=odds ratio; CI=confidence interval; *p<0.05; **p<0.01; ***p<0.001; Model D-ETS at home or public places.

General and specific health knowledge on ETS exposure significantly ($p<0.001$) influenced the exposure in combined settings. For instance, the respondents with general health knowledge on ETS exposure had higher chance to be exposed to ETS in the combined settings than the respondents without health knowledge. Moreover, adults with some knowledge (OR=1.18, CI=1.12-1.25) and good knowledge (OR=1.29, CI=1.22-1.37) about ETS exposure had significantly higher likelihood of ETS exposure than the adults with no specific knowledge (the reference category). Attitude about ETS at home significantly ($p<0.001$) lowered the exposure level in combined settings. It was apparent that the risk of exposure could be almost zero if smoking was not allowed at home (**Table 5.9**).

Model E considers the number of settings a respondent was exposed to ETS either at home or public places, and treating this variable as ordinal. The test statistic for the goodness-of-fit test did not provide evidence of a model with good fit. The values of Pseudo R^2 (Cox and Snell=0.32, Nagelkerke=0.36, and McFadden=0.22) and classification accuracy (58.3%) showed that the model has reasonably good explanatory power considering the large dataset, and many independent or categorical variables with many levels or grouping (**Appendix B6**). In the ordinal regression, it was assumed that the relationships between the independent variables and the logits are same for all the logits. Here, a highly significant test statistic ($p<0.001$) suggest that separate parameters for each category would be more appropriate (**Appendix B6**).The model was again tested using next the Cauchit link function, but the test was also rejected. Since all tests failed, the multinomial logistic regression that ignores the ordinal nature in the number of settings is recommended. The bivariate analyses provide supportive information for designing the ordinal regression model. The variables that were significant in the bivariate analyses at the significance level of $p<0.001$ (**Appendix B6**) were included in the model.

Table 5.10: Parameter Estimates for Ordinal Logistic Regression, India

Factors	Estimate	95% CI	OR=exp(estimate)
Age in years			
15-24	.38***	.32-.43	1.46
25-44	.29***	.24-.34	1.34
45-59	.18***	.13-.24	1.20
60+	-	-	-
Gender			
Male	.85***	.82-.88	2.34
Female	-	-	-
Place of residence			
Urban	-.02	-.06-.01	.98
Rural	-	-	-
Educational level			
No formal education	.07***	.02-.12	1.07
< primary (1-4 years)	.02	-.03-.07	1.02
Pri completed (5 years)	.05*	-.003-.10	1.05
< secondary (6-9 years)	-.04*	-.08-.006	.96
Second & above (10+year)	-	-	-
Wealth index			
Lowest (1st quintile)	.11***	.05-.16	1.12
Low (2nd quintile)	.27***	.21-.32	1.31
Middle (3rd quintile)	.25***	.20-.29	1.28
High (4th quintile)	.15***	.11-.20	1.16
Highest (5th quintile)	-	-	-
GHK on ETS exposure			
Yes	.29***	.25-.33	1.34
No	-	-	-
Specific HK on ETS			
No knowledge	-.30***	-.35-(-.25)	.74
Some knowledge	-.15***	-.18-(-.12)	.86
Good knowledge	-	-	-
Attitude of ETS home			
Smoking allowed	1.24***	1.19-1.28	3.46
Not allowed	-1.36***	-1.40-(-1.32)	.26
No rules/policy	-	-	-

GHK=general health knowledge; HK=health knowledge; OR=odds ratio; CI=confidence interval; *p<0.05; **p<0.01; ***p<0.001; link function: logit.

It was found that age, gender, wealth index, general and specific health knowledge about ETS, attitude about ETS exposure at home were significantly (p<0.001) related to the ETS exposure level (**Table 5.10**). For instance, the respondents who were 15-24, 25-44, and 45-59 years old had 1.5, 1.3 and 1.2 times higher likelihood to be more exposed (the higher group/category of dependent variable) than the respondents with 60 or more years old. The males compared to females had a higher probability (about 2.34 times) to be exposed to ETS in more settings. The urban-rural differential was not found to be significant. Similarly, educational attainment did not show any significant differences among categories exposed at a higher level of ETS except for those with no education who were more prone to ETS exposure. The respondents from the 1^{st}, 2^{nd}, 3^{rd}, and 4^{th} wealth quintiles were 1.12, 1.31, 1.28, and 1.16 times more likely to be exposed to ETS in more settings than the respondents from the 5^{th} wealth quintile.

The respondents with general health knowledge about ETS had 1.34 times higher likelihood to be more exposed to ETS than the respondents having no knowledge about ETS exposure. Like the general health knowledge, the respondents with no knowledge and some knowledge had lower probability of being exposed to a higher level of ETS than their counterparts who had good knowledge about ETS. The respondents who had smoking allowed at home were 3.46 times more likely to be exposed to a higher level of ETS. However, the odds ratio for the respondents who did not allow smoking at home was low at 0.26 (**Table 5.10**).

The results for the estimation of the multinomial logistic regression are reported in **Table 5.11** and the diagnostic test results are given in **Appendix B7**. There are two parts of the results, the first part compares respondents who had some exposure of ETS to those who had no ETS exposure at all and the second part compares those who had more exposure of ETS to those who had no such exposure. The odds of some and more ETS exposure decreased with age, suggesting the younger respondents had more ETS exposure than those older. The males had significantly ($p<0.001$) higher likelihood of exposure (both, some and more) compared to their female counterparts. The urban residents had a lower chance ($p<0.05$) to be exposed to some ETS than those from the rural areas. It was found that the respondents with less education had significantly ($p<0.05$) higher likelihood of being exposed to some or more ETS. For wealth index, those from the 2^{nd}, 3^{rd}, and 4^{th} quintiles had about 1.2 times higher likelihood ($p<0.001$)

of being exposed to some ETS compared to the respondents from the highest quintile. Those who were in the poorer categories were also more likely to be exposed to a high level of ETS.

Table 5.11: Parameter Estimates for Multinomial Logistic Regression, India

Predictors	**Some vs. No exposure**		**More vs. No exposure**	
	Estimate	OR (95% CI)	Estimate	OR (95% CI)
Age in years				
15-24	.32	1.38*** (1.3-1.5)	.63	1.88*** (1.7-2.1)
25-44	.27	1.31*** (1.2-1.4)	.48	1.6*** (1.47-1.7)
45-59	.15	1.16*** (1.1-1.2)	.31	1.36*** (1.2-1.5)
60+	-	-	-	-
Gender				
Male	.66	1.9*** (1.87-2.0)	1.53	4.63*** (4.4-4.9)
Female	-	-	-	-
Place of residence				
Urban	-.05	.95** (.92-.99)	-.02	.99 (.93-1.05)
Rural	-	-	-	-
Educational level				
No formal education	.12	1.13*** (1.1-1.2)	.14	1.15*** (1.1-1.2)
< primary (1-4 years)	.07	1.07*** (1.0-1.1)	.07	1.07 (.98-1.18)
Pri complete (5 years)	.02	1.02 (.96-1.08)	.13	1.13** (1.04-1.2)
< secondar (6-9 year)	-.06	.94** (.89-.99)	-.01	.99 (.92-1.08)
Secod & above (10+)	-	-	-	-
Wealth index				
Lowest (1st quintile)	.05	1.05 (.98-1.12)	.24	1.27*** (1.1-1.4)
Low (2nd quintile)	.20	1.2*** (1.14-1.3)	.46	1.58*** (1.4-1.7)
Middle (3rd quintile)	.20	1.22*** (1.2-1.3)	.42	1.53*** (1.4-1.6)
High (4th quintile)	.11	1.12*** (1.1-1.2)	.26	1.29*** (1.2-1.4)
Highest (5th quintile)	-	-	-	-
GHK on ETS				
Yes	.172	1.19*** (1.1-1.3)	.60	1.82*** (1.7-1.9)
No	-	-	-	-
Specific HK on ETS				
No knowledge	-.20	.82*** (.77-.87)	-.61	.55*** (.50-.60)
Some knowledge	-.05	.95** (.92-.99)	-.32	.73*** (.69-.77)
Good knowledge	-	-	-	-
Attitude ETS (home)				
Smoking allowed	1.55	4.69*** (4.4-4.9)	2.03	7.6*** (7.1-8.19)
Not allowed	-1.05	.35*** (.34-.37)	-2.01	.13*** (.1-.14)
No rules/policy	-	-	-	-

GHK=general health knowledge; HK=health knowledge; OR=odds ratio; CI=confidence interval; the reference category is not exposed; *p<0.05; **p<0.01; ***p<0.001.

The respondents with general health knowledge about ETS had 1.2 times and 1.8 times higher likelihood (p<0.001) to be exposed to some or more ETS respectively, compared to those without such knowledge. For specific health knowledge about ETS, respondents with no knowledge and some knowledge had lower chance of being exposed to ETS. ETS exposure was also lower for those who did not allow smoking at home.

5.5.2 Association between ETS Exposure and TC

The logistic regressions (model diagnostic results are similar to those in **Appendix B5**) adjusted for other variables as confounders were estimated to examine the association between TC and ETS exposure in different settings. Model A revealed that the respondents who smoked daily and less than daily had 4.5 and 2.2 times higher likelihood, respectively, for being exposed to ETS at home compared to those who did not smoke (**Table 5.12**). In addition, respondents who used any smokeless tobacco daily (OR=1.23, CI=1.13-1.35) and less than daily (OR=1.13, CI=1.08-1.18) were also significantly (p<0.001) more likely to be exposed to ETS at home than the non-users.

Table 5.12: Odds Ratio and 95% CI (BLRs) for Association between ETS Exposure and TC, India

Tobacco consumption	ETS exposures in different settings			
	Model A	Model B	Model C	Model D
	AOR (CI)	AOR (CI)	AOR (CI)	AOR (CI)
Use of TS				
No	-	-	-	-
< Daily use	2.2***(1.99-2.4)	1.37***(1.2-1.6)	1.4***(1.-1.5)	1.8*** (1.6-2.)
Daily use	4.49***(4.2-4.8)	1.6***(1.4-1.8)	1.6***(1.5-2)	3.***(2.9-3.3)
Use of SLT				
No	-	-	-	-
< Daily use	1.13***(1.1-1.2)	1.03*(.89-1.17)	1.1***(1.-1.2)	1.2***(1.-1.2)
Daily use	1.23***(1.1-1.4)	1.08*(.98-1.19)	1.2***(1.-1.2)	1.2***(1.-1.3)

AOR=adjusted odds ratio; CI=confidence interval; *p<0.05; **p<0.01; ***p<0.001; "<daily" means do not use daily; (TS=smoked tobacco and SLT=smokeless tobacco); Model A-ETS at home; Model B-ETS at workplace; Model C-ETS at public places; Model D-ETS at home or public places.

From Model B, it was found that daily smoking of tobacco (OR=1.62, CI=1.44-1.83) and those who smoked less than daily (OR=1.37, CI=.99-1.98) had significantly (p<0.001) higher likelihood of exposure to ETS at workplaces. For smokeless tobacco use, the risk of exposure was marginally higher. Model C showed that the respondents who smoked daily and less than daily revealed 1.6 and 1.4 times higher likelihood of ETS exposure at public places than the non-users. Besides, respondents who used any smokeless tobacco product daily (OR=1.17, CI=1.12-1.22) and less than daily (OR=1.13, CI=1.05-1.22) were also more likely to be exposed to ETS at public places. The results are similar for the combined settings considered in Model D, where the likelihood of ETS exposure was higher among those who smoked.

5.6 Concluding Remarks

This section compares the findings on ETS exposure for Bangladesh and India along with a comparison with past studies. The respondents aged 45 years and above from both countries were found to have significantly lower chance of ETS exposure at home. Similar findings were also reported in other studies where it was clear that age were significantly associated with ETS exposure at home (Abdullah et al., 2011; Palipudi et al., 2011). Consistent with other studies (Abdullah et al., 2011; Palipudi et al., 2011; Rachiotis et al., 2010; Rudatsikira et al., 2007), the females had lower likelihood to be exposed to ETS than the males in Bangladesh and India. In both countries, a larger household size significantly increases the chances of being exposed to ETS at home. Similar findings were also reported in some studies (Akhtar et al., 2007; Bolte et al., 2009; Hyland et al., 2009; Sims et al., 2010) and this might be due to more smokers in the household and also more of those being exposed as family size increases. In line with other studies (Abdullah et al., 2011; Palipudi et al., 2011), place of residence showed an important role in both countries. For instance, the rural respondents had significantly higher chance to be exposed to ETS than their urban counterparts and this may also be related to knowledge gap. The population with low socio-economic status tends to have higher rates of smoking and thus a higher likelihood of exposure to ETS (Abdullah et al., 2011; Curtin et al., 1999). This was found consistent in Bangladesh and

India (education only). However, the contrary was found for India in regards to wealthiness, where the respondents who were wealthier had higher likelihood of being exposed to ETS at home.

TC was greatly influenced by the level of knowledge of the ill effects of tobacco products, individual’s attitude towards TC and perception about the social acceptance of smoking (WHO, 2009). Mixed results were found for Bangladesh and India in case of general and specific health knowledge about ETS. For instance, people in Bangladesh with some knowledge and good knowledge had lower chance to be exposed to ETS at home compared with people of no knowledge. In contrast with the results for the Bangladeshi adults, the Indian adults with some knowledge and good knowledge had higher likelihood to be exposed to ETS at home. This may be due to socio-economic and cultural differences (Abdullah et al., 2010; Chen et al., 2009; Liu et al., 2008; Mak et al., 2008; Mei et al., 2009; Öberg et al., 2011). In both countries, attitude towards ETS at home that restricts smoking significantly lowered the exposure level and support for smoke-free homes. This was found consistent with other studies (Abdullah et al., 2010; Chen et al., 2009; Liu et al., 2008; Mak et al., 2008; Öberg et al., 2011), where awareness of health risks of ETS through knowledge, attitude and perception towards ETS and higher education was positively associated with support for smoke-free environment at home.

Like ETS exposure at home, the adults were also exposed to ETS at workplaces. Consistent with the findings of Abdullah et al. (2011) and Palipudi et al. (2011), the Bangladeshi and Indian adults aged 25-44 years old were more likely to have ETS exposure at workplaces than those who were 15-24 years old. This might be due to the working status of those in their productive age. In both countries, females had lower likelihood to be exposed to ETS at workplaces than their male counterparts. This also might be due to gender gap in the labour force. In the South Asian region, the females were mostly not working or engaged in self-employment (WHO, 2011). The urban-rural differentials in exposure level at workplaces were not noticeable in both countries. This factor was also found to be insignificant in other studies (Palipudi et al., 2011).The education has a positive role and the smokers and non-smokers who were illiterate may not fully understand the health risks of ETS (Abdullah, et al. 2011; Palipudi et al., 2011). Higher education was positively associated with support for smoke-free workplaces (Chen et al., 2009; Liu et al., 2008; Mak et al., 2008; Öberg et al., 2011). Consistent with other findings, this study showed that the respondents with higher education had significantly lower chance of being exposed to ETS at workplaces than the respondents with no education. In contrast with other studies (Abdullah et al., 2011; Curtin et al., 1999), the Bangladeshi adults had higher likelihood of ETS exposure at workplaces if they are wealthier. This might be due to working environment and perception. However, in India wealthiness did not show significant impact on ETS exposure and this needs further investigation.

Consistent with other studies (Chen et al., 2009; Liu et al., 2008; Mei et al., 2009; Öberg et al., 2011) awareness of health risks of ETS from knowledge, attitude and perception towards ETS was positively associated with support for smoke-free workplaces. It was found that general and specific health knowledge on ETS had significantly influenced the exposure to ETS at workplaces in both countries with different exposure level. For instance, an inverse association was found between higher knowledge about the adverse effects of ETS and the chances of being exposed to ETS at workplaces. Knowledge of health risks and attitude towards smoking is associated with support for smoking restrictions and quitting (Abdullah et al., 2010; Chen et al., 2009; Lim et al., 2006; Mei et al., 2009). In both countries, attitude towards restriction of smoking at home had lowered the likelihood of being exposed to ETS at workplaces. In addition, positive attitude towards ETS at workplaces also significantly lowered the exposure level in Bangladesh and India.

In both countries, the older people (45 years and above) and females were found to be less likely to be exposed to ETS at public places. This might be due to less time spent outside home for these groups of the population. The results were found to be consistent with other studies (Akhtar et al., 2007; Bolte et al., 2009; Hyland et al., 2009; Sims et al., 2010). An interesting finding for both countries is that the respondents with higher education level (secondary & above) have higher likelihood of being exposed to ETS at public places than those with no education. This might be because those educated were more responsive about the exposure level than those with less education.

Awareness of health risks of ETS from knowledge, attitude and perception towards ETS was positively associated with support for smoke-free environment in public places (Chen et al., 2009; Liu et al., 2008; Mei et al., 2009; Öberg et al., 2011). Similar to other findings, this study showed that in the Bangladeshi and Indian communities, general and specific health knowledge on ETS exposure significantly influenced exposure to ETS in public places. People with good knowledge about the adverse effects of ETS tend to be more responsive and aware of ETS exposure than those who had little of such knowledge.

With little variations between the two countries, a positive association was found between TC and exposure to ETS in different settings. The results were supported by other studies (Abdullah et al., 2011; Chen et al., 2009; Hyland et al., 2009; Öberg et al., 2011; Palipudi et al., 2011; Sims et al., 2010). Binary, multinomial and ordinal logistic regressions along with diamond-shaped equiponderant graphs showed the prevalence, patterns and determinants of ETS exposure for both countries in different settings. From model diagnostic results, it can be stated that the binary logistic regression model has reasonably good fit followed by the multinomial logistic regression for large dataset with many independent or categorical variables. The findings from this study suggest the need for equitable public health initiatives to educate all sections of people through appropriate intervention programmes. Scientific evidence has clearly established that 100% smoke-free environments were the only proven way to fully protect the health of people from harmful effects of ETS (Eriksen, Mackay, & Ross, 2012; Öberg et al., 2011; WHO, 2009). Therefore, ETS controls should not be overlooked in public health policy options. Protection from ETS at home is particularly important, given its impact on the attitude towards and awareness about ETS exposure at all places.

CHAPTER 6: PREVALENCE, PATTERNS AND DETERMINANTS OF ILLICIT DRUG USE AMONG MALES IN BANGLADESH

6.1 Introduction

Tobacco consumption (TC) is a leading cause to many preventable and premature deaths. While TCs are common habits among the general male population in Bangladesh, TC is also widespread among the young males living in urban slum areas (Choudhury et al., 2007; Kabir et al., 2012; Palipudi et al., 2012; WHO, 2009). This phenomenon may be attributed to various factors like urbanization, migrations, marketing strategies of tobacco industries, westernization and misconception that associates smoking with maturity (WHO, 2011). Like TC, illicit drug use (IDU) and its impacts at the individual, family and community level are growing globally. Particularly, the impacts of IDU are huge in developing countries because of poor health infrastructure and limited resources to deal with the problem (UNODC, 2010). Geographically, Bangladesh is highly vulnerable to IDU because of its proximity to the drug trafficking zones of the Golden Triangle and the Golden Crescent, and its common boundary with India (a heavy consumer of opium) and Myanmar (where drug abuse is serious) (Banglapedia, 2006; UNODC, 2010). The annual prevalence rate of cannabis (locally known as Ganja) in the general population aged 15 to 64 years was 3.3% in Bangladesh (UNODC, 2010). Besides, annually about 4 metric-tons of opium (popularly known as heroine) was consumed in Bangladesh which originates from India, the leading consumer of opium (UNODC, 2010). In addition to the general male population, the young men in urban slums were also vulnerable in taking illicit drugs due to rapid urbanization, overcrowded and stressful living conditions, unhealthy lifestyles, lack of health knowledge, loneliness and failure to integrate into the social network and new environment (Dragano et al., 2009; Khan et al., 2009; Khan & Kraemer, 2008; Pearce et al., 2008; Reijneveld, 1998).

TC has long been recognized as a "gateway drug" to other illicit substances, which harm both psychosocially and pharmacologically (Fleming et al., 1989; Kandel & Yamaguchi, 1993), particularly in individuals with attention-deficit or hyperactivity disorder (Biederman et al., 2006). Although numerous studies had already been conducted in developed countries to examine the association between TC and IDU, such studies are scarce for Bangladesh. Most of the studies conducted on Bangladesh so far dealt with micro-level data. Because of the lack of national-level data on TC and IDU, little is known about the vulnerability of these issues. Therefore, this chapter examines the association between TC and IDU among males in Bangladesh. **Section 6.2** describes the data sources, variables and methods of analysis. **Section 6.3** discusses the results for the general male population while **Section 6.4** explores the results for the urban slum male population. Finally, **Section 6.5** compares the findings on the general male population and the urban slum male population and provides some concluding remarks.

6.2 Data, Variables and Methods of Analysis

The data for TC and IDU among males aged 15-54 years from the general population and males aged 15-24 years from the urban slum population were obtained from Bangladesh Demographic and Health Survey (BDHS) and Bangladesh Urban Health Survey (BUHS), respectively. A brief description of the data collection method, sampling procedure, questionnaires and relevant information was given in **Chapter 3,** Sections 3.5 and 3.6.

For males from the general population, a number of variables from the large dataset of BDHS namely respondent's age, education, occupation, place of residence, exposure to mass media (print and electronics), pre-marital engagement in sex, wealth index, incidence of sexually transmitted infections (STIs), TC in different forms and IDU were included in the analysis. Besides, for males from the urban slum population (BUHS), age, marital status, level of education, religion, working status, duration of living in the slums, whether the respondent has any symptoms of STIs, access to television, monthly income and the wealth index were used as predictors. It should be mentioned that the selection of variables for TC and IDU study was guided by the relevant literature as discussed in **Chapter 2,** Section 2.3.5 and the conceptual framework in **Chapter 3,** Figure 3.8. The questions related to the variables on TC and IDU and their coding for analysis are presented in **Appendices C1** and **C2**.

6.3 The Results for the General Male Population Aged 15-54 Years

6.3.1 Basic Information about Respondents

Frequency runs were generated to compute the basic information of the respondents (**Table 6.1**). About 33% of the respondents were in the age group of 35-44 years, and more or less similar proportions (about 29%) were from 25-34 and 45-54 years, respectively. The average age of the respondents was about 38 years. About 31% of the respondents had no formal education and one third had primary level of education. Only 12% respondents had education of college and higher degree. Majority of the respondents (about 77.3%) were rural residents. About 53% of the respondents were exposed to mass media of some form (print and electronic media). About 17% of the respondents reported their involvement in sex before marriage. It was found the respondents were equally distributed across the five quintiles of the wealth index. About 98% of the respondents reported that they did not have sexually transmitted infections (STIs) during the survey. Occupational status showed that about 68% of the respondents were involved in farming, worked as labors or as semi-skilled workers. In addition, 22%

reported their involvement in business (small and large). However, only 2.3% mentioned their status as unemployed.

Table 6.1: Basic Information about the Male Respondents Aged 15-54 Years

Basic information	n*	%
Age in years		
15-24	310	8.22
25-34	1093	28.98
35-44	1241	32.91
45-54	1127	29.89
Education		
No Education	1157	30.68
Primary (5 years of schooling)	1237	32.80
Secondary (10 years of schooling)	917	24.32
College and higher (> 10 years)	460	12.20
Place of residence		
Urban	857	22.73
Rural	2913	77.27
Exposure to mass media‡		
No media	1763	46.75
Any media	2008	53.25
Pre-marital sex		
Yes	651	17.28
No	3116	82.72
Wealth index[a]		
Poorest (1st quintile)	709	18.81
Poor (2nd quintile)	777	20.61
Average (3rd quintile)	777	20.61
Rich (4th quintile)	748	19.84
Richest (5th quintile)	759	20.13
Any STIs		
No	3710	98.59
Yes	53	1.41
Occupation		
Unemployed	87	2.31
Farmers, workers, labour, semi-skilled	2554	67.75
Business (small & large)	839	22.25
High skilled	170	4.51
Others	120	3.18
Total	3771	100

*The total is not always 3771 due to missing values; ‡ includes print and electronic media; STIs= sexually transmitted infections; [a]detailed in **Appendix C1**.

6.3.2 Patterns, Prevalence and Determinants

Frequency runs were also generated to examine patterns and prevalence of TC and IDU. About 70% of the respondents used at least one of the three tobacco products i.e., cigarettes, *bidis* and other forms of tobacco. Among the tobacco users, 78% consumed only one of the three types, 20% consumed any two of the three types and only 2% used all three types of tobacco products (**Table 6.2**).

Table 6.2: Patterns and Prevalence of TC and IDU, General Male Population

Tobacco products and illicit drugs	**Current use**		**Daily consumption**
	Number*	**%**	**Mean ±SD**
Types of TC			
Smoking cigarettes			
No	1508	40.0	
Yes	2263	60.0	5.01±7.06
Smoked in past 24 hours	1274	33.8	
None	989	43.7	
1-5 times	537	23.7	3.23±1.38
6 or more times	737	32.6	13.03±7.17
Smoking *bidis*			
No	1517	40.2	
Yes	2254	59.8	4.99±7.05
Smoked in past 24 hours	1194	31.7	
None	1059	47.0	
1-10 times	565	25.1	6.56±2.74
11 or more times	629	27.9	20.05±7.40
Uses of other tobacco†			
No	2961	78.6	
Yes	807	21.4	5.36±4.99
Number of types of tobacco (cigarette, *bidi* and others) used			
No	1127	29.9	
Yes (any of three)	2644	70.1	
If yes,			
Only one	2057	77.8	
Any two	537	20.3	
All three	47	1.8	
Types of illegal drug use††	**Number***	**%**	
Not used	3639	96.7	
Used any drug	124	3.4	
Used only 1 drug	104	83.8	
Used 2 or more drugs	20	16.1	

†chewing tobacco leaves or *sada pata or gul*, betel quid (*pan*) with tobacco or *zarda*; **††d**rug includes *Ganja*, *Charas*, Phensidyl, Pethedine, Heroin, Morphine, and Injectable drugs; *total is not always 3771 due to missing values.

The overall prevalence rates of cigarette and *bidi* use were roughly the same (about 60%, for both categories). On average, the respondents smoked five cigarettes or *bidis* a day. The prevalence rate of other forms of tobacco use (i.e., chewing tobacco leaves or *sada pata* or *gul*, betel quid (*pan masala*) with tobacco or *zarda*) was about 21%. About 33% of the male adults smoked more than six times a day with an average of 13 cigarettes per day. However, TC was found among 28% of the males who smoked *bidis* more than 11 times a day with an average of 20 *bidis* per day. About 3.4% of the respondents used illicit drugs and this proportion is statistically significant (Z=11.32, P=0.000). Among them, 84% used only one type of drug and 16% used two or more types (**Table 6.2**).

The prevalence rates of TC and IDU were also computed for selected background characteristic variables in order to identify the determinants. The significance of the determinant variables was evaluated using the Pearson's Chi-square (χ^2) test. The null hypothesis of no relationship between TC (IDU) and the independent variable is rejected if the p-value of the test statistic is less than 0.05 ($p<0.05$). In **Table 6.3**, TC was significantly related to the respondent's age ($\chi^2=68.14$, $p<0.001$). The older age groups were more likely to smoke *bidis* and other tobacco products, while the younger group had a higher tendency to smoke cigarettes. Literacy is another significant determinant ($\chi^2=227.60$, $p<0.001$). The prevalence of TC among males with no education was 1.8 times higher than those with at least college education. TC (in any form) was higher ($\chi^2=19.91$, $p<0.001$) among rural males, although cigarette smoking was significantly ($\chi^2=56.68$, $p<0.001$) higher among urban males than their rural counterpart. Other forms of tobacco and *bidi* consumption were higher ($\chi^2=177.60$, $p<0.001$) among rural inhabitants. Exposure to mass media was also a significant determinant ($\chi^2=113.78$, $p<0.001$) of TC. Besides, pre-marital engagement in sex showed a positive relationship ($\chi^2=14.52$, $p<0.001$) with all types of TC except *bidi* smoking. TC was significantly dependent on occupation ($\chi^2=100.37$, $p<0.001$) and wealth status ($\chi^2=128.91$, $p<0.001$). Cigarette smoking was more prevalent in the affluent group, whereas the poor tended to smoke *bidis* and other forms of tobacco. In sum, the significant determinants of TC were age, education, place of residence, exposure to mass media, engagement in pre-marital sex, wealth status and occupation.

Table 6.3: Chi-Squared Analysis of Prevalence of TC by Selected Background Characteristics

Background characteristic ǂ	Smoking cig (% yes)	Smoking *bidis* (% yes)	Other TC (% yes)	Any type (% yes)
Age in years	$\chi^2 = 30.8$ [a]	$\chi^2 = 60.7$ [a]	$\chi^2 = 83.6$ [a]	$\chi^2 = 68.1$ [a]
15-24	43.5	26.8	10.3	66.5
25-34	37.6	23.7	15.9	62.5
35-44	31.3	34.1	21.9	70.3
45-54	30.1	38.2	29.3	78.3
Education	$\chi^2 = 48.4$ [a]	$\chi^2 = 445.7$ [a]	$\chi^2 = 30.7$ [a]	$\chi^2 = 227.6$ [a]
No Education	26.2	50.6	24.2	81.0
Primary	36.6	34.8	24.0	74.6
Secondary	39.7	17.6	17.9	62.5
College& higher	33.5	3.7	14.4	46.2
Residence	$\chi^2 = 56.7$ [a]	$\chi^2 = 177.2$ [a]	$\chi^2 = 4.6$ [c]	$\chi^2 = 19.9$ [a]
Urban	44.5	13.1	18.8	64.0
Rural	30.6	37.1	22.2	71.9
Exposure to mass media‡	$\chi^2 = 51.1$ [a]	$\chi^2 = 292.2$ [a]	$\chi^2 = 24.1$ [a]	$\chi^2 = 113.7$ [a]
No media	27.9	45.5	24.9	78.6
Any media	38.9	19.5	18.3	62.7
Pre-marital sex	$\chi^2 = 20.9$ [a]	$\chi^2 = 1.3$	$\chi^2 = 6.1$ [a]	$\chi^2 = 14.5$ [a]
Yes	41.5	33.6	25.0	76.3
No	32.2	31.3	20.7	68.8
Wealth index[a]	$\chi^2 = 142.1$ [a]	$\chi^2 = 543.3$ [a]	$\chi^2 = 44.4$ [a]	$\chi^2 = 128.9$ [a]
Poorest	19.5	54.8	26.6	80.1
Poor	26.0	46.6	25.0	75.3
Average	38.5	31.7	23.4	73.6
Rich	40.6	21.1	17.4	66.2
Richest	43.6	5.0	15.0	55.7
Any STIs	$\chi^2 = .39$	$\chi^2 = 2.24$	$\chi^2 = 10.5$ [a]	$\chi^2 = .002$
No	33.6	31.8	21.2	70.1
Yes	37.7	22.2	39.6	69.8
Occupation	$\chi^2 = 79.6$ [a]	$\chi^2 = 192.2$ [a]	$\chi^2 = 13.3$ [b]	$\chi^2 = 100.3$ [a]
Unemployed	36.8	17.2	12.8	58.6
Farmers, workers, labour, semi-skilled	30.5	38.2	22.4	72.8
Business (small & large)	46.2	19.8	19.9	70.0
High skilled	27.1	0.0	14.8	37.6
Others	24.2	31.4	27.5	67.5

ǂ total is not always 3771 due to missing values; P (two-sided) value based on Pearson's χ^2 test; ‡includes print and electronic media; [a] p<.001; [b] p<.01; [c] p<.05, where p is the p-value; STIs= sexually transmitted infections; detailed are in **Appendix C1**.

Table 6.4 showed that the significant determinants of IDU were age (χ^2=6.56, p<0.08), education (χ^2=12.10, p<0.007), engagement in pre-marital sex (χ^2=59.56, p<0.001), wealth status (χ^2=15.08, p<0.005), incidence of STIs (χ^2=11.47, p<0.001) and occupation (χ^2=10.30, p<0.03). Some groups like those younger than 24 years old, men with no education, living in urban areas, and had pre-marital sex revealed higher prevalence of illicit drug use.

Table 6.4: Chi-Squared Analysis of Prevalence of IDU by Selected Background Characteristics

Background characteristics	n ǂ	Taking any drug†† (% yes)	Taking only one drug† (% yes)
Overall		3.41	2.86
Age in years		$\chi^2 = 6.56$*	$\chi^2 = 9.12$**
15-24	310	4.5	4.5
25-34	1093	4.1	3.5
35-44	1241	2.7	1.9
45-54	1127	2.8	2.5
Education		$\chi^2 = 12.10$***	$\chi^2 = 8.70$**
No Education	1157	4.4	3.6
Primary	1237	2.7	2.4
Secondary	917	3.6	2.9
College and higher	460	1.3	1.1
Place of residence		$\chi^2 = 0.69$	$\chi^2 = 0.310$
Urban	857	3.7	3.0
Rural	2913	3.2	2.7
Pre-marital sex		$\chi^2 = 59.56$***	$\chi^2 = 39.79$***
Yes	651	8.2	6.4
No	3116	2.3	2.0
Mass media‡		$\chi^2 = 1.84$	$\chi^2 = 2.16$
No media	1763	3.7	3.2
Any media	2008	2.9	2.4
Wealth Index[a]		$\chi^2 = 15.08$***	$\chi^2 = 11.10$***
Poorest	709	2.7	2.4
Poor	777	2.3	2.1
Average	777	4.3	3.7
Rich	748	4.9	3.9
Richest	759	2.1	1.7
Any STIs		$\chi^2 = 11.47$***	$\chi^2 = 4.99$***
No	3702	3.1	2.6
Yes	53	11.3	7.5
Occupation		$\chi^2 = 10.30$**	$\chi^2 = 12.52$**
Unemployed	87	1.1	1.1
Farmers, workers, labour, semi-skilled	2550	3.8	3.3
Business (small & large)	837	2.9	2.3
High skilled	170	1.2	0
Others	120	0	0

ǂ Total is not always 3771 due to missing values; † taking only one prominent drug; ††any type means use of any drug in last three months; p (two-sided) value based on Pearson's χ^2 test; ‡includes print and electronic media; ***p<.001; **p<.01; *p<.05, where p is the p-value; STIs= sexually transmitted infections; [a]detailed are in **Appendix C1**.

Similarly, those who had no exposure to media, from the fourth quintile (rich group) of wealth index, experienced STIs, and from the semi-skilled occupational groups were associated with higher rate of IDU (any type).

Fourteen binary logistic regressions (7 for any IDU as response variable and another 7 for main IDU as response variable) as mentioned in the analytical framework of **Chapter 3**, Figure 3.13 were used to examine the association between TC and IDU, adjusting for other variables as confounders. These factors were the significant determinants of IDU reported earlier. The analysis was performed using the model described in **Chapter 3,** Section 3.8. In the model diagnostic tests, Nagelkerke R^2 showed that the percentage of variation in the outcome variable (taking any drugs and taking a prominent type of drug) explained by the model was between 11% to 16% and 10% to 15% respectively (**Appendices C3** and **C4**). The values of Hosmer and Lemeshow (H-L) goodness-of-fit tests for all 14 models had p-values more than 5% level, suggesting that the models had good fit. In addition, the overall classification accuracy of the models was about 97%. The check of multicollinearity by different techniques such as SEs, VIF, and correlation matrix did not detect any serious problem.

The odds ratios for IDU by different types of tobacco use and the estimated 95% CI for these odd ratios were presented in **Table 6.5**. The odds ratio provides an indication of the likelihood of IDU among the tobacco consumers compared to the non-tobacco consumers, while confidence interval states the lower and upper bounds of the odds ratio. According to the multivariable analyses, the respondents who smoked cigarettes, *bidis* and used other forms of tobacco revealed 3.8, 1.8 and 2.0 times higher likelihood of using any illicit drug compared to the corresponding reference category of no TC. In addition, the respondents who used any tobacco product (cigarettes, *bidis* or any other forms of tobacco considered together) were 19.6 times more likely to use illicit drug compared to those who did not use any tobacco product. The likelihood of using any illicit drug also increased with more frequent smoking, and this was found true for any type of TC. For example, the odds ratio for those who smoked 6 cigarettes or more per day was 5.3, while the odds ratio was much lower (2.0) for those who smoked 1 to 5 cigarettes per day. The results from the logistic regressions also suggested that TC carried by far the highest association with drug use amongst all variables.

Table 6.5: AOR and 95% CI (BLRs) for IDUs by TC, Adjusting for Confounding Factors, General Males in Bangladesh

Tobacco consumption	Taking any drug †		Taking only one drug††	
	AOR	95% CI	AOR	95% CI
Smoking cigarettes				
No	1.00	-	1.00	-
Yes	3.82***	2.62-5.56	3.20***	2.14-4.77
If yes,				
1-5 times per day	1.95*	1.11-3.41	1.85*	1.03-3.34
6 or more	5.26***	3.53-7.81	4.23***	2.75-6.47
Smoking *bidis*				
No	1.00	-	1.00	-
Yes	1.76***	1.23-2.53	2.06***	1.39-3.04
If yes,				
1-10 times per day	1.40	0.85-2.31	1.56	0.91-2.68
11 or more	2.09***	1.36-3.19	2.51***	1.60-3.92
Uses of other tobacco				
No	1.00	-	1.00	-
Yes	2.01***	1.37-2.93	1.79***	1.18-2.72
If yes,				
1-5 times per day	1.52*	1.25-4.11	1.31	.90-2.53
6 or more	2.61***	2.10-5.78	2.10***	1.42-2.99
Type of tobacco used				
Not used	1.00	-	1.00	-
Used any tobacco	19.61***	5.91-65.09	21.26***	5.44-83.02

AOR= adjusted odds ratio; CI=confidence interval; †any drug means use of drugs as mentioned in footnote of Table 6.2; ††only one drug means any prominent drug; ***p<.001; **p<.01; *p<.05, where p is the p-value.

6.3.3 Discussions for TC and IDU

This study found several socio-economic, demographic, cultural and behavioral factors that were significant determinants of TC and IDU. It also identified a positive association between TC in various forms and IDU among Bangladeshi men. The study revealed a high prevalence of TC (about 70%) among Bangladeshi men aged 15-54 years. The finding is consistent with recent report on adult tobacco survey in Bangladesh (WHO, 2009). Similar to other studies (Choudhury et al., 2007; Finney-Rutten et al., 2008; Khan et al., 2006), all types of TC except cigarette smoking were more prevalent among the poor with low education and occupational status and residing in rural areas. The pattern of cigarette smoking was contradictory, which could be attributed to various factors like the mildness of cigarette, westernized lifestyles, glamour and fashion (Schaap et al., 2008). Compared with cigarette smokers, the *bidi* smokers (cheapest substitute for cigarettes) and other forms of tobacco users were socio-economically poor, characterized by low income, poor education, and rural background. The poor are more likely to consume tobacco, a behavior that is very harmful because this population group is likely to be malnourished and particularly ill-equipped to protect themselves against respiratory and other tobacco-related diseases. In addition, the poor are less able to afford health care services, which could deteriorate their overall health situation further (Choudhury et al., 2007; Kamal et al., 2010).

Consistent with other studies (Kamal et al., 2010; Khan et al., 2009), a positive association was found between health awareness gained via mass media and TC. It is very apparent that education level and health knowledge is positively related to each other and also important determinants of TC. Therefore, increasing education and awareness about the adverse health effects of tobacco should be a noteworthy policy for reducing the social and economic burden of TC in Bangladesh. Behavioral factors such as pre-marital sex were associated with TC except *bidi* smoking. The incidence of IDU in Bangladeshi men was 3.4%, which is similar to the other study (UNODC, 2010). IDU was significantly associated with socio-economic factors such as educational and occupational status, wealth index, as well as behavioural aspects namely, pre-marital sex and being infected by STI. However, urban-rural differences and mass media association were inconsistent and further studies are recommended in this regard.

The revealed positive association between TC and IDU is also found to be consistent with other studies (Chen et al., 2001; Hanna & Grant, 1999; Kamal et al., 2010; Khan et al., 2006; Mohler-Kuo et al., 2003; Padrão et al., 2011; Richter et al., 2002). Some further supporting evidence for this association is as follows. The increased frequency of cigarette smoking may be a marker for more serious patterns of illegal drug use (Bailey, 1992). Mohler-Kuo et al. (2003) reported a positive association between smoking regularly and IDU. Another study showed that regular TC was the predictor of life-time drug use (Hanna & Grant, 1999). Besides, a positive association between TC and IDU was also reported in Khan et al. (2006). Chen et al. (2001) found that the use of illicit drugs was 6.4 times greater among tobacco users than non-users. In addition, there is evidence that cannabis use during teenage and young adulthood is associated with an increased risk of TC and nicotine dependence (Patton et al., 2005). Moreover, life-time smoking was linked significantly to alcohol, cannabis, hard drug and multiple drug use disorders, which was reported by Lewinsohn et al. (1999). Padrão et al. (2011) also reported a positive association between TC and alcohol use. TC and IDU were found to be positively associated among Bangladeshi males. Therefore, tobacco and drug control strategies along with existing policies should be implemented to reduce their use. At the same time, the positive association between TC and IDU would also imply that any of such policies and strategies will serve as a two-pronged approach.

6.4 The Results for the Urban Slum Male Population Aged 15-24 Years

6.4.1 Basic Information about Respondents

Frequency runs were generated to compute the basic information of the respondents aged 15-24 who stayed in urban slums (**Table 6.6**). More than 70% of the respondents were in the age group of 20-24 years, and about 30% of them aged 15-19 years. Less than one third (31%) of the respondents were ever married (currently married, divorced or widowed). Most of the respondents attained either primary (33%) or secondary (40%) education.

Table 6.6: Basic Information about Respondents of Urban Slum Population

Basic information	**N**	**%**
Age in years		
15-19	454	28.8
20-24	1122	71.2
Marital status		
Ever married [#]	483	30.6
Never married	1093	69.4
Level of education		
No education	276	17.5
Primary (5 years of schooling)	513	32.5
Secondary (10 years of schooling)	625	39.6
Higher [*] **(**> 10 years of schooling)	162	10.3
Religion		
Islam	1500	95.2
Others	75	4.8
Currently working		
No	185	11.7
Yes	1391	88.3
Duration in slums (in years)		
<5	353	22.4
5-9	304	19.3
10-<24	273	17.4
Permanent	645	41.0
Any STIs		
No	1508	95.7
Yes	68	4.3
TV watching		
No	84	5.3
Yes	1492	94.7
Monthly income (BDT) [¶]		
None	478	30.3
<5000	1021	64.8
5000+	76	4.8
Wealth index/quintiles [**]		
Poorest (1^{st} quintile)	497	31.6
Poor (2^{nd} quintile)	419	26.6
Middle (3^{rd} quintile)	351	22.3
Rich (4^{th} quintile)	226	14.3
Richest (5^{th} quintile)	82	5.2
Total	1576	100.0

[#]currently married or married at least once; ***** at least 11 years of education; [¶] Bangladeshi Taka and exchange rate is 78.11 BDT/USD; ******quintiles based on principal component analysis (**Appendix C1**); STIs= sexually transmitted infections.

About one-fifth (18%) did not have any formal education, whereas 10% had post-secondary education. More than 95% of the respondents were Muslims. Majority of these youths (88%) were currently working. About two-fifth (41%) had resided in the slum areas permanently while only 22% were living in slums for less than 5 years. Slightly over 4% of the male youths in the slums reported symptoms of STIs. Almost all (95%) had access to television. Some 30% of the youths had no income and 65% had a monthly income of less than BDT 5000.00. In terms of wealth index, more than 58% were from the bottom 40% poorest groups while only 19% were from the top 40% richest groups.

6.4.2 Patterns, Prevalence and Determinants

Table 6.7: Patterns and Prevalence of TC and IDU, Urban Slum Population

Tobacco/drug Use	N	%	Mean ± SD
Smoking cigarettes #			
No	923	58.6	-
Yes	653	41.4	8.3±5.7
If yes			
1-5 per day	264	40.4	3.7±1.3
6-10 per day	268	41.0	8.5±1.6
10+ per day	121	18.6	18.2±5.0
Smoking *bidis* #			
No	1527	96.9	-
Yes	49	3.1	10.9±10.5
If yes			
1-5 per day	22	44.4	3.8±1.4
6-10 per day	12	25.3	8.8±1.7
10+ per day	15	30.2	23.2±12.5
Smoking cigarettes/*bidis* #			
No	910	57.7	-
Any one	630	40.0	-
Both	36	2.3	-
Illicit drugs taken in last one month before the survey ¶			
Ganja (marijuana)	44	2.8	-
Phensidle *	6	0.4	-
Heroin	3	0.2	-
Tari**	15	1.6	-
Injected any drugs***	51	3.2	-
Others ǂ	24	0.9	-
Total	143	9.1	-

Total respondents for tobacco smoking is 1576 and for ¶ IDU is 143; * a cough syrup containing codeine; ** locally made palm wine; *** injected drugs mainly pethedine, or morphine; ǂ charas (hashis); SD=standard deviation.

Frequency runs were also generated for patterns and prevalence of TC and IDU. The current smoking prevalence among the respondents was 42.3%, with the rate of smoking cigarettes at 41.4% and *bidis* at 3.1% (**Table 6.7**). The average daily consumption of cigarettes and *bidis* were about 8 and 11 sticks respectively. Of those smoking, about 60% of the young male slum dwellers smoked at least 6 sticks of cigarettes daily. Close to one fifth (18.6%) of them smoked an average of 18 cigarettes per day. Some 56% of the *bidi* users consumed at least 6 sticks per day, and 30% of them had an average daily intake of 23 sticks. About 9.1% of the youths were involved in IDU. This IDU rate was a lot higher than the rate found for the general male population. The main source of drug abuse was injectable drugs (3.2%). The other more serious cases involved the use of ganja (2.8%) and *tari* (1.6%).

The prevalence rates of TC and IDU were computed for selected background characteristic variables in order to identify the determinants (**Table 6.8**). The significance of the determinant variables was evaluated using the Pearson's chi-square (χ^2) test. The null hypothesis of no relationship between TC (IDU) and the independent variable is rejected if the p-value of the test statistic is less than 0.05 ($P<0.05$). The variables that were significantly ($p<0.001$) associated with cigarette and *bidi* smoking among young men in urban slums include age, marital status, education, current working status, whether they have symptoms of any STIs, and wealth index. Although duration of living in slums was not associated with *bidi* smoking, it has a significant impact ($p<0.001$) on those who smoked cigarettes. Those who dwelled in the slums for a longer period had a higher tendency to be cigarette users. Income was significantly associated ($p<0.001$) with only *bidi* smoking but did not affect the behavior of cigarette smokers (**Table 6.8)**. The significant determinants of IDU include age, marital status, education, duration of stay in slums, and whether the respondents had symptoms of STIs ($p<0.001$). As is the case for TC, those with better educational attainment were less likely to be involved in IDU. The prevalence of IDU was higher among the migrants who stayed in the slums for a longer period and those with symptoms of STIs.

Table 6.8: Chi-Squared Analysis of Prevalence of TC and IDU by Selected Background Characteristics, Young Urban Slum Population, Bangladesh

Background characteristics	**Currently smoking (% yes)**			**(% yes)**
	Cigarettes	***Bidis***	**Cigarett/*Bidis***	**IDU**
Age in years	χ^2 =11.6 [a]	χ^2 =3.8 [a]	χ^2 =14.3 [a]	χ^2 =3.9 [a]
15-19	34.8	1.7	34.9	6.8
20-24	44.1	3.7	45.2	10.0
Marital status	χ^2 =58.4 [a]	χ^2 =32.1 [a]	χ^2 =67.4 [a]	χ^2 =10.7 [a]
Ever married	55.7	6.8	57.6	12.6
Never married	35.1	1.5	35.5	7.5
Level of education	χ^2 =78.0 [a]	$\chi^2$53.2 [a]	$\chi^2$91.0 [a]	$\chi^2$15.8 [a]
No education	59.9	9.7	63.1	13.6
Primary	44.9	2.8	45.4	10.2
Secondary	35.7	1.3	36.0	7.7
Higher	21.2	.0	21.2	2.8
Religion	χ^2 =0.9	χ^2 =0.05	χ^2 =0.77	χ^2 =0.10
Islam	41.7	3.1	42.5	9.1
Others	36.3	2.9	37.8	8.5
Currently working	χ^2 =10.8 [a]	χ^2 =6.7 [a]	χ^2 =12.4 [a]	χ^2 =2.4
No	30.2	0.00	30.2	6.1
Yes	42.9	3.5	43.9	9.5
Duration in slums	χ^2 =12.8 [a]	χ^2 =1.8	χ^2 =13.1 [a]	χ^2 =24.9 [a]
<5	33.3	2.5	34.2	4.2
5-9	44.4	4.3	46.2	7.3
10-<24	44.6	2.9	46.1	15.5
Permanent	43.2	2.9	43.2	9.9
Any STIs	χ^2 =7.4 [a]	χ^2 =7.9 [a]	χ^2 =9.5 [a]	χ^2 =6.6 [a]
No	40.7	2.8	41.5	8.7
Yes	57.3	9.1	60.1	17.8
TV watching	1.4	0.1	1.05	1.0
No	47.6	3.5	47.6	6.3
Yes	41.1	3.1	42.0	9.2
Monthly income (BDT)	χ^2 =2.3	χ^2 =13.9 [a]	χ^2 =3.1	χ^2 =0.7
None	39.7	0.9	39.8	9.3
<5000	41.7	4.3	42.8	8.8
5000+	48.8	1.6	50.3	11.2
Wealth index	χ^2 =20.2 [a]	χ^2 =27.5 [a]	χ^2 =26.0 [a]	χ^2 =4.8
Poorest (1st quintile)	46.1	6.2	48.7	9.7
Poorer (2nd quintile)	46.2	1.0	46.2	10.5
Middle (3rd quintile)	35.4	3.0	35.4	6.1
Richer (4th quintile)	35.7	1.5	35.7	9.8
Richest (5th quintile)	30.4	.0	30.4	8.3
Total	41.4	3.1	42.3	9.1

Figures in the first row of every independent variable are the chi-squared statistics for the tests of association; [a] p<0.001; [b] p<0.01; [c] p<0.05, where p is the p-value; STIs= sexually transmitted infections.

Pearson's Chi-square (χ^2) test was also used to examine the bivariate association between TC and IDU (**Table 6.9**). It must also be noted that IDU was highly associated (p<0.001) with TC. The rate of IDU among those who smoked was about 9 times higher (18.5%) than those who were not tobacco users (2.1%). Notably, the prevalence of IDU was higher among those who were heavy cigarette smokers. For instance, the IDU rate was 33.9% among those who smoked more than 10 cigarettes per day, compared to 20.7% among those who smoked 6-10 cigarettes per day, and 9.6% among those who smoked 1-5 cigarettes per day.

Table 6.9: Bivariate Association between TC and IDU, Urban Slum Population

Tobacco consumption	**IDU (% yes)**
Smoking cigarettes/*bidis*	χ^2 =127.2***
No	2.1
Yes	18.5
Number of cigarettes smoked per day	$\chi^2$148.3***
None	3.8
1-5	9.6
6-10	20.7
10+	33.9
Number of *bidis* smoked per day	$\chi^2$58.2***
None	8.2
1-5	32.7
6-10	60.3
10+	27.1
Total	9.1

Figures in the first row of every independent variable are the Chi-squared statistics for the tests of association; ***p<.001; **p<.01; *p<.05, where p is the p-value.

To examine the influencing factors of TC and IDU, two multivariable binary logistic regressions (details are in **Chapter 3,** Section 3.8**)** were estimated separately, one for cigarette or *bidi* smoking and another one for any illicit drug use by background characteristics. In the model diagnostic tests, Nagelkerke R^2 shows the percentage of variation in the outcome variable of tobacco smoking and taking any illicit drugs explained by the model was 12% and 13% respectively (**Appendix C5**). The Hosmer and Lemeshow (H-L) goodness of fit test (p>0.05) showed that the models have good fit. In addition, the overall classification accuracy of two models showed that about 80%

of the cases were correctly classified by the models. The check of multicollinearity by different techniques such as SEs, VIF, and correlation matrix indicated no serious multicollinearity problem was detected among the independent variables.

It was revealed that the older males were more likely (OR=1.32; 95% CI=1.04-1.69) to smoke tobacco than their younger counterparts (**Table 6.10**). Youths who were ever married had almost two times higher likelihood of TC than those who were not married. Illiteracy was associated with five-time higher likelihood of TC than those with at least 11 years of education. The odds ratio reduced to 2.7 for those with primary education and 1.95 for secondary education. All migrants to the slum areas were 1.4-1.6 times more likely to be smoker compared to those who stayed in the slums permanently. Male youths who reported having STI symptoms were at increased risk (OR=2.13, 95% CI=1.27-3.57) of TC.

Table 6.10: OR and 95% CI (BLRs) for TC and IDU by Background Characteristics, Young Urban Slum Population, Bangladesh

Background characteristics	Smoking cigarette/*bidi*		Use of any illicit drugs	
	OR	95% CI	OR	95% CI
Age in years				
20-24	1.32[b]	1.04-1.69	ns	-
15-19	1.00	-	ns	-
Marital status				
Ever married	1.92[a]	1.51-2.44	ns	-
Never married	1.00	-	ns	-
Level of education				
No education	5.00[a]	3.13-7.98	2.28[d]	0.82-6.39
Primary	2.71[a]	1.76-4.15	2.42[c]	0.89-6.61
Secondary	1.95[a]	1.29-2.97	2.19[d]	0.80-5.97
Higher	1.00	-	1.00	-
Duration in slums (years)				
<5	1.45[c]	1.04-2.01	0.44[b]	0.24-0.80
5-9	1.27[c]	0.90-1.79	0.61[c]	0.36-1.03
10-<24	1.62[a]	1.22-2.15	1.58[c]	1.01-2.48
Permanent	1.00	-	1.00	-
Any STIs				
Yes	2.13[b]	1.27-3.57	1.74[d]	0.87-3.50
No	1.00	-	1.00	-

OR=odds ratis, CI=confidence interval, [a] $p<0.001$, [b] $p<0.01$, [c] $p<0.05$, and [d] $p<0.10$, ns=not significant, STIs= sexually transmitted infections; BLRs=Binary Logistic Regressions.

Those with less education were at least twice more likely to use illicit drugs compared to the youths with at least 11 years of education. However, the difference between the three categories of education (no education, primary and secondary) was not as clear as for TC. While the migrants who stayed in the slums for less than 10 years had a lower tendency of IDU than the youths who lived there permanently, the highest likelihood of IDU was among the migrants who lived there for at least 10 years. Tendency to be illicit drug users was also higher among those who had symptoms of STIs.

In addition, 3 logistic regressions with any IDU as response variable were used to examine the association between TC and IDU, controlling for other variables as confounders (detailed analytical framework is in **Chapter 3**, Figure 3.14). From the model diagnostic test results, Nagelkerke R^2 shows that the percentage of variation in the outcome variable (taking any drugs) explained was 21%, 20% and 11% for the models with the explanatory variable of tobacco smoking (yes/no), number of cigarettes smoked per day, and number of *bidis* smoked per day, respectively. The Hosmer and Lemeshow (H-L) goodness-of-fit tests indicated that all 3 models ($p>0.05$) had good fit. In addition, the overall classification accuracy showed that about 91% of the cases were correctly classified by the models (**Appendix C6**).

The odds ratios and their 95% CI for IDU in relation to TC are plotted in **Figure 6.1**. The results indicated that the respondents who smoked tobacco (cigarettes or *bidis)* revealed 9.6 times higher likelihood of using any illicit drugs compared to the non-tobacco users. The odds ratio increased with the number of cigarettes smoked daily. Those who smoked 5 cigarettes or less per day were between two to three times more likely to use illicit drugs compared to non-tobacco users, but the likelihood for those who smoked 10 or more cigarettes per day increased to 12 times higher. The risk of IDU for *bidi* smokers could be up to 12 times higher than the youths who do not smoke *bidis* depending on the amount of daily *bidi* consumption.

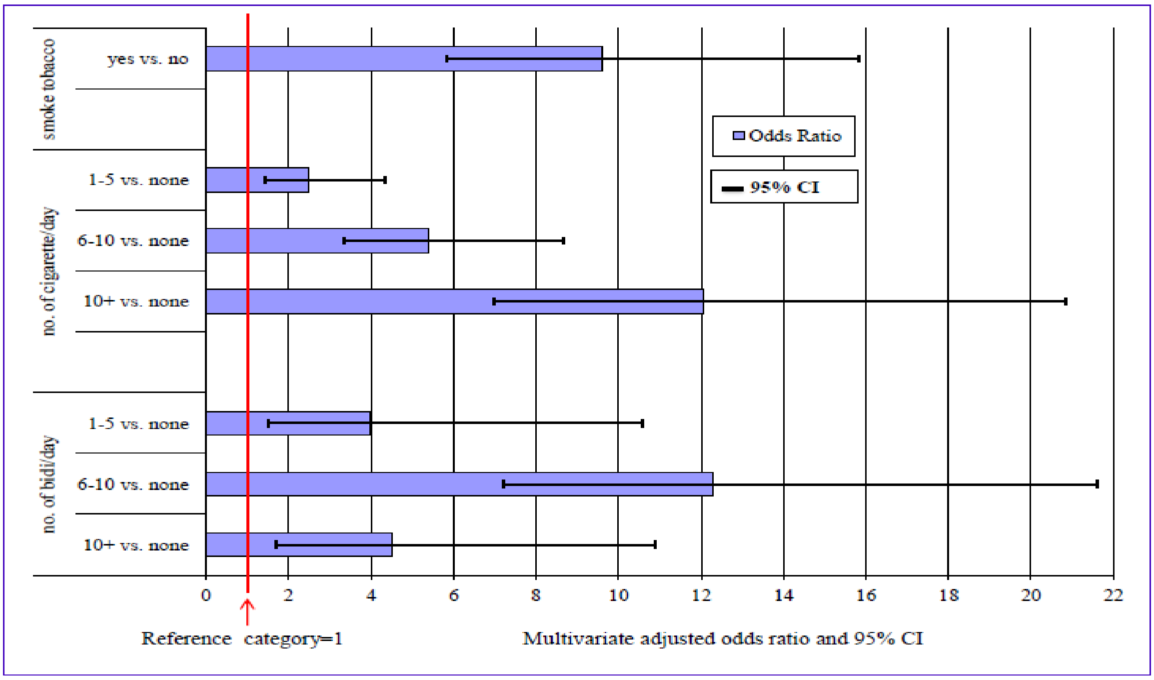

Figure 6.1: OR and 95% CI (BLRs) of IDU for TCs and Number of Cigarettes/*Bidis* Used Per Day, Adjusted for Confounding Factors, Young Slum Population, Bangladesh

6.4.3 Discussions for TC and IDU

The study revealed that about two-fifth (42.3%) of the young men aged 15-24 living in urban slums of Bangladesh were tobacco smokers. This prevalence is much higher when compared with youths of the population in Bangladesh (9.1%) and other neighboring countries such as India (16.8%), Nepal (13.0%), Sri Lanka (12.4%), Maldives (8.5%), Pakistan (12.4%) and Myanmar (22.5%) (WHO, 2011). It was also found that the male youths in slums were more likely to use cigarettes than *bidis*, which could be associated with urban culture, working status and availability of tobacco products (Khan et al., 2009). Like the higher prevalence of TC among urban slum youths, the rate of IDU (9.1%) was also 2.6 times higher than the rate (3.4%) for the youths in Bangladesh (Kabir et al., 2012; Khan et al., 2006; NIPORT, 2009; UNODC, 2010). A higher level of risky behaviors in deprived or overcrowded areas was also reported in other studies (Dragano et al., 2009; Khan et al., 2009; Kleinschmidt et al., 1995; Pearce et al., 2008; Reijneveld, 1998). Unhealthy lifestyles in adverse socio-economic conditions, weak social norms and cultural beliefs, undesirable neighborhood characters, availability of tobacco products, and lack of preventive services in the deprived areas may have significant influence on individuals' behaviors (Dragano et al., 2009; Duncan et al., 1999).

Several demographic, socioeconomic and behavioral factors are identified as significant determinants of both TC and IDU among young men in urban slums. For instance, among the youths, significantly higher prevalence of TC and IDU was found among those aged 20-24 years, which are consistent with the findings of other studies in Bangladesh and elsewhere (Chen et al., 2001; Kabir et al., 2012; Kamal et al., 2011; Khan et al., 2009; Khan et al., 2006; Subramanian et al., 2004). This may be partially attributed to the traditional and cultural norms in Bangladesh and stress related issues. In the prevailing cultural norms of the Bangladeshi society, TC among youths is discouraged by elders and family members. TC by any younger members in the presence of older people is viewed as indecent and intolerable. IDU is totally prohibited in Bangladesh. In line with other studies (Gupta, 1996; Kabir et al., 2012; Sorensen et al., 2005), TC and IDU revealed a strong inverse association with level of education. The likelihoods of TC and IDU were found to be approximately five and two times higher among male youths with no formal education and completion of primary schooling, respectively, compared to those with post-secondary education. The finding suggests that improvement of education could be an important strategy for reducing both TC and IDU in urban slums. The health behavior model of stress indicates that populations under stress generally engage in health detrimental behaviors, particularly in the context of low social status (Ensel et al., 1996). Based on this model, a study revealed that stressful conditions in slums (Khan et al., 2009) may lead to an increased risk of smoking and illicit drug use (Dell et al., 2005; Fisher et al., 2005; Shankle, 2006; Volzke et al., 2006), which is also evident from the higher prevalence of such risky behaviors among the slum youths compared to the youths in the country.

Consistent with the health behavior model of stress (Ensel et al., 1996) and other empirical studies (Khan et al., 2009), the likelihood of TC among youths in new settlements (like slums) is significantly ($p<0.001$) higher than the youths who lived in the same places since birth. While the likelihood of IDU was higher among the young male migrants who had settled in the slums for a long period of time, the likelihood among the recent migrants (duration less than 10 years) is lower. This may be partly attributed to the social network and environmental factors. Similarly, the higher rates of TC and IDU among the youths having symptoms of STIs could be outcomes of their risky lifestyles in poorly managed living conditions (Kamal et al., 2011; Khan et al., 2006). This study found a significant ($p<0.001$) positive association between TC and IDU which was consistent with other studies (Algotar et al., 2011; Kamal et al., 2010; Khan et al., 2006; Padrao et al., 2011). Other empirical evidence also supported the relationship between TC and IDU. For example, regular use of tobacco was the predictor of life-time drug use (Hanna & Grant, 1999; Mohler-Kuo et al., 2003). This study showed that the likelihood of IDU was more than 9 times higher among slum youths who smoked regularly. In line with other studies (Bailey, 1992; Kamal et al., 2010; Khan et al., 2006), the likelihood of IDU of any form increased with more frequent cigarette smoking. Although the likelihood of IDU increased with *bidi* smoking, but its relationship with the consumption rate of *bidis* is not as clear as that for cigarette smoking.

6.5 Concluding Remarks

In Bangladesh, about 42% of the males aged 15-24 living in urban slums were tobacco smokers. It is much higher when compared with the youths of the general population in Bangladesh and other neighboring countries such as, India, Nepal, Sri Lanka, Maldives, Pakistan and Myanmar. However, the prevalence of TC among the males of general population aged 15-54 years was about 70% which is much higher than the young males aged 15-24 living in urban slums (42%). It was found that the prevalence of IDU among males in urban slums was 2.6 times higher than the general male population. The ORs for TC and IDU were remarkably higher among the males in slums than the general male population when controlled for confounding variables including socio-economic and behavioral factors. Therefore, the risks of TC and IDU were remarkably higher among slum male youths.

Although the findings were not directly comparable, some studies found higher prevalence of TC among migrants than non-migrants (Lu, 2010a; Yang et al., 2009). Based on these studies, the higher prevalence of TC and IDU among slum youths may be related to rural-to-urban migration. Generally migrants are distinct and unprivileged group in cities, and mainly employed in low-paying and hazardous jobs (Yang et al., 2009). Migration may disrupt social support and network system and the migrants face a higher level of stress as they need to cope with new living conditions, social and cultural contexts and intense competitions (Lu, 2010a). Briefly, isolation from home and the lack of social support, pace of city life along with unstable living and employment conditions may induce a high level of stress among migrants, which ultimately increases the likelihood of TC (Chen et al., 2004; Lu, 2010a; Yang et al., 2009). Some smokers also perceive smoking as a coping strategy to reduce stress, anxiety, sadness and anger (Chen et al., 2004). Slums in rapidly urbanizing countries are generally featured by poor housing, overcrowding, poor environmental and healthcare services, and other risk factors related to unhealthy lifestyles (Jahan, 2012; Khan, 2012). In Bangladesh, about 40% of the urban populations are slum dwellers, mostly migrants from rural areas. Rural-based push factors as well as urban-based pull factors lead to migration to urban areas particularly among the youths and adults (Jahan, 2012). The uncontrolled growth of slums put enormous strains on the urban infrastructure and environmental sustainability, thereby influencing the health of slum population in general and slum male youths in particular (Jahan, 2012; Khan, 2012; Lu, 2010a).

In conclusion, TC among young men living in urban slums is high compared to other youths in Bangladesh and other neighboring countries. Moreover, TC was found to be positively associated with IDU. Of all the predictors of IDU, TC revealed the strongest association with IDU. Since both tobacco and illicit drug use are perilous in all aspects and young people from poor families in slums are more likely to be vulnerable, comprehensive control strategies should be implemented to overcome these problems.

CHAPTER 7: CONCLUSION

7.1 Summary of the Study

This study analysed the data from four nationally representative surveys, namely, Global Youth Tobacco Survey (GYTS) for Bangladesh, Nepal and Sri Lanka; Global Adult Tobacco Survey (GATS) for Bangladesh and India; Bangladesh Demographic and Health Survey (BDHS), and Bangladesh Urban Health Survey (BUHS). The theoretical, conceptual and analytical frameworks along with empirical evidence in the literature were used as guidance throughout the study for choosing tools and techniques for analysis. TC, ETS exposure at different settings, and IDU were the three main focus of this study. Demographic and socioeconomic variables of youths and adults; environmental, motivating, and programmatic predictors of youth TC; knowledge, attitude, and perceptions (KAP) about the consequences of TC and health knowledge about ETS, attitude towards ETS and perception of smoking restrictions among adults; mass media exposure and behavioural factors of males on IDU were studied. Univariate, bivariate, multivariate (binary, ordinal, multinomial logistic regressions, and classification and regression tree) analyses were used to examine these issues. Moreover, diamond-shaped equiponderant graphs for ETS were also employed in this study. This concluding chapter provides a brief summary of the findings, policy recommendations, and the strength and limitations of the study. In addition, it also explains the contributions of the study and provides suggestions for future research.

Majority of the respondents in the GYTS surveys were 14 years old and slightly more females than males were involved. About 50% of the sampled youths from Bangladesh and Nepal reported that at least one of their parents was a tobacco user. The corresponding figure for Sri Lanka was about 30%. TC among friends was lower in Sri

Lanka (16%) and higher in Nepal (27%). About 35% of the youths from the three countries had experienced either family members or visitors smoking at home in their presence. Higher exposure to smoking at other places was reported (66%) by the Sri Lankan youths. The Sri Lankan youths were less exposed to advertisements on hoarding, and in bus-stops and railway stations. They were also exposed to more teaching in schools about the danger of smoking and health than the youths from the other two countries. The overall prevalence of youth TC in the three selected countries was below 10% with significantly higher rates among the males. Various tobacco products, whether smoked, smokeless or both were popular among the youths in the three countries. Gender, smoking history of parents and friends, exposure to smoking at home and public places, and availability of free tobacco products were significantly associated with TC in the three countries. Other factors, such as exposure to advertisements on tobacco products, and discussion of smoking hazards in school curricula were associated with youth TC in at least one of the three countries. Youths from the older age groups had a higher tendency of tobacco use in all the three countries. Likewise, the likelihood of TC was also significantly higher (1.3 to 2.1) among the males than females. Parental TC showed less effect on the TC behaviour among youths compared to peers influence. TC among friends and peers increased the likelihood of TC by at least two times for Bangladesh and Sri Lanka but about 4 times in Nepal. The likelihood of youths who were exposed to smoking at home to be involved in TC was at least two times higher, and the impact was higher among the Sri Lankan youths compared to the youths from the other two countries. Exposure to smoking in public places also increased the likelihood of TC in all the three countries, and the impact was higher among the Bangladeshi and Nepalese youths. The provision of free tobacco products by vendors led to 3 times and 2.6 times higher likelihood to influence TC behaviour among the Bangladeshi and Sri Lankan youths respectively.

Teaching in schools about the danger of smoking and its association with health in school curriculum had reduced the likelihood of TC.

More than 40% of the respondents in Bangladesh and India were 25-44 years old with almost similar proportion of males and females in the sample for the GATS survey. Majority of the adults (more than 70%) resided in rural areas and about one third have no formal education. One in four adults was from a poor household. Some 90% adults from both countries have good to high KAP towards the consequences of TC with an average score of 11.2 (out of 13 for Bangladesh) and 3.76 (out of 5 for India). Anti-tobacco information (ATI) score showed that about one the third of the adults had no knowledge of such information. Pro-tobacco information (PTI) score revealed that about 40% of the adults in Bangladesh and 65% in India had zero score. TC was still high showing 43% of the Bangladeshi and approximately 35% of the Indian adults were currently consuming at least one tobacco product (either smoking cigarettes/*bidis* or using any smokeless tobacco products). Several socio-demographic factors significantly influenced the TC behaviours. For instance, the older age groups compared to those younger, the males compared to females, the rural residents compared to their urban counterparts were more likely to be tobacco users. In addition, adults with low level of education, and from poor households had significantly higher risk of TC. For Bangladesh and India, the respondent's age, gender, education, wealth status, residence, family size, and anti-tobacco information (ATI) score were significantly associated with knowledge, attitude and perception (KAP) towards the consequences of TC. TC was greatly influenced by the level of knowledge of ill effects of tobacco products, individual's attitude and perception about social acceptance of smoking. A high level of knowledge was associated with a higher level of educational attainment. Knowledge of diseases related to TC significantly influenced the behaviors (Hammond et al., 2006; Nsereko et al., 2008; WHO, 2009). It was found that the respondents who did not smoke at all or smoked less than once daily had higher likelihood of high KAP compared to those who smoked daily for Bangladesh and India. More or less similar patterns were revealed for smokeless tobacco (SLT) users for both countries with some country specific variations. Education level was strongly associated with knowledge and attitude scores, and both knowledge and attitude were associated with TC practices. Therefore, increasing knowledge through education about the harmful effects of tobacco and changing attitude and behaviors through counseling programs could be good interventions to control tobacco use.

The classification and regression tree (CART), a data mining technique, was used to characterize smoking patterns among adults in Bangladesh and India. The CART algorithm was utilized to build a tree model to classify "average number of cigarettes and *bidis* smoked per day". Gender, place of residence, highest level of education, wealth index, age when first started smoking cigarettes/*bidis*, knowledge on serious illnesses related to smoking, advertisements of cigarettes/*bidis* at points of sale, and health warning labels on cigarette/*bidi* packets were used as predictors in the CART model. The CART algorithm excluded any variables that did not make any significant contributions to the final model for classifying the smoking behaviours. Age of tobacco use initiation, gender, wealth status, place of residence, level of education, and warnings printed on packets were found to be important classifying variables. The efficiency of CART model and other techniques such as CHAID, QUEST, binary and multinomial logistic regressions were tested separately based on overall classification accuracy. It was apparent that the CART model yielded higher classification accuracy than other data mining techniques such as CHAID and QUEST. The CART model also yielded higher classification accuracy than the binary and multinomial logistic regressions. Other advantages of CART are that it can efficiently accommodate any non-normally distributed variables, and a mixture of continuous and categorical variables, and CART does not require any distributional assumptions.

The extent of ETS exposure among adults at home depended on their age. The respondents aged 45 years and above from Bangladesh and India had significantly lower chance of ETS exposure at home. It was found that females had lower likelihood to be exposed to ETS than the males in Bangladesh and India. In both countries, larger family size significantly increased the chance to be exposed to ETS at home and this might be due to more smokers in the household. Place of residence showed significant impact on ETS exposure. The rural respondents were more likely to be exposed to ETS than those who resided in urban areas and this may also be related to knowledge gap. In Bangladesh and India, those who received less education had higher rates of smoking and thus a higher likelihood of exposure to ETS. Smoking and thus ETS exposure was also more prevalent among those poorer in Bangladesh. However, the contrary was true in India where those with better wealth status had higher likelihood of being exposed to ETS at home. Mixed results were found in Bangladesh and India where the impact of general and specific health knowledge about ETS was concerned. For example, Bangladeshi adults with some or good knowledge were less likely to be exposed to ETS at home compared with those without such knowledge. In contrast, the Indian adults with some or good knowledge had higher prevalence of ETS exposure at home. The results seemed to suggest that the adults in Bangladesh with knowledge of ETS were aware of its hazards and avoided exposure to ETS. On the other hand, the Indian adults without such knowledge also had low level of awareness of ETS exposure. In both countries, correct attitude towards ETS at home had supported smoke-free homes and significantly lowered the exposure level.

Like ETS exposure at home, adults were also exposed to ETS at workplaces where they worked. The Bangladeshi and Indian adults aged 25-44 years were more likely to be exposed to ETS at workplaces than those aged 15-24 years. In both countries, the females had lower likelihood to be exposed to ETS at workplaces than their male counterparts. The urban-rural differentials in exposure level at workplaces were not noticeable in both countries. Consistent with some findings, this study showed that the respondents with higher education had significantly lower chance of ETS exposure at workplaces. It was found that the wealthier Bangladeshi adults had higher likelihood to be exposed to ETS at workplaces. The same wealth impact was not found for India. General and specific health knowledge on ETS had significantly influenced the exposure to ETS at workplaces in both countries. An inverse association was found between knowledge about the adverse effects of ETS and the exposure to ETS at workplaces. In both countries, correct attitude towards ETS at home had also lowered the likelihood to be exposed to ETS at workplaces. In addition, correct attitude towards ETS at workplaces also significantly lowered the exposure level for Bangladesh and India.

In both countries, the adults aged 45 years and above and the females were less likely to be exposed to ETS at public places. The respondents with higher education level had higher likelihood of being exposed to ETS at public places. While this group of the population could take steps to reduce exposure to ETS at home and workplaces, they had less control on exposure to ETS at public places. This study showed that for the Bangladeshi and Indian communities, general and specific health knowledge on ETS exposure significantly influenced the exposure to ETS in public places. Those with good knowledge about the adverse effects of ETS are more responsive to avoid ETS exposure than their counterparts with no knowledge at all. A positive association was found between tobacco consumption (smoked and smokeless tobacco products) and exposure to ETS in different settings. The findings from this study highlight the importance of equitable public health initiatives to educate all factions of the population through appropriate programmes. Protection from ETS at home is particularly important, given its impact on the attitude towards and awareness of ETS exposure at all places.

For the BDHS survey, more than 30% of the male respondents from the population in Bangladesh were in age group of 35-44 years. About one third of them had no formal education. Majority of the respondents (about 77%) were rural residents and more than 50% reported the access of any mass media exposure. About 17% reported involvement in sex before marriage. However, 98% reported no sexually transmitted infections during the survey. About 70% of the respondents were engaged in farming, day labour or as semi-skilled workers. About 70% of the respondents used at least one tobacco product (cigarettes, *bidis* or other forms of tobacco). The prevalence rates of cigarette and *bidi* smoking were roughly the same (about 60%). On an average, men smoked five cigarettes/*bidis* a day. The prevalence of using other tobacco products (i.e., chewing tobacco leaves or *sada pata or gul*, betel quid (*pan masala*) with tobacco or *zarda*) was roughly 21%. About 3.4% of the respondents used illicit drugs and this proportion is statistically significant.

TC was significantly associated with the respondent's age, where the older age groups were more likely to smoke *bidis* and other tobacco products, while those younger had a higher tendency to smoke cigarettes. TC among males with no education was about 2 times higher than those with at least college education. TC (in any form) was higher among the rural males, although cigarette smoking was significantly higher among the urban males. Other forms of tobacco and *bidi* consumption were higher among rural inhabitants. Exposure to mass media, occupation, and wealth status were significant determinants of TC. Besides, pre-marital engagement in sex showed a positive relationship with all types of TC except *bidi* smoking. Cigarette smoking was more prevalent among the affluent group, whereas the poor tended to smoke *bidis* and other forms of tobacco. The significant determinants of IDU included age, education, place of residence, engagement in pre-marital sex, exposure to mass media, wealth status, incidence of STI and occupation. Those who were in the age group 15-24 years were twice more likely to use drugs compared to those who were 35 years or older. The likelihood of IDU increased about 2 times for those without education compared to those with at least primary school education. The likelihood of IDU was 3.6 times higher among those who had pre-marital sex engagement. Likewise, the odds ratio was about 3 times for those who were infected before by any STI. The males from rich families were 2.5 times more likely to use illicit drug compared to those who were poorer. Besides, those engaged in semi-skilled occupational groups were also associated with a higher rate of IDU. Logistic regression results adjusted for other variables as confounders showed that the respondents who smoked cigarettes, *bidis* and used other forms of tobacco revealed 3.8, 1.8 and 2.0 times higher likelihood of illicit drug use, respectively, compared to non-tobacco users. In addition, the respondents who used any tobacco product were 19.6 times more likely to be illicit drug users compared to those who did not use any tobacco products. The likelihood of using any illicit drug also increased with more frequent smoking, and this was found true for any type of TC. For example, the odds ratio in favour of IDU for those who smoked 6 cigarettes or more per day was 5.3, while the odds ratio was much lower (2.0) for those who smoked 1 to 5 cigarettes per day. The results also suggested that TC by far had the highest association with drug use amongst all variables.

More than 70% of the male respondents from the urban slums were 20-24 years old, and slightly less than one third of the respondents were ever married (currently married, divorced or widowed). About 18% the respondents had no formal education and more than 95% of them were Muslims. Majority of the urban youths (88%) were currently working and about two-fifth had resided in the slum areas permanently.

Slightly over 4% of the male youths in the slums reported symptoms of STIs. Some 30% of the youths had no income and more than 58% were from the bottom 40% poorest groups. The current smoking (cigarettes and *bidis*) prevalence rate among the males from urban slums was roughly 42%. The average daily consumption of cigarettes and *bidis* were about 8 and 11 sticks respectively. About 9% of the youths were involved in IDU. The main source of drug abuse was injectable drugs followed by the use of ganja and *tari*. Respondent's age, marital status, education, current working status, whether they had symptoms of any STIs, and wealth index were significantly associated with cigarette and *bidi* smoking among the males in urban slums of Bangladesh. Although the duration of living in slums was not associated with *bidi* smoking, it has a significant impact on those who smoked cigarettes. Those who dwelled in the slums for a longer period had a higher tendency to be cigarette users. Income was significantly associated with only *bidi* smoking but did not affect the behavior of cigarette smokers. It was revealed that the older males were more likely to smoke tobacco than their younger counterparts. Youths who were ever married had almost two times higher likelihood of TC than those who were not married. Illiteracy was associated with five-time higher likelihood of TC than those with at least 11 years of education. Youths who reported having STI symptoms were at increased risk of TC.

The significant determinants of IDU included age, marital status, education, duration of stay in slums, and whether the respondents had symptoms of STIs. As is the case for TC, those with better education attainment were less likely to be involved in IDU. Those with less education were at least twice more likely to use illicit drugs compared to the youths with at least 11 years of education. The prevalence of IDU was higher among the migrants who stayed in the slums for a longer period and those with symptoms of STIs. The highest likelihood of IDU was among the migrants who lived in slum areas for at least 10 years. It must also be noted that IDU was highly associated with TC. Notably, the prevalence of IDU was higher among those who were heavy cigarette smokers. It was found that the respondents who smoked tobacco (cigarettes or *bidis)* revealed 9.6 times higher likelihood of using any illicit drugs compared to the non-tobacco users. The odds ratio increased with the number of cigarettes smoked daily. The risk of IDU for *bidi* smokers could be up to 12 times higher than the youths who do not smoke *bidis* depending on the amount of daily *bidi* consumption.

7.2 Policy Implications

Although Bangladesh, Nepal and Sri Lanka have country-specific tobacco control laws and policies, TC among the youths is common. The study on youth TC have identified several factors responsible for TC among the youths and suggested some guidelines for policy purpose. First, the peer influence factor could be reduced by close monitoring by parents and school personnel. Parents and teachers have a role to play to prevent the youths from influence by peers. Youth smoking should be curbed at an early stage to prevent addiction and further spread of the problem. Second, elimination of passive smoking (e.g., posing more barriers at home and other public places to prevent smoking in the presence of youths), punishment for tobacco vendors who violates existing laws or offer free tobacco products to minors, restriction of advertisements on hoardings, and in bus-stops and rail stations should be geared up to reduce TC and increase tobacco cessation among the youths in this region. Third, school curriculum for country-specific needs should also be revised to emphasize tobacco prevention and the consequences of TC to increase awareness among youths. Besides, no smoking should be allowed in school compounds as students can imitate the smoking behaviour of teachers or other staff.

Considering the above issues in mind, parents, teachers, sports and media personalities, religious and community leaders, government stakeholders, and regional organizations should consider the issue of youth TC as a common interest for implementing existing laws and to work together to develop new tobacco control programs. Given that GYTS is a school based survey, the prevalence of TC among students has further economic and social implications. Any negative health outcomes due to smoking may directly affect the academic performance of the youths, causing absenteeism in schools and increasing the dropout rate, all of which bear high social and economic costs. In addition, smoking creates additional strains on family budget especially for the poor, making it more difficult for them to break the poverty cycle. Youth TC will indirectly increase government expenditure on health, education and programs to redress the social and economic problems associated with smoking. Therefore, comprehensive strategies along with preventive programs should be tightened to help youths avoid smoking, quit such hazardous behaviours, and prevent life-long addiction.

From the study on adult TC in Bangladesh and India, social factors were identified as determinants of TC. In the long term, TC itself causes social problems. In deprived sections of the society, spending on TC often deprives spending on other essential items and services needed by the family. In the long term, basic need crisis and also deaths related to TC may be suffered, and affect particularly the young children. An important finding in this study is the high prevalence rate of TC among the middle age group (45 to 64) that demands more health attention. Therefore, targeting termination of TC in these age groups would be extremely important for policy formulation. TC accounted for one in six of all deaths resulting from non-communicable diseases (NCDs) and socioeconomic impacts of NCDs are affecting the progress of a nation (Alwan, 2011). It is therefore clear that a high level of TC especially among the deprived groups is an important hindrance to the attainment of development of a country. TC was greatly influenced by knowledge, attitude and perception (KAP) towards its consequences. Consistent with some other studies, it was found that education level had significant influence on KAP, which in turn was associated with TC among adults. Therefore, increasing knowledge through education on the harmful effects of tobacco and changing attitude and behaviors through counseling programs could be good interventions.

In Bangladesh and India, diverse and frequent use of smoking tobacco products other than cigarettes (like *bidis, kreteks*, cheroots, and hookah), crowding, lack of awareness at public places and workplaces, and weak or little enforcement of legal provisions to protect those exposed to ETS have aggravated the problems and hazards of ETS (WHO FCTC). Enforcement of smoke-free laws in South Asian region is weak but the situation is improving as stronger legislations are enacted, and rigorous enforcement is demanded by people who have growing awareness on the harms of ETS exposure (Oberg et al., 2011). These policies contribute decisively to smoking reduction, and help with the approval and implementation of other policies that reduce tobacco demand, such as a comprehensive ban of tobacco advertisement, promotion, and sponsorship. The formulation of policy to ensure smoke-free environment is the most effective way to protect the public, including children, women, and people at their work, public places and homes from exposure to ETS. There is sufficient evidence that implementation of smoke-free policies substantially decrease exposure to ETS (Oberg et al., 2011; Pierce & Leon, 2008). Studies of the effects of smoke-free policies consistently show that these policies reduce exposure to ETS by 80-90% in high exposure settings, and they can lead to overall decreases in exposure of up to 40% (Haw & Gruer, 2007). Some special approaches such as unannounced inspections, and surprise checks and raids by the empowered government agency can be very effective deterrents for public places erring smoking ban. Increased awareness of the considerable health risks posed by ETS at home, public places and work places and concerns for public safety have led to an active movement to impose a total ban on smoking at public places. The results clearly indicate that smoke-free policy needs to be strengthened by declaring more public places to be smoke free in Bangladesh and India. The study also suggests that innovative programs are needed to enhance the implementation of smoking bans at home and workplace. Awareness campaigns through effective public education, media advocacy and communication is the key to implement smoke-free policies.

Since both TC and IDU are of public health concerns, and a positive association between them was identified, their consequences could be reduced by employing suitable intervention programs at different levels. According to the National Strategic Plan of Action (2007-2010) in Bangladesh, some options namely, setting appropriate price and tax policies; prohibition of advertisements, sponsorships for increasing awareness through training, education and communication; ban on sale of tobacco products to and by minors; packaging and labelling of tobacco products; and research and partnership building for tobacco control along with control of illicit trade may be useful to reduce the consequences of TC. Some of these strategies are already enacted in Bangladesh. For instance, advertisements of cigarettes or *bidis* now must include a warning message to state that smoking is harmful to health. Besides, health warnings are also mandatory on packages of cigarettes and *bidis*. Unfortunately, these printed messages are not effective in Bangladesh because a large number of the population are still illiterate and hence they cannot read the message on packets. Moreover, many smokers buy single stick rather than full packets of cigarettes or *bidis*. Therefore, they miss the warning message written on the packets. In relation to the points raised by WHO FCTC (**Chapter 1**, Section 1.6)**,** this study found that some may not be suitable currently for the selected countries. For instance, printed messages on packaging of tobacco products are not fully effective in South Asia as literacy rate among the adult population is still low. In addition, the idea of 'plain packaging[6]' is also not suitable, because, many smokers buy single sticks rather than full packets of cigarettes or *bidis* due to low income. Therefore, graphic advertisements about harmful effects of tobacco at points of sale should be more appropriate for countries with low literacy rate.

In connection with other interventions or policies, a few recommendations can be proposed based on the findings on TC and IDU. First, given the importance of awareness, short documentaries on the adverse effect of TC could be broadcasted before the national news, or popular drama series, or sport events that are more likely to draw a large audience. In addition, digital posters carrying warning messages on the adverse effects of TC and its relation with IDU can be displayed at places in slums where youths gather and also at points of sale. Second, religious leaders especially *Imams* (the head of a mosque) could play a vital role in preventing TC and IDU by addressing the gatherings for Friday prayers (a special prayer for Muslims attended by the majority). *Imams* can speak briefly about the harm of TC and IDU from the religious perspectives. This approach is especially important as over 85% of the population in Bangladesh are Muslim, and TC and IDU were more prevalent among the Muslim (NIPORT et al., 2009). The same practice could also be adopted in other countries where religious leaders can deliver messages on the hazards of smoking in their teaching. Moreover, given the higher prevalence rate of TC among the families with lower socio-economic status, government could provide support by cash as incentive for those who successfully quit these hazardous addictions. At the same time, the government could provide health cards for those who are IDUs, followed by tobacco users.

[6] Plain cigarette packaging, also known as generic, standardised or homogenous packaging, refers to packaging that requires the removal of all branding (colours, imagery, corporate logos and trademarks), permitting manufacturers to print only the brand name in a mandated size, font and place on the pack, in addition to the health warnings and any other legally mandated information such as toxic constituents and tax-paid stamps. The appearance of all tobacco packs is standardised including the colour of the pack (Eriksen, Mackay, & Ross, 2012).

7.3 Contributions of the Study

Prevalence, patterns, and determinants of TC among youths and adults are commonly researched for developed and middle-income countries. Several studies also reported on ETS, and knowledge, attitude and perception (KAP) towards the consequences of TC, and the association between TC and IDU, but such studies are very much limited for South Asian countries. Many of the studies dealt with small data sets, which may not be representative. Due to lack of national-level data in many developing countries, little is known about the vulnerability of these issues. Therefore, this study contributes in several ways to the literature, methodological approach, and policy recommendations.

This thesis has important contributions in literature. First, studies concerning TC in various forms using nationally representative data on youths and adults in developing countries are comparatively scarce compared to the literature on developed countries. Second, studies focusing on large country-level dataset in South Asia are very limited and hence little is known about the vulnerability of TC among youths and adults, particular when considered together. In addition, study on KAP towards the consequences of TC among adults will enrich the literature in this region. Third, the findings on ETS in different settings of densely populated countries like Bangladesh and India using nationally representative data of 78,925 adults, collected for the first time, will enrich not only the empirical literature on South Asia but also provide parallel lessons to other developing countries for policy options. Fourth, the use of nationally representative data enhances the literature on Bangladesh about prevalence, patterns and determinants of IDU and its association with TC. Further, the findings of this study allow comparisons to be made with other South Asian countries where nationally representative data are collected with common methodology on TC and IDU.

This thesis has expanded the applications of statistical techniques, thus contributing to the methodological approach. Different options of dependent variables were also included in the analysis. Most of the studies on TC employed binary logistic regressions (BLRs) for analysis. They mostly analyzed dichotomous outcomes whether one is smoking any cigarettes. In South Asian countries, diverse tobacco products were consumed. This study considered different forms of TC, e.g., smoking cigarettes or not, smoking *bidis* or not, using any other smoked tobacco products or not, and using any smokeless tobacco or not. Ordinal logistic regressions (OLR) and multinomial logistic regressions (MLR) were used to find out the determinants of KAP towards the consequences of TC, and to examine the association between TC and KAP. The classification and regression tree (CART), a data mining technique, was utilized for characterizing smoking patterns among the adults. This technique has better classification accuracy than other traditional methods such as BLR, MLR and other data mining techniques like CHAID, and QUEST.

Unlike other studies, this study considered ETS in different settings including ETS at home, at workplace, at public places and at different places considered together. Furthermore, the prevalence of ETS exposure among men, women and both by age group and different settings (home, workplace, public places, and combined settings) were displayed using diamond-shaped equiponderant graphs. Fourteen BLRs (for the general population) and three BLRs (for the urban slum population) adjusted for confounders were used to explore the association between TC and IDU among males in Bangladesh. The rigorous analysis provided consistent findings that were supported by the gateway drug theory (Frosch et al., 2000; Golub & Johnson, 2001; Pundey, 2002), which states that the use of less deleterious drugs may lead to a future risk of using more dangerous hard drugs.

The countries selected for this study have their own country-specific tobacco control laws and policies, and they also signed the WHO Framework Convention on Tobacco

Control (WHO FCTC). In support of the country-specific laws and policies, this study adds important insights for policy design:

- For youths, parents with the help of school personnel should monitor their children and friends they mix with, as TC among friends has strong influence on smoking behavior. Boys should be the focus but girls should not be ignored as they remain the marketing targets of tobacco companies.

- Posing more barriers at home and other public places for ETS, and punishment for tobacco vendors who offer free tobacco products to minors.

- Curriculum for schools in each country should be revised to include tobacco prevention and awareness programs. Besides, smoking should not be allowed in school compounds by teachers and staffs as students can imitate them. This should be monitored by school disciplinary committees on a regular basis.

- Awareness about the harmful effects of TC, ETS exposure and IDU should be instilled to improve KAP, through training, education and communication programs.

-The realization of the association between TC and ETS, and TC and IDU is important in policy designs. Tobacco use control can effectively reduce ETS and IDU.

7.4 Strengths and Limitations of the Study

The Ministry of Health and Family Welfare (MoHFW) of each country with the consultation of local agencies and international organizations such as WHO South East Asia Regional Office and Centers for Disease Control and Prevention (CDC) conducted the GYTS and GATS surveys. Besides, a national expert committee from different organizations, and universities under the umbrella of MoHFW always monitored the surveys. The methodologies for GYTS and GATS were same for all countries and regions. Therefore, the data are appropriate for cross-country comparison. Moreover, GATS was the first large-scale survey ever conducted in Bangladesh and India that used electronic devices such as handheld computers, often called the Pocket PC systems. This device was useful to facilitate the complex skip pattern used in the GATS questionnaire, as well as some in-built validity checks on questions during data collection. A repeated quality control mechanism was used to test the quality of questionnaire programming. The Bangladesh Demographic and Health Survey (BDHS) was conducted by the National Institute of Population Research and Training (NIPORT) of MoHFW with the consultation of Mitra and Associates, a Bangladeshi research firm and Macro International Inc., Maryland, USA. The survey used the MEASURE DHS Model Questionnaires. The Bangladesh Urban Health Survey (BUHS) was also conducted by NIPORT, with the collaboration of an international organization, MEASURE Evaluation, USA, two local agencies namely, ICDDR, B: Knowledge for Global Lifesaving Solutions and Associates for Community and Population Research (ACPR).

The standard ethical clearance was obtained from the respective countries and informed consent from respondents was taken during the survey. For reliability, the household head or any senior knowledgeable person of the household was selected to collect information. Therefore, GYTS, GATS, BDHS and BUHS produced representative and independent cross-sectional information for each country. In addition, the use of different statistical tools such as diamond-shape equiponderant graphs, bivariate analysis, multivariate analysis (binary, multinomial and ordinal logistic regressions) and comparisons of the results produced by different techniques are also the strengths of this study. Furthermore, the use of classification and regression tree (CART), a data mining technique and its comparison with other traditional statistical tools add to the rigorous analysis of this study. The theoretical, conceptual and analytical frameworks and the existing literature guided the selection of dependent and independent variables for the study.

Self-reported data on TC, ETS and IDU could suffer from recall bias and deliberate misreporting. Even though anonymity and confidentiality were ensured during the survey, the respondents might have under-reported or over-reported the incidence as TC and IDU is not a widely acceptable social norm in the South Asian region. This misreporting could influence the prevalence, patterns, and determinants of TC, ETS and IDU. Since GYTS is a school based survey, it reflects the opinion of students about TC which may not represent the views of all the youths, especially those who are not schooling. For BDHS, the information on engagement in premarital sex may be under reported. Premarital sex is not acceptable in the society both culturally and from the religious point of view. In addition, the information on sexually transmitted infections in BDHS and BUHS were also subject to under reporting because of the negative social stigma associated with such disease will put some pressure on the respondents from revealing the truth. Therefore, the behavioural factors obtained from the BDHS and the BUHS may suffer from under reporting bias.

Although many variables (based on the related theories and existing literature) were analysed from four different sets of data to meet the objectives to examine TC, ETS and IDU among youths, adults, and males, exclusion of some other variables might limit the findings. The multivariate analysis controls for the effect of gender in examining the impact of the other determinants. In some parts of the analysis, cigarette and *bidi* use, and use of other tobacco products were analyzed separately. Due to a low prevalence of tobacco use among women and because diverse tobacco products were used in the selected South Asian countries, gender specific and product specific analysis cannot be conducted without compromising the usefulness of the results.Finally, since the datasets are cross-sectional in nature, cause-effect relationships could not be inferred.

7.5 Suggestions for Future Research

Self-reported data on TC, ETS exposure and IDU could suffer from recall bias and deliberate misreporting. Respondents might have under-reported the incidence as TC and IDU in the South Asian region is not a widely acceptable social norm. This misreporting could influence the accuracy research findings. Validation checks can be implemented using verifications through biomarkers such as exhaled carbon monoxide or cotinine assessment in saliva, urine, blood and hair could be used in national surveys collecting such information. Along with these, the assessment of ETS exposure can be done by measuring indoor air concentrations of ETS constituents, and through constant monitoring.

It should be noted that epidemiological studies generally rely on questionnaire measures. Therefore, on-going surveillance is necessary to monitor implementation of tobacco control measures including ETS exposure through cost effective and sustainable systems. Future research should focus on the policies related to TC, ETS and IDU controls, as well as their implementation gives a number of outstanding issues. The countries have the task forces to implement smoke-free policies which need to be further strengthened and functioning in collaboration with community participation. Bangladesh and India along with other countries of South Asia have enacted tobacco control legislation, laws and policies to protect people from ETS exposure. However, most of these existing measures are partial and inadequate, and do not provide for a complete ban on smoking at public places. Further, the level of implementation and enforcement varies across national and sub-national levels in the countries. In Bangladesh and India, despite all public places are being declared smoke-free, compliance levels are not consistent. As a result, diligent implementation of provisions of the law, backed by compliance studies and public opinion polls that inform policy makers, public and the media play a crucial role in initiating and maintaining smoke-free efforts. The most important challenge so far has been effective enforcement of smoke-free laws. The mechanism of enforcement of laws is not well spread at the grassroots levels but mostly in urban-centric areas and limited to selected few metropolitans and large cities. The benefits of going smoke-free have not reached the people living in semi-urban and rural areas. Legislations must mandate implementation of complete smoke-free environments, as opposed to voluntary policies, in order to protect public health. Implementation and enforcement plans together with infrastructure for enforcement, including awareness building, education and high-profile prosecutions with the imposition of fines or closing of businesses of repeated violators, are crucial for successful implementation. Longitudinal surveys and cohort studies are recommended for examining these policy related issues. Future studies that are qualitative in nature would also be useful for supplementing a better understanding of TC, ETS, and IDU among youths and adults. Since detailed gender and product specific analysis were limited in this study, future researches can be conducted in this direction.

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APPENDIX A: Supplementary Information for Chapter 4

Appendix A1: Variables from GYTS and their Coding for Analysis

RESPONSE VARIABLE: Current tobacco consumption (smoked and smokeless tobacco)		
(a) Smoked tobacco		
Variable name	Question asked in the survey	Coding for analysis
Variable ID: CR3; BDR15 NPR12	No. of days smoked (cigarettes or *bidis*) in last 30 days before the survey. 1=0 days, 2=1 or 2 days, 3=3-5 days, 4=6-9 days, 5=10-19 days, 6=20-29 days, 7=30 days	0=Not using cigarettes (option 1); 1=Any use (option 2 to 7)
Variable ID: NPR17 CR8	In last 30 days before the survey, smoked any tobacco products other than cigarettes and *bidis* such as cigars, water pipe (*hukkah*), cigarillos, little cigars, pipe etc. Options included: 1=yes, 2=no	0=Not using other smoked tobacco products (option 2) 1=Any use (option 1)
(b) Smokeless tobacco		
Variable name	Question asked in the survey	Coding for analysis
Variable ID: BDR23 NPR20	In last 30 days before the survey, no. of days use smokeless tobacco (chewing or applying or snuff) such as *surti*, *khaini*, *panmasala*, *gutka*, *parag*, *gul* etc.? Options included: 1=0 days, 2=1 or 2 days, 3=3 -5 days, 4=6-9 days, 5=10-19 days, 6=20-29 days, 7=30 days	0=Not using any smokeless products (option 1) 1=Any use (option 2 to 7)
Variable ID: CR9	In last 30 days before the survey, use any form of smokeless tobacco (e.g. chewing tobacco, snuff, dip)? Options included: 1=yes, 2=no	0=Not using any smokeless (option 2) 1=Any use (option 1)

The selected variables as predictors or independent variables		
Variable name	Question asked in the survey	Coding for analysis
Age in years CR52	How old are you? Options included: 11 to 17 years	1=youths **(13 to 15 years of age);** 0=others
Gender: CR53	Sex of the respondent	1=male, 2=female
Education BDR73, NPR75, LKR54	In what grade are you?	Seventh, Eighth, Ninth, Tenth
Parental tobacco use CR12, BDR25, BDR26	Do your parents smoke cigarettes/*bidis* or use smokeless tobacco? 1=none, 2=both, 3=only father, 4=only mother, 5=don't know	0=no (option 1 & 5) 1=yes (option 2 to 4)
Friends tobacco use, CR25	Any of your closest friends smoke? 1=none, 2=some, 3=most, 4=all of them	0=no (option 1) 1=yes (option 2 to 4)
Smoking at home CR30	In last 7 days before the survey, how many days' people smoked in your presence at home? Options: 1=0, 2=1 to 2, 3=3 to 4, 4=5 to 6, 5=7 days	0=no (option 1), 1=1-4 days (option 2 & 3);3=5-7days (option 4 & 5)
Smoking at other places than home CR31	In last 7 days before the survey, how many days' people smoked in your presence in places other than home? 1=0, 2=1-2, 3=3-4, 4=5-6, 5=7 days	0=no (option 1), 1=1-4 days (option 2 & 3),3=5-7days (option 4 & 5)
free tobacco by sales men: CR47	Any vendors offer free tobacco products? Options included: 1=yes, 2=no	0=no (option 2) 1=yes (option 1)
Advertisement seen in hoarding, bus-stop, station CR44	In last 30 days before the survey, no. of advertisements of cigarettes seen on hoardings, bus-stops, trains, railway platforms, shops or as writings on walls? Options included: 1=a lot, 2=a few, 3=none	0=none (option 3) 1=a few (option 2) 2=a lot (option 1)
Taught in class about danger of smoking: CR48	In survey session of school, taught in classes about dangers of smoking? Options included: 1=yes, 2=no, 3=not sure	0=no (option 2 and 3) 1=yes (option 1)
Discussed smoking & health as part of a lesson BDR70, CR51	When last discussed smoking & health as part of a lesson? 1=never, 2=this year/term, 3=last year/term, 4=2 years/terms ago, 5=3 years/terms ago, 6=more than 3 years/terms ago	0=never (option 1) 1=during this survey year (option 2); 2=before year of survey (option 3 to 6)

CR indicates the core questions that were asked for all countries in GYTS; country specific questions were labelled as BDR for Bangladesh, NPR for Nepal and LKR for Sri Lanka.

Appendix A2: Variables from GATS and their Coding for Analysis

(a) Social determinants and tobacco consumption (TC)

RESPONSE VARIABLE: Current tobacco consumption (smoked and smokeless tobacco)		
Smoked tobacco		
Variable name	Question asked in the survey	Coding for analysis
Variable ID: B1	Currently smoke tobacco or not? Options: 1=daily; 2= < daily; 3=not at all; 7=don't know; 9=refused.	0=Not using cigarettes (option 3, 7) 1=Any use (option 1 & 2)
Smokeless tobacco		
Variable name	Question asked in the survey	Coding for analysis
Variable ID: C1	Currently use smokeless tobacco or not? Options: 1=daily; 2= < daily; 3=not at all; 7=don't know; 9=refused.	0=Not using smokeless tobacco (option 3, 7) 1=Any use (option 1 & 2)
Former tobacco users: Former user means ever used tobacco (smoked or smokeless) but currently do not use any tobacco products (smoked or smokeless).		
Never users: Never user means, neither used any tobacco products (smoked or smokeless) in their life time.		

(b) Knowledge, attitude and perception (KAP) towards the consequences of TC

RESPONSE VARIABLE: KAP towards the consequences of TC		
Variable name	Question asked in the survey	Coding for analysis
Variable ID: H1, H3, H2a, H2b, H2c, **Bangladesh & India**	Based on see or believe, does smoking (**H1:** yes=1 and No=0) and smokeless (**H3:** yes=1 and No=0) cause serious illness, Smoking causes stroke (**H2a:** yes=1 and No=0); heart attack (**H2b:** yes=1 and No=0); lung cancer (**H2c:** yes=1 and No=0).	The score ranged from **0-5** for **INDIA** and grouped as: score 0-2: **some KAP** score 3-4: **good KAP** score 5: **high KAP**
Variable ID: H2d, H3a, H3b, H3d, H2_3, H2_3a, H2_3b, H5 **Bangladesh only**	Smoking causes long term respiratory distress (**H2d:** yes=1 and No=0), Smokeless tobacco cause stroke (**H3a:** yes=1 and No=0), heart attack (**H3b:** yes=1 and N0=0), cancer of mouth (**H3d:** yes=1 and No=0). **Based on your believe are tobacco products (TPs) addictive?** Cigarettes (**H2_3:** yes=1 and No=0), *bidis* (**H2_3a:** yes=1 and No=0) and smokeless (**H2_3b:** yes=1 and No=0). **You are in favour or oppose of increasing taxes on TPs?** (**H5:** yes=1 and No=0).	The score ranged from **0-13** for **BANGLADESH** and grouped as: score 0-7: **some KAP** score 8-12: **good KAP** score 13: **high KAP**

Appendix A2, Continued, Variables from GATS and their Coding for Analysis

The selected variables as predictors or independent variables		
Variable name	Question asked in the survey	Coding for analysis
Age in years, A3	How old are you? Open ended question	15-24, 25-44, 45-59, 60+
Gender, A1	Record gender from observation	1=male, 2=female
Household members, HH1	In total, how many persons live in this household? Open ended question	1-3, 4-5, 6-8, 9+
Place of residence	What is the place of residence?	1=urban, 2=rural
Educational attainment A4	Highest education level? 1=no education; 2= < primary school completed; 3=primary school completed; 4= < secondary school completed; 5=secondary school completed; 6=high school completed; 7=college/ university completed; 8=post graduate degree completed; 77=don't know; 99=refused	0=no education (option 1 & 77); 1= < primary to primary completed (option 2 & 3); 2= < secondary to secondary completed (option 4 & 5); higher= option 6, 7 & 8
Wealth Index A6	Based on assets in the household or any member in the household has the following assets: a. Electricity b. flush toilet c. fixed telephone d. cell /telephone e. television f. radio g. refrigerator h. car i. moped/scooter/motorcycle j. washing machine k. bicycle l. sewing machine m. *almirah*/wardrobe n. table o. bed or cot p. chair or bench q. watch or clock	1st quintile: lowest 2nd quintile: low 3rd quintile: middle 4th quintile: high 5th quintile: highest Based on factor analysis
Anti-tobacco information (ATI) score		
Variable ID: G1b, G1c, G1d, G1e, G2, G2a **Bangladesh & India**	**Noticed any ATI in:** TV (**G1b**), radio (**G1c**), billboards (**G1d**), somewhere else (**G1e**) **Warnings on tobacco products:** On cig package (**G2**), on smokeless products (**G2a**).	GATS collect information on three products (cigarettes, *bidis* and smokeless tobacco). Each question ends with yes=1 and No=0. For **BANGLADESH**, the possible ATI score of each respondent ranged from **0-24** and for **INDIA**, the score ranged from **0-17**. **Coding for analysis:** 0 score; 1-3 scores 4-6 scores 7 and above
G1a **India (only)**	**Noticed any ATI in:** Newspapers or magazines (**G1a**)	
G1aa, G1ab, G1dd, GG2 **Bangladesh (only)**	**Noticed any ATI in:** Newspapers (**G1aa**), magazines (**G1ab**), posters (**G1dd**) **Warnings on tobacco products:** On *bidi* package (**GG2**)	
Pro-tobacco information (PTI) score		
Variable ID: G4a, G4b, G4c, G4d, G4e, G4g, G4h, G4i, G4j, G4k, G6a, G6b, G6c, G6d, G6e, G6f **Bangladesh & India**	**Advertisements or promotions of tobacco products:** At point on sale (**G4a)**, TV (**G4b)**, radio (**G4c)**, billboards (**G4d)**, posters (**G4e)**, cinemas (**G4g)**, internet (**G4h)**, public transportation or station (**G4i)**, public walls (**G4j)**, anywhere else (**G4k)** **Information regarding tobacco products:** Free samples (**G6a)**, sold at sale prices (**G6b)**, coupons (**G6c)**, free gifts (**G6d)**, logo at cloths (**G6e)**, promotions by mail (**G6f)**	GATS collect information on three products (cigarettes, *bidis* and smokeless tobacco). Each question ends with yes=1 and No=0. For **BANGLADESH**, the possible PTI score of each respondent ranged from **0-63** and for **INDIA**, the score ranged from **0-54**. **Coding for analysis:** 0 score 1-3 scores 4-6 scores 7 and above
G4f, G4g **India (only)**	**Advertisements or promotions of tobacco products:** In newspapers/magazines (**G4f**) **Information regarding of tobacco products:** Other products with same brand name (**G4g**)	
G4fa, G4fb, G5, GG5, GG6 **Bangladesh (only)**	**Advertisements or promotions of tobacco products:** In newspapers (**G4fa**), magazines (**G4fb**); **Information regarding of tobacco products:** Sporting events (**G5**), music, theatre, etc. (**GG5**), movies or dramas (**GG6**)	

Appendix A3: Variables from GATS and their Coding for Analysis-Application of CART

RESPONSE VARIABLE: Average number of cigarettes or *bidis* smoked per day	
Variables	Specific question asked or how variable was derived i.e. coding for analysis
Cigarettes B06a	Currently, average no. of cigarettes smoke per day? Options: “0” cigarette; a range of “1-60” cigarettes for Bangladesh and a range of “1-110” cigarettes for India; smokes product but not everyday
Bidis smoking B06h (Bangladesh) B06c (India)	Currently, average no. of *bidis* smoke per day? Options: “0” *bidi*; a range of “1-75” *bidis* for Bangladesh and a range of “1-125” *bidis* for India; smokes product but not everyday

The selected variables as predictors or independent variables		
Variables name	Question asked in the survey	Coding for analysis
Gender A1	Record gender from observation	1=male, 2=female
Residence	What is the place of residence	1=urban, 2=rural
Education (HEDU) A4	Highest education level? Option included: 1=no education; 2= <primary school completed; 3=primary school completed; 4= <secondary school completed; 5=secondary school completed; 6=high school completed; 7=college or university completed; 8=post graduate degree completed; 77=don’t know; 99=refused	1=no formal education (option-1); 2=less than or equal to primary (options 2 & 3); 3=more than primary (options 4, 5, 6, 7& 8);
Wealth Index (WI) A6	Based on assets in the household or any member in the household has the following assets: a. Electricity b. flush toilet c. fixed telephone d. cell /telephone e. television f. radio g. refrigerator h. car i. moped/scooter/motorcycle j. washing machine k. bicycle l. sewing machine m. *almirah*/wardrobe n. table o. bed or cot p. chair or bench q. watch or clock. Options based on factor analysis: 1=1^{st} quintile; 2=2^{nd} quintile; 3=3^{rd} quintile; 4=4^{th} quintile; 5=5^{th} quintile	1=poor (option 1 &2) 2=middle (option 3) 3=rich (option 4 & 5)
Age when first started smoking cigarettes or *bidis* (SAGE) B4	Age of the adults when they first started smoking tobacco daily? (continuous form)	Dataset contains 12 to 36 years old for Bangladeshi adults and 10 to 40 years old for Indian adults.
Smoking causes serious illness (SSI) H1	On the basis of information and believe, does smoking tobacco cause serious illness? Options. 1=yes; 2=no; 7=don’t know; 9=refused	1=yes (option 1) 2=no (option 2 and 7)
Advertisement at point on sale (APS) G4a1 & G4a2	Last 30 days before the survey, noticed any advertisements or signs promoting the cigarettes/*bidis* in stores where the products are sold? Options: 1=yes; 2=no; 7=don’t know; 9=refused	1=yes (option 1) 2=no (option 2 and 7)
Health warning labels in cigarette or *bidi* packets (HWP) G2 & GG2	Last 30 days before the survey, noticed any health warnings on cigarette/*bidi* packages? Options. 1=yes; 2=no; 3=did not see any cigarette/*bidi* packages; 9=refused	1=yes (option 1) 2=no (option 2)

Appendix A4: Model Diagnostic Results of Binary Logistic Regression, Youth TC

Criteria	Current tobacco consumption		
	Bangladesh	**Nepal**	**Sri Lanka**
Model summary Cox and Snell R^2 Nagelkerke R^2	 0.062 0.163	 0.124 0.267	 0.071 0.161
Hosmer and Lemeshow test p-values	 0.066	 0.396	 0.265
Overall classification	93.5%	90.8%	91.9%
Checking Multicollinearity 1. By standard errors (SEs) 2. By variance inflation factor (VIF) 3. Correlation matrix	1. The SEs of independent variables is <1.00 (recommended value is **0.001-5.0**) 2. The VIF of independent variables is <1.00 (recommended value is **≤3**) 3. The correlation between any two variables are within the tolerance level		
Therefore, clear evidence of no multicollinearity			

Appendix A5: Model Diagnostic Results of Binary Logistic Regression, Adult TC-Social Determinants

Criteria	Current tobacco consumption	
	Bangladesh	**India**
Model summary Cox and Snell R^2 Nagelkerke R^2	 0.35 0.39	 0.32 0.36
Hosmer and Lemeshow test p-values	 0.10	 0.08
Overall classification	79.6%	78.2%
Checking Multicollinearity 1. By standard errors (SEs) 2. By variance inflation factor (VIF) 3. Correlation matrix	1. The SEs of independent variables is <1.00 (recommended value is **0.001-5.0**) 2. The VIF of independent variables is <1.00 (recommended value is **≤3**) 3. The correlation between any two variables are within the tolerance level	
Therefore, clear evidence of no multicollinearity		

Appendix A6: Association Measures of Predictors with KAP, Bangladesh

Variables/predictors	P-χ^2 (LRT) L-L	Sig.
Age in years	115.38 (102.73) 66.76	0.000
Gender	74.73 (75.41) 62.12	0.000
Place of residence	47.45 (49.97) 42.71	0.000
Educational level	396.30 (424.30) 329.19	0.000
Wealth index	304.98 (297.84) 257.42	0.000
Number of persons in household	48.98 (50.0) 45.7	0.05
Current tobacco smoking	39.88 (40.40) 35.9	0.000
Current smokeless tobacco using	65.11 (62.68) 54.53	0.000
Anti-tobacco information (ATI) score	481.50 (502.20) 352.45	0.000
Pro-tobacco information (PTI) score	220.06 (222.57) 130.37	0.000
Checking Multicollinearity		
-By standard errors (SEs)	-The SEs of independent variables (IVs) is **<1.00** (recommended value is **0.001-5.00**)	
-By variance inflation factor (VIF)	-The VIF of IVs is **<1.00** (recommended value is **≤3**)	
-Checking in correlation matrix	-Correlation between any two variables are within tolerance level	
Therefore, clear evidence of no multicollinearity		

P-χ^2=Pearson Chi-square; LRT=Likelihood Ratio Test; L-L=Linear by Linear.

Appendix A7: Model Diagnostic Results of Ordinal and (Multinomial [ǂ]) Logistic Regressions for KAP, Bangladesh

Model fitting information			
Model	**-2 log likelihood**	**Chi-square**	**Sig.**
Intercept only	12167.62		
Final	11568.14 (11303.40)	599.48 (864.22)	0.000
Goodness-of-fit		**Chi-square**	**Sig.**
Pearson		9010.78 (9889.43)	0.000
Deviance		9096.35 (8831.61)	0.000
Pseudo R^2	**Statistic**		
Cox and Snell	0.14 (.17)		
Nagelkerke	0.21 (.25)		
McFadden	0.11 (.13)		
***Model accuracies**	53.4% (55.7%)		
Test of parallel lines			
Model	**-2 log likelihood**	**Chi-square**	**Sig.**
Null hypothesis	11568.14		
General	11314.28	253.86	0.000

*ordinal regression does not have the classification table option, therefore a cross-tabulation between predicted categories and the groups is used to determine the model's accuracy; ǂ value in parentheses presents the multinomial regression results.

Appendix A8: Association Measures of Predictors with KAP, India

Variables/predictors	**P-χ^2 (LRT) L-L**	**Sig.**
Age in years	980.82 (915.70) 672.86	0.000
Gender	261.78 (261.79) 136.24	0.000
Place of residence	884.81 (932.69) 815.49	0.000
Educational level	5670.73 (5791.36) 5075.91	0.000
Wealth index	3698.99 (3764.35) 3382.71	0.000
Number of persons in household	104.22 (103.84) 101.8	0.000
Current tobacco smoking	309.79 (299.03) 298.75	0.000
Current smokeless tobacco using	501.62 (487.35) 465.40	0.000
Anti-tobacco information (ATI) score	8484.24 (8446.03) 7108.89	0.000
Pro-tobacco information (PTI) score	2028.65 (2188.74) 1667.49	0.000
Checking Multicollinearity -By standard errors (SEs)	-The SEs of independent variables (IVs) is **<1.00** (recommended value is **0.001-5.00**)	
-By variance inflation factor (VIF)	-The VIF of IVs is **<1.00** (recommended value is **≤3**)	
-Checking in correlation matrix	-Correlation between any two variables are within tolerance level	
Therefore, clear evidence of no multicollinearity		

P-χ^2=Pearson Chi-square; LRT=Likelihood Ratio Test; L-L=Linear by Linear.

Appendix A9: Model Diagnostic Results of Ordinal and (Multinomial ǂ) Logistic Regressions for KAP, India

Model fitting information			
Model	**-2 log likelihood**	**Chi-square**	**Sig.**
Intercept only	66324.34		
Final	56989.20 (55001.84)	9335.14 (11322.51)	0.000
Goodness-of-fit		**Chi-square**	**Sig.**
Pearson		38884.89 (41124.59)	0.000
Deviance		40791.90 (38804.54)	0.000
Pseudo R^2	**Statistic**		
Cox and Snell	.18 (.20)		
Nagelkerke	.24 (.27)		
McFadden	.14 (.16)		
***Model accuracies**	54.6% (57.2%)		
Test of parallel lines			
Model	**-2 log likelihood**	**Chi-square**	**Sig.**
Null hypothesis	56989.20		
General	55048.16	1941.04	0.000

*ordinal regression does not have the classification table option, therefore a cross-tabulation between predicted categories and the groups is used to determine the model's accuracy; ǂ values in parentheses present the multinomial regression results.

APPENDIX B: Supplementary Information for Chapter 5

Appendix B1: Variables from GATS and their Coding for Analysis-ETS

RESPONSE VARIABLE: Environmental tobacco smoke (ETS) exposure		
Var name	Question asked in the survey	Coding for analysis
At home E3	How frequently anyone smoke (inside home)? 1=daily; 2=weekly; 3=monthly; 4= <monthly; 5=never; 7=don't know	1=yes (option 1 to 3) 0=no (option 4 & 5)
Workplace E8	In last 30 days before survey, anyone smoke in indoor areas of your workplace? 1=yes; 2=no; 7=don't know; 9=refused	1=yes (option 1) 0=no (option 2)
At public places	In last 30 days before the survey, anyone smoke inside of any following settings that you visited? Options for all type of places: **1=yes; 2=no; 7=don't know; 9=refused**	
E10	Government buildings or offices?	1=yes (option 1); 0=no (option 2)
E12	Health care facilities?	1=yes (option 1); 0=no (option 2)
E14	Restaurants?	1=yes (option 1); 0=no (option 2)
E16	Public transportation?	1=yes (option 1); 0=no (option 2)

The selected variables as predictors or independent variables		
Variables name	Question asked in the survey	Coding for analysis
Age in years; A3	How old are you? Open ended question	15-24, 25-44, 45-59, 60+
Gender; A1	Record gender from observation	1=male, 2=female
No. of persons in household; HH1	Total number of persons living in the household. Open ended question	1-2,3-4,5-9,10+
Residence	What is the place of residence?	1=urban, 2=rural
Education A4	Highest education level? Option included: 1=no education; 2= <primary school completed; 3=primary school completed; 4= <secondary school completed; 5=secondary school completed; 6=high school completed; 7=college or university completed; 8=post graduate degree completed; 77=don't know; 99=refused	1=no formal education (option 1 & option 77); 2=less than primary; 3=primary completed 4=less than secondary; 5=secondary & above (option 5 to 8)
Wealth Index A6	Based on assets in households: a. Electricity b. flush toilet c. fixed telephone d. cell /telephone e. television f. radio g. refrigerator h. car i. moped/scooter/motorcycle j. washing machine k. bicycle l. sewing machine m. *almirah*/wardrobe n. table o. bed or cot p. chair or bench q. watch	1st quintile: lowest 2nd quintile: low 3rd quintile: middle 4th quintile: high 5th quintile: highest Based on factor analysis
General Health knowledge about SHS exposure; E17	From your information or believe, does SHS cause serious illness in non-smokers? 1=yes; 2=no; 7=don't know; 9=refused	1=yes (option 1) 2=no (option 2 and 7)
Specific Health knowledge about SHS exposure E18	From your information or believe does SHS cause any of the following: a. Heart disease in adults? b. Lung cancer in adults? c. Lung illness in children? For all three type of questions: 1=yes; 2=no; 7=don't know; 9=refused	0=no knowledge (answer no questions correctly); 1=some knowledge (ans. anyone/two correctly); 2=good knowledge (answer all correctly)
Attitudes about ETS (at home) E1	Smoking rules inside your home? 1=allowed; 2=not allowed, but exception; 3=never allowed; 4=no rules; 7=don't know; 9=refused	1=smoking allowed ; 2=not allowed; 3=no rules/policy
Attitudes about ETS (at workplace) E7	Smoking rules in indoor areas at your work place? 1=allowed anywhere; 2=allowed only in some areas; 3=not allowed in any areas; 4=there is no policy; 7=don't know; 9=refused	1=smoking allowed ; 2=not allowed; 3=no rules/policy
Perceptions to smoking restrictions at other places E29*	Your opinion, smoking should or should not be allowed in indoor areas such as? Workplaces? 2. Restaurants? 3. Universities? For all three type of questions: 1=should be allowed; 2=should not be allowed; 7=don't know; 9=refused	0=no support (all answers for allowed); 1= moderate (any 1 or 2 in favour of restrictions); 2=strong (all for restrictions)
For tobacco consumption B01 and C01	Do you currently smoke tobacco or using smokeless tobacco? Options: 1=daily; 2=less than daily; 3=not at all; 7=don't know; and 9=refused	For both products: 0=not at all; 1=daily; and 2=less than daily

***** The information on these variables in GATS India was not reported.

Appendix B2: Model Diagnostic Results of Binary Logistic Regressions-ETS, Bangladesh

<table>
<tr><th rowspan="2">Criteria</th><th colspan="4">Environmental tobacco smoke exposure in different settings</th></tr>
<tr><th>At home
Model: A</th><th>At workplace*
Model: B</th><th>Public places
Model: C</th><th>Model: D #</th></tr>
<tr><td>Dependent variable encoding</td><td>No=0
Yes=1</td><td>No=0
Yes=1</td><td>No=0
Yes=1</td><td>No=0
Yes=1</td></tr>
<tr><td>Model summary
-2log likelihood
Cox and Snell R^2
Nagelkerke R^2</td><td>
8394.04
0.441
0.580</td><td>
1608.07
0.395
0.523</td><td>
10413.55
0.291
0.374</td><td>
8262.21
0.303
0.412</td></tr>
<tr><td>Hosmer and Lemeshow test
Chi-square
p-values</td><td>
11.03
0.121</td><td>
13.44
0.101</td><td>
23.70
0.002</td><td>
21.07
0.005</td></tr>
<tr><td>Overall classification</td><td>81%</td><td>82.6%</td><td>74.8%</td><td>81.1%</td></tr>
<tr><td>Checking Multicollinearity
-By standard errors (SEs)

-By variance inflation factor (VIF)
-Correlation matrix</td><td colspan="4">-The SEs of independent variables is <1.00 (recommended value is 0.001-5.0)
-The VIF of independent variables is <1.00 (recommended value is ≤3)
-The correlation between any two variables are within the tolerance level</td></tr>
<tr><td colspan="5">Therefore, clear evidence of no multicollinearity</td></tr>
</table>

exposed at home or public places (0=none, 1=yes of at least any one place); * respondents who are workers.

Appendix B3: Model Diagnostic Results of Ordinal Logistic Regression-ETS, Bangladesh

Model fitting information			
Model	**-2 log likelihood**	**Chi-square**	**Sig.**
Intercept only	11570.75		
Final	7443.13	4127.62	0.000
Goodness-of-fit		**Chi-square**	**Sig.**
Pearson		5621.99	0.000
Deviance		5075.87	0.000
Pseudo R^2	**Statistic**		
Cox and Snell	0.38		
Nagelkerke	0.43		
McFadden	0.24		
Test of parallel lines			
Model	**-2 log likelihood**	**Chi-square**	**Sig.**
Null hypothesis	7443.13		
General	7106.37	336.76	0.000
***Model accuracies**	63.4%	4052.84	0.000
Pearson Chi-square		**Value**	**Sig.**
Age in years		67.70	0.000
Gender		1419.72	0.000
Place of residence		49.84	0.000
Educational level		64.07	0.000
Wealth index		84.00	0.000
GHK on ETS exposure		58.50	0.000
Specific HK on ETS		116.05	0.000
Attitudes about ETS (at home)		1738.88	0.000
Perceptions of SR at SP		47.52	0.000

*ordinal regression does not have the classification table option, therefore a cross-tabulation between predicted categories and the groups is used to determine the model's accuracy.

Appendix B4: Model Diagnostic Results of Multinomial Logistic Regression-ETS, Bangladesh

Model fitting information			
Model	**-2 log likelihood**	**Chi-square**	**Sig.**
Intercept only	11570.75		
Final	7171.21	4399.54	0.000
Goodness-of-fit		**Chi-square**	**Sig.**
Pearson		6132.11	0.000
Deviance		4803.96	0.000
Pseudo R^2	**Statistic**		
Cox and Snell	0.40		
Nagelkerke	0.45		
McFadden	0.25		
Overall classification	65.2%		
Likelihood Ratio Test (LRT)		**Chi-square**	**Sig.**
Age in years		136.03	0.000
Gender		1980.57	0.000
Place of residence		12.50	0.002
Educational level		37.14	0.000
Wealth index		20.37	0.049
GHK on ETS exposure		6.24	0.044
Specific HK on ETS		22.26	0.000
Attitudes about ETS (at home)		2532.15	0.000
Perceptions of SR at SP		11.40	0.022

Appendix B5: Model Diagnostic Results of Binary Logistic Regressions- ETS, India

Criteria	**Environmental tobacco smoke exposure in different settings**			
	At home Model: A	**At workplace* Model: B**	**Public places Model: C**	**Model: D #**
Dependent variable encoding	No=0 Yes=1	No=0 Yes=1	No=0 Yes=1	No=0 Yes=1
Model summary				
-2log likelihood	69287.42	15153.21	88692.04	86646.32
Cox and Snell R^2	0.42	.23	.13	0.31
Nagelkerke R^2	0.56	.30	.17	0.40
Hosmer and Lemeshow test				
Chi-square	65.326	37.272	66.825	109.75
p-values	0.000	0.000	0.000	0.000
Overall classification	81.5%	74.6%	71.1%	71.4%
Checking Multicollinearity				
-By standard errors (SEs)	-The SEs of independent variables is <1.00 (recommended value is **0.001-5.0**)			
-By variance inflation factor (VIF)	-The VIF of independent variables is <1.50 (recommended value is **≤3**)			
-By correlation matrix	-The correlation between any two variables are within the tolerance level			
Therefore, clear evidence of no multicollinearity				

#exposed at home or public places (0=none, 1=yes of at least any one place); * respondents who are workers.

Appendix B6: Model Diagnostic Results of Ordinal Logistic Regression- ETS, India

Model fitting information			
Model	**-2 log likelihood**	**Chi-square**	**Sig.**
Intercept only	57929.30		
Final	32316.12	25613.18	0.000
Goodness-of-fit		**Chi-square**	**Sig.**
Pearson		22750.38	0.000
Deviance		21097.54	0.000
Pseudo R^2	**Statistic**		
Cox and Snell	.32		
Nagelkerke	.36		
McFadden	.22		
Test of parallel lines			
Model	**-2 log likelihood**	**Chi-square**	**Sig.**
Null hypothesis	32316.12		
General	31290.74	1025.38	0.000
***Model accuracies**	58.3%	18340.59	0.000
Pearson Chi-square		**Value**	**Sig.**
Age in years		201.55	0.000
Gender		2231.13	0.000
Place of residence		509.24	0.000
Educational level		430.69	0.000
Wealth index		757.83	0.000
GHK on ETS exposure		241.45	0.000
Specific HK on ETS		255.80	0.000
Attitudes about ETS (at home)		19756.47	0.000

*ordinal regression does not have classification table option, therefore a cross-tabulation between predicted categories and groups is used to determine model's accuracy.

Appendix B7: Model Diagnostic Results of Multinomial Logistic Regression- **ETS, India**

Model fitting information			
Model	**-2 log likelihood**	**Chi-square**	**Sig.**
Intercept only	57929.30		
Final	31488.88	26440.42	0.000
Goodness-of-fit		**Chi-square**	**Sig.**
Pearson		22373.42	0.000
Deviance		20270.30	0.000
Pseudo R^2	**Statistic**		
Cox and Snell	.32		
Nagelkerke	.37		
McFadden	.21		
Overall classification	61.2%		
Likelihood Ratio Test (LRT)		**Chi-square**	**Sig.**
Age in years		208.56	0.000
Gender		3192.99	0.000
Place of residence		5.43	0.05
Educational level		49.70	0.000
Wealth index		182.12	0.000
GHK on ETS exposure		227.70	0.000
Specific HK on ETS		241.11	0.000
Attitudes about ETS (at home)		22164.87	0.000

APPENDIX C: Supplementary Information for Chapter 6

Appendix C1: Variables from BDHS and their Coding for Analysis- IDU and TC

RESPONSE VARIABLE: Tobacco consumption (smoked and smokeless tobacco products)		
Variables name	Question asked in the survey	Coding for analysis
Variable ID: SM709	Currently smoked cigarettes/*bidis*? Options included: 1=yes, 2=no	0=Not using cigarettes/*bidis* (option 2); 1=Any use (option 1)
Variable ID: SM710	Number of cigarettes/*bidis* smoked in last 24 hours. Open ended questions (in numbers)?	**For cigarettes:** 0=none; 1=1-5 times a day; 2=6 or more times a day. **For *bidis*:** 0=none; 1=1-10 times a day; 2=11 or more times a day
Variable ID: SM711	Do you currently smoke or use any other type of tobacco? Options included: 1=yes, 2=no	0=Not using other types (option 2) 1=Any use (option 1)
Variable ID: SM712	If yes, what type of tobacco (smoke or smokeless) currently use? Options: pipes, chewing tobacco, snuff or others	0=Not using other types 1=Any use
RESPONSE VARIABLE: Illicit drugs use (IDU)		
Variable ID: SM820	In the last three months, have you ever taken: *Ghanja*? *Charas*? *Phensidle*? *Pethedine*? Heroin? Morphine? Injectable drugs? Or other drugs? Options: 1=yes, 2= no	0=Not using any drugs (option 2) 1=Using any drugs (option 1)

The selected variables as predictors or independent variables		
Variables name	Question asked in the survey	Coding for analysis
Age in years MV105	Age of the respondent in completed years 15-54	1=15-24; 2=25-34; 3=35-44; 4=45-54
Education MV106	Highest class of education you completed	0=no education, 1=primary, 2=secondary,3=college and higher
Residence: MV025	Type of place of residence	1=urban, 2=rural
Exposure to mass media (print and electronic)	Do you read newspaper or magazine (SM112)? Do you listen to radio (SM113)? Do you watch television (SM114)? Options: 1=yes, 2=no	0=no media (all no, option 2) 1=any media (at least one yes, option 1)
Pre-marital sex SM310A	Did you have sex before (first) marriage?	0=no; 1=yes
Wealth Index MV190	Your household have the following? A radio? A television? A mobile telephone? A non-mobile telephone? A refrigerator? An *almirah* or wardrobe? A table? A chair? A watch? A bicycle? A motorcycle? An animal-drawn cart? A car or truck? A boat with motor? A rickshaw/van	Based on principal component (20% of asset) analysis the category included: 1=poorest; 2=poorer; 3=middle; 4=richer; 5=richest
Any STI MV763A	Had any STI in last 12 months?	0=no; 1=yes; DK=don't know
Occupation MV716	Respondent's occupation	0=Unemployed; 1=farmers, workers, labour, semiskilled; 2=business (small and large); 3=highly skilled; 4=others

Appendix C2: Variables from BUHS and their Coding for Analysis- IDU and TC

RESPONSE VARIABLE: Tobacco consumption (cigarettes and *bidis* smoked)		
Variables	Questions asked in the survey	Coding for analysis
Smoking cigarette M901a	In the last 1 month, have you smoked cigarette? Options included: 1=Yes, 2=No	0=Not using cigarette 1=Yes
Smoking *bidi* M901b	In the last 1 month, have you smoked *bidi*? Options included: 1=Yes, 2=No	0=Not using *bidi* 1=Yes
Prevalence of cigarette smoking (if yes), M903a	How many cigarettes do you smoke in a typical day? 1 to 60 (in continuous form)	1=1-5 sticks daily 2=6-10 sticks daily 3=10+ sticks daily
Prevalence of *bidi* smoking (if yes) M905a	How many *bidis* do you smoke in a typical day? 1 to 75 (in continuous form)	1=1-5 sticks daily 2=6-10 sticks daily 3=10+ sticks daily
Smoking cigarette/*bidi* M901a, M901b	Whether respondent is currently smoking either cigarette or *bidi*. This variable is created by combining the response from M901a and M901b.	0=No 1=Any one 2=Both cigarette and *bidi*
RESPONSE VARIABLE: Illicit drug use (IDU)		
Variables	Questions asked in the survey	Coding for analysis
Use of illicit drugs: M906aa;M906ab M906ac;M906ad M906ae;M907aa M907ab	In the last 1 month, have you used the following? Options: *Ganja* (1=yes, 2=no); *Charas* (1=yes, 2=no); *Phensidle* (1=yes, 2=no); Heroin (1=yes, 2=no); *Tari* (1=yes, 2=no); *Pethedine* (1=yes, 2=no); *Morphin* (1=yes, 2=no)	0=No, for all cases 1=Yes, any one of the mentioned drugs
The selected variables as predictors or independent variables		
Variables	Questions asked in the survey	Coding for analysis
Age in years, M101A	How old are you at your last birthday? (in continuous form)	1=15-19 2=20-24
Marital status, M102	Marital status? 1=Currently married; 2-5=separated/ deserted/widowed/divorced; 6=never married	1=Ever married (1-5) # 2=Never married (only 6)
Education , M104A	What level of schooling have you last attended? (in open form)	0=No education; 1=Primary; 2=Secondary; 3=Higher *****
Religion, M109	What is your religion? 1=Islam; 2=Hinduism; 3=Buddhism; 4=Christianity; 6=Others	1=Islam 2=Others (2-6)
Currently working M115	Are you currently working? 1=Yes; 2=No	1=Yes 2=No
Duration in slums M127	How long have you been here? 1-24 years (in continuous form); 95=Less than 1 year; 97=Always	1=<5 years; 2=5-9 years; 3= 10-<24 years; 4=Permanent
Have any STIs? M503AA, M503AB, M503AC	Sexually Transmitted Diseases Any discharge from penis? (Option: yes, no) Any sore on or near penis? (Option: yes, no) Any pain during urination? (Option: yes, no)	0=No, for all options. 1=Yes, for any of the options
TV Watching, M108	Do you watch TV? 1=Yes, 2=No	1=Yes; 2=No
Income M120	Net salary/wage during the last month in (BDT) ¶ (in continuous form)	0=No income (None) 1=<5000; 2=5000+
Wealth quintiles **	Basic durable goods and assets in household	1=poorest; 2=poor; 3=middle; 4=rich; 5=richest

currently married or married at least once; ***** at least 11 years of education; ¶ Bangladeshi Taka and exchange rate is 78.11 BDT/USD; ******quintiles based on principal component analysis.

Appendix C3: Model Diagnostic Results of Binary Logistic Regressions- IDU and TC, General Male Population of Bangladesh

Criteria	Taking any drugs: Response or dependent variable						
	Smoking cigarettes (no/yes)	Smoking cigarettes (1-5, 6+)	Smoking *bidis* (no/ yes)	Smoking *bidis* (1-10, 11+)	Use other tobacco (yes/no)	Use other tobacco (1-5, 6+)	Any type used (not used/any used)
Model summary							
Cox and Snell R^2	0.035	0.040	0.027	0.027	0.028	0.0328	0.04
Nagelkerke R^2	0.142	0.163	0.110	0.111	0.113	0.133	0.163
H-L test p-values	0.143	0.684	0.314	0.058	0.999	0.483	0.704
Overall classification	96.8%						
Checking Multicollinearity 1. By standard errors (SEs) 2. By variance inflation factor (VIF) 3. Correlation matrix	1. The SEs of independent variables is <1.00 (recommended value is **0.001-5.0**) 2. The VIF of independent variables is <1.00 (recommended value is **≤3**) 3. The correlation between any two variables are within the tolerance level						
Therefore, clear evidence of no multicollinearity							

Appendix C4: Model Diagnostic Results of Binary Logistic Regressions- IDU and TC, General Male Population of Bangladesh

Criteria	Taking any one drug (main): Response or dependent variable						
	Smoking cigarettes (no/yes)	Smoking cigarettes (1-5, 6+)	Smoking *bidis* (no/ yes)	Smoking *bidis* (1-10, 11+)	Use other tobacco (yes/no)	Use other tobacco (1-5, 6+)	Any type used (not used/any used)
Model summary							
Cox and Snell R^2	0.026	0.029	0.023	0.023	0.022	0.026	0.033
Nagelkerke R^2	0.119	0.135	0.105	0.107	0.100	0.119	0.150
H-L test p-values	0.310	0.828	0.417	0.163	0.526	0.508	0.805
Overall classification	97.3%						
Checking Multicollinearity 1. By standard errors (SEs) 2. By variance inflation factor (VIF) 3. Correlation matrix	1. The SEs of independent variables is <1.00 (recommended value is **0.001-5.0**) 2. The VIF of independent variables is <1.00 (recommended value is **≤3**) 3. The correlation between any two variables are within the tolerance level						
Therefore, clear evidence of no multicollinearity							

Appendix C5: Model Diagnostic Results of Binary Logistic Regressions- IDU and TC by Background Characteristics, Urban Slum Male Population of Bangladesh

Criteria	TC (cigarettes/*bidis*)	IDU (any)
Model summary Cox and Snell R^2 Nagelkerke R^2	 0.092 0.124	 0.089 0.132
Hosmer and Lemeshow test p-values	 0.474	 0.323
Overall classification	81.3%	79%
Checking Multicollinearity 1. By standard errors (SEs) 2. By variance inflation factor (VIF) 3. Correlation matrix	1. The SEs of independent variables is <1.00 (recommended value is 0.001-5.0) 2. The VIF of independent variables is <1.00 (recommended value is ≤3) 3. The correlation between any two variables are within the tolerance level	
Therefore, clear evidence of no multicollinearity		

Appendix C6: Model Diagnostic Results of Binary Logistic Regressions- IDU and TC, Urban Slum Male Population of Bangladesh

Criteria	Taking any drugs		
	Tobacco consumption (cigarettes/*bidis*) (yes/no)	No. of cigarettes per day (1-5, 6-10, 10+)	No. of *bidis* per day (1-5, 6-10, 10+)
Model summary Cox and Snell R^2 Nagelkerke R^2	 0.096 0.211	 0.091 0.199	 0.048 0.106
H-L test p-values	 0.737	 0.642	 0.143
Overall classification	90.9%		
Checking Multicollinearity 1. By standard errors (SEs) 2. By variance inflation factor (VIF) 3. Correlation matrix	1. The SEs of independent variables is <1.00 (recommended value is **0.001-5.0**) 2. The VIF of independent variables is <1.00 (recommended value is **≤3**) 3. The correlation between any two variables are within the tolerance level		
Therefore, clear evidence of no multicollinearity			

APPENDIX D: S-Plus Programming Syntax for Chapter 5

(Sample syntax for drawing diamond-shaped equiponderant graphs for **Bangladesh**[7]) (**Source**: Li et al., 2003)

Appendix D1: Syntax for Both (Men and Women), Bangladesh

```
row <- 4
col <- 4
par(pty="s")
plot(0,0, plim=c(0-row, col), qlim=c(0,row+col),axes=F, type="n", plab="", qlab="")
for (i in 1:4)
{
  if (i == 1){
    cp <- seq(0,(col-1) )
    cq <- seq(1,col)
  }
  else{
    cp <- c(cp, seq( (1-i),(col-i) ) )
    cq <- c(cq, seq(i,(col+i-1)) )
  }
}
outcome <- c(.518,.558,.537,.497,
             .577, .647,.671,.626,
             .479,.461,.443,.321,
             .756,.766,.752,.642)
k <- outcome
scale <- 1.005 - 0.005*(row+col)
k[k<1] <- k[k<1] *scale
k[k==1] <- k[k==1]*scale+0.005
for (i in 0:row) lines(c(-i,col-i),c(i,col+i),lwd=0.01)
for (i in 0:col) lines(c(i, -row+i), c(i, row+i),lwd=0.01)
p1<- cp - (1-k)/2
p2<- cp + (1-k)/2
p3<- cp + (1+k)/2
p4<- cp + (1-k)/2
p5<- cp - (1-k)/2
p6<- cp - (1+k)/2
q1<- cq + k
q2<- cq + k
q3<- cq
q4<- cq - k
q5<- cq - k
q6<- cq
n <- row*col
for (i in 1:n) {
  if (k[i]>0)
    polygon(c(p1[i],p2[i],p3[i],p4[i],p5[i],p6[i]),
            c(q1[i],q2[i],q3[i],q4[i],q5[i],q6[i]), density=-.1, border=F, col=5)
```

[7] The same syntax was used for drawing diamond-shaped equiponderant graphs for **India** by changing the relevant parameters.

```
  if (outcome[i]>=0){
 # In Windows system, S-plus needs 0.03 to be added to cq so that label is properly centered
    text(cp[i], cq[i]+.03, outcome[i]*100, cex=0.7*scale, lwd=2)
  }
}
text(c(-0.7,-0.7), c(.35,.35), adj=1, cex=.9,"Home")
text(c(-1.7,-1.7), c(1.35,1.35), adj=1, cex=.9,"Indoor workplaces")
text(c(-2.7,-2.7), c(2.35,2.35), adj=1, cex=.9,"Public Places")
text(c(-3.5,-3.5), c(3.35,3.35), adj=1, cex=.9,"Overall")
text(c(0.7, 0.7), c(.35,.35), adj=0, cex=.9,"15-24")
text(c(1.7, 1.7), c(1.35,1.35), adj=0, cex=.9,"25-44")
text(c(2.7, 2.7), c(2.35,2.35), adj=0, cex=.9,"45-59")
text(c(3.7, 3.7), c(3.35,3.35), adj=0, cex=.9,"60+")
```

Appendix D2: Syntax for Men, Bangladesh

```
row <- 4
col <- 4
par(pty="s")
plot(0,0, plim=c(0-row, col), qlim=c(0,row+col),axes=F, type="n", plab="", qlab="")
for (i in 1:4)
{
  if (i == 1){
    cp <- seq(0,(col-1) )
    cq <- seq(1,col)
  }
  else{
    cp <- c(cp, seq( (1-i),(col-i) ) )
    cq <- c(cq, seq(i,(col+i-1)) )
  }
}
outcome <- c(.541,.589,.567,.531,
             .643, .701,.685,.635,
             .743,.741,.646,.463,
             .898,.897,.868,.741)
k <- outcome
scale <- 1.005 - 0.005*(row+col)
k[k<1] <- k[k<1] *scale
k[k==1] <- k[k==1]*scale+0.005
for (i in 0:row) lines(c(-i,col-i),c(i,col+i),lwd=0.01)
for (i in 0:col) lines(c(i, -row+i), c(i, row+i),lwd=0.01)
p1<- cp - (1-k)/2
p2<- cp + (1-k)/2
p3<- cp + (1+k)/2
p4<- cp + (1-k)/2
p5<- cp - (1-k)/2
p6<- cp - (1+k)/2
q1<- cq + k
q2<- cq + k
q3<- cq
```

```
q4<- cq - k
q5<- cq - k
q6<- cq
n <- row*col
for (i in 1:n) {
  if (k[i]>0)
    polygon(c(p1[i],p2[i],p3[i],p4[i],p5[i],p6[i]),
            c(q1[i],q2[i],q3[i],q4[i],q5[i],q6[i]), density=-.1, border=F, col=5)
  if (outcome[i]>=0){

# In Windows system, S-plus needs 0.03 to be added to cq so that label is properly centered
    text(cp[i], cq[i]+.03, outcome[i]*100, cex=0.7*scale, lwd=2)
  }
}
text(c(-0.7,-0.7), c(.35,.35), adj=1, cex=.9,"Home")
text(c(-1.7,-1.7), c(1.35,1.35), adj=1, cex=.9,"Indoor workplaces")
text(c(-2.7,-2.7), c(2.35,2.35), adj=1, cex=.9,"Public Places")
text(c(-3.5,-3.5), c(3.35,3.35), adj=1, cex=.9,"Overall")
text(c(0.7, 0.7), c(.35,.35), adj=0, cex=.9,"15-24")
text(c(1.7, 1.7), c(1.35,1.35), adj=0, cex=.9,"25-44")
text(c(2.7, 2.7), c(2.35,2.35), adj=0, cex=.9,"45-59")
text(c(3.7, 3.7), c(3.35,3.35), adj=0, cex=.9,"60+")
```

Appendix D3: Syntax for Women, Bangladesh

```
row <- 4
col <- 4
par(pty="s")
plot(0,0, plim=c(0-row, col), qlim=c(0,row+col),axes=F, type="n", plab="", qlab="")
for (i in 1:4)
{
  if (i == 1){
    cp <- seq(0,(col-1) )
    cq <- seq(1,col)
  }
  else{
    cp <- c(cp, seq( (1-i),(col-i) ) )
    cq <- c(cq, seq(i,(col+i-1)) )
  }
}
outcome <- c(.496,.530,.504,.457,
             .235, .311,.500,.333,
             .222,.207,.219,.150,
             .617,.646,.624,.523)
k <- outcome
scale <- 1.005 - 0.005*(row+col)
k[k<1] <- k[k<1] *scale
k[k==1] <- k[k==1]*scale+0.005
for (i in 0:row) lines(c(-i,col-i),c(i,col+i),lwd=0.01)
for (i in 0:col) lines(c(i, -row+i), c(i, row+i),lwd=0.01)
```

```
p1<- cp - (1-k)/2
p2<- cp + (1-k)/2
p3<- cp + (1+k)/2
p4<- cp + (1-k)/2
p5<- cp - (1-k)/2
p6<- cp - (1+k)/2
q1<- cq + k
q2<- cq + k
q3<- cq
q4<- cq - k
q5<- cq - k
q6<- cq
n <- row*col
for (i in 1:n) {
  if (k[i]>0)
    polygon(c(p1[i],p2[i],p3[i],p4[i],p5[i],p6[i]),
            c(q1[i],q2[i],q3[i],q4[i],q5[i],q6[i]), density=-.1, border=F, col=5)
  if (outcome[i]>=0){

 # In Windows system, S-plus needs 0.03 to be added to cq so that label is properly centered
    text(cp[i], cq[i]+.03, outcome[i]*100, cex=0.7*scale, lwd=2)
  }
}
text(c(-0.7,-0.7), c(.35,.35), adj=1, cex=.9,"Home")
text(c(-1.7,-1.7), c(1.35,1.35), adj=1, cex=.9,"Indoor workplaces")
text(c(-2.7,-2.7), c(2.35,2.35), adj=1, cex=.9,"Public Places")
text(c(-3.5,-3.5), c(3.35,3.35), adj=1, cex=.9,"Overall")
text(c(0.7, 0.7), c(.35,.35), adj=0, cex=.9,"15-24")
text(c(1.7, 1.7), c(1.35,1.35), adj=0, cex=.9,"25-44")
text(c(2.7, 2.7), c(2.35,2.35), adj=0, cex=.9,"45-59")
text(c(3.7, 3.7), c(3.35,3.35), adj=0, cex=.9,"60+")
```

APPENDIX E: List of Publications and Papers Presented

Publications [8]

(A) Published/accepted based on findings of **PhD thesis**

1. **Kabir**, **M. A.,** & Goh, K. L. (**2013**). Determinants of Tobacco Use among Students Aged 13-15 Years in Nepal and Sri Lanka: Results from Global Youth Tobacco Survey, 2007. *Health Education Journal*, doi: 10.1177/0017896912469576
2. **Kabir**, **M. A.,** Goh, K. L., & Khan, M. M. H. (**2013**). A Cross-country Comparison of Tobacco Consumption among Youths from Selected South Asian Countries. *BMC Public Health, 13*, 379. doi:10.1186/1471-2458-13-379
3. **Kabir**, **M. A.,** Goh, K. L., Kamal, S. M. M., & Khan, M. M. H. (**2013**). Tobacco Smoking and Its Association with Illicit Drug Use among Young Men Aged 15-24 Years Living in Urban Slums of Bangladesh. *PLoS ONE, 8*(7), e68728. doi:10.1371/journal.pone.0068728
4. **Kabir**, **M. A.,** Goh, K. L., & Khan, M. M. H. (**2013**). Adolescent Tobacco Use and Its Determinants: Evidence from Global Youth Tobacco Survey, Bangladesh 2007. *Asia-Pacific Journal of Public Health*, doi: 10.1177/1010539512472357
5. **Kabir**, **M. A.,** Goh, K. L., & Khan, M. M. H. (**2012**). Tobacco Consumption and Illegal Drug Use among Bangladeshi Males: Association and Determinants. *American Journal of Men's Health*, *7*(2), 128-137. doi: 10.1177/1557988312462737

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2. **Kabir**, **M. A.,** & Goh, K. L. (**2012**). Data Mining: Techniques and Applications in Healthcare. Presented at a Seminar in the Department of Public Health Medicine, School of Public Health, University of Bielefeld, **Germany**: September 14.
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4. **Kabir, M. A.,** Goh, K. L., Khan, M. M. H., Al-Amin, A. Q., & Azam, M. N. (2011). Determinants of Safe-delivery Practices among Bangladeshi Women. Presented in UM-QUB Public Health Research Collaboration Symposium, Improving Population Health through Translational Research, at UMMC, **Malaysia**: July 13.
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Determinants of tobacco use among students aged 13–15 years in Nepal and Sri Lanka: Results from the Global Youth Tobacco Survey, 2007

MA Kabir[a,b] and Kim-Leng Goh[a]

[a]Department of Applied Statistics, Faculty of Economics and Administration, University of Malaya, Malaysia
[b]Department of Statistics, Jahangirnagar University, Bangladesh

Abstract

Objectives: This study aims to investigate tobacco use behaviours and its correlates among secondary school students in Nepal and Sri Lanka together with cross-country comparisons.

Design: Cross-sectional survey.

Methods and Settings: The data were from the Global Youth Tobacco Survey (GYTS), 2007. Current tobacco use was considered as a response variable. Predictors were selected based on existing literature and theories on adolescent tobacco use. The data of 1,444 Nepalese and 1,377 Sri Lankan students aged 13–15 years was used for analysis.

Results: Prevalence of tobacco use varies with 9.4% and 9.1% among Nepalese and Sri Lankan students respectively. Boys (13.2 vs. 5.3 for Nepal, 12.4 vs. 5.8 for Sri Lanka), older and senior students was more likely to be tobacco users in both countries. The average age of tobacco initiation was 10.2 years in Nepal and 8.6 years in Sri Lanka. Factors, namely, individual characteristics, tobacco use among friends, smoking at home and public places, free tobacco products, and lessons about negative effects of tobacco in class were significantly associated with tobacco use in Nepal and Sri Lanka. For instance, friends' tobacco use was a good predictor for adolescents' usage (odds ratio [OR] = 4.0, confidence interval [CI] = 2.61–6.23 in Nepal; OR = 2.5, CI = 1.50–4.23 in Sri-Lanka). Similarly, course curriculum significantly reduced smoking among students.

Conclusion: Prevention of tobacco use among school students should be top priority of a country as they are long-term customers and replacement smokers who quit or die. Therefore comprehensive strategies as we proposed along with existing prevention programmes should be tightened to stop them from hazardous behaviours.

Keywords

adolescents, developing country, Global Youth Tobacco Survey, school students, tobacco use

Corresponding author:
MA Kabir (BSc, MSc), Department of Applied Statistics, Faculty of Economics and Administration, University of Malaya, 50603 Kuala Lumpur, Malaysia.
Email: alamgirfa_juniv@yahoo.com

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RESEARCH ARTICLE | Open Access

A cross-country comparison of tobacco consumption among youths from selected South-Asian countries

Mohammad Alamgir Kabir[1,2*], Kim-Leng Goh[3] and Mobarak Hossain Khan[4]

Abstract

Background: Tobacco consumption (TC) among youths poses significant public health problem in developing countries. This study utilized the data of Global Youth Tobacco Survey (GYTS), 2007 to examine and compare youth TC behavior in Bangladesh, Nepal and Sri Lanka.

Methods: The GYTS covered a total of 2,242 Bangladeshi, 1,444 Nepalese and 1,377 Sri-Lankan youths aged 13–15 years. They represented response rates of 88.9%, 94.6%, and 85.0% for the three countries, respectively. Socioeconomic, environmental, motivating, and programmatic predictors of TC were examined using cross tabulations and logistic regressions.

Results: Prevalence of TC was 6.9% (9.1% in males, 5.1% in females) in Bangladesh, 9.4% (13.2% in males, 5.3% in females) in Nepal and 9.1% (12.4% in males, 5.8% in females) in Sri Lanka. The average tobacco initiation age was 9.6, 10.24 and 8.61 years, respectively. Cross tabulations showed that gender, smoking among parents and friends, exposure to smoking at home and public places, availability of free tobacco were significantly ($P < 0.001$) associated with TC in all three countries. The multivariable analysis [odds ratio (95% confidence interval)] indicated that the common significant predictors for TC in the three countries were TC among friends [1.9 (1.30-2.89) for Bangladesh, 4.10 (2.64-6.38) for Nepal, 2.34 (1.36-4.02) for Sri Lanka], exposure to smoking at home [1.7 (1.02-2.81) for Bangladesh, 1.81 (1.08-2.79) for Nepal, 3.96 (1.82-8.62) for Sri Lanka], exposure to smoking at other places [2.67 (1.59-4.47) for Bangladesh, 5.22 (2.76-9.85) for Nepal, 1.76 (1.05-2.88) for Sri Lanka], and the teaching of smoking hazards in schools [0.56 (0.38-0.84) for Bangladesh, 0.60 (0.41-0.89) for Nepal, 0.58 (0.35-0.94) for Sri Lanka].

Conclusions: An understanding of the influencing factors of youth TC provides helpful insights for the formulation of tobacco control policies in the South-Asian region.

Keywords: Developing country, Global youth tobacco Survey, Secondary school students, Tobacco consumption

Background

Annually, tobacco consumption (TC) kills more than 5 million people worldwide and the number is projected to increase to 8 million by 2030. More than 80% of those deaths will be in low- and middle-income countries [1,2]. In South Asia, approximately 1.2 million people die every year from TC [1]. The prevalence of TC and the associated consequences are declining rapidly in developed countries. However, TC of any form and the resulting death rates are still high in developing countries [1]. The gap in death rates due to TC between developing and developed countries is expected to increase over the next several decades [3]. The increase in youth TC, not only in percentages but also in numbers, in developing countries [1] widens this gap further. The prevalence of youth TC in developing countries varies by country and gender. However, the males are more likely to consume tobacco than females [4,5] in general.

Notable theories such as the theory of triadic influence, social learning theory, social identity theory, primary socialization theory, social network theory, and

* Correspondence: alamgirfa_juniv@yahoo.com
[1]Department of Applied Statistics, Faculty of Economics and Administration, University of Malaya, 50603, Kuala Lumpur, Malaysia
[2]Department of Statistics, Jahangirnagar University, Savar, Dhaka 1342, Bangladesh
Full list of author information is available at the end of the article

PLOS ONE

Tobacco Smoking and Its Association with Illicit Drug Use among Young Men Aged 15-24 Years Living in Urban Slums of Bangladesh

Mohammad Alamgir Kabir[1,2]*, Kim-Leng Goh[3], Sunny Mohammad Mostafa Kamal[4,5], Md. Mobarak Hossain Khan[6]

1 Department of Applied Statistics, Faculty of Economics and Administration, University of Malaya, Kuala Lumpur, Malaysia, **2** Department of Statistics, Jahangirnagar University, Savar, Dhaka, Bangladesh, **3** Department of Applied Statistics, Faculty of Economics and Administration, University of Malaya, Kuala Lumpur, Malaysia, **4** Visiting Research Fellow, Unit for the Enhancement of Academic Performance, Office of the Vice-Chancellor, University of Malaya, Kuala Lumpur, Malaysia, **5** Department of Mathematics, Islami University, Kustia, Bangladesh, **6** Department of Public Health Medicine, School of Public Health, Bielefeld University, Postfach, Bielefeld, Germany

Abstract

Background: Tobacco smoking (TS) and illicit drug use (IDU) are of public health concerns especially in developing countries, including Bangladesh. This paper aims to (i) identify the determinants of TS and IDU, and (ii) examine the association of TS with IDU among young slum dwellers in Bangladesh.

Methodology/Principal Findings: Data on a total of 1,576 young slum dwellers aged 15–24 years were extracted for analysis from the 2006 Urban Health Survey (UHS), which covered a nationally representative sample of 13,819 adult men aged 15–59 years from slums, non-slums and district municipalities of six administrative regions in Bangladesh. Methods used include frequency run, Chi-square test of association and multivariable logistic regression. The overall prevalence of TS in the target group was 42.3%, of which 41.4% smoked cigarettes and 3.1% smoked *bidis*. The regression model for TS showed that age, marital status, education, duration of living in slums, and those with sexually transmitted infections were significantly ($p<0.001$ to $p<0.05$) associated with TS. The overall prevalence of IDU was 9.1%, dominated by those who had drug injections (3.2%), and smoked *ganja* (2.8%) and *tari* (1.6%). In the regression model for IDU, the significant ($p<0.01$ to $p<0.10$) predictors were education, duration of living in slums, and whether infected by sexually transmitted diseases. The multivariable logistic regression (controlling for other variables) revealed significantly ($p<0.001$) higher likelihood of IDU (OR = 9.59, 95% CI = 5.81–15.82) among users of any form of TS. The likelihood of IDU increased significantly ($p<0.001$) with increased use of cigarettes.

Conclusions/Significance: Certain groups of youth are more vulnerable to TS and IDU. Therefore, tobacco and drug control efforts should target these groups to reduce the consequences of risky lifestyles through information, education and communication (IEC) programs.

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* E-mail: alamgirfa_juniv@yahoo.com

Introduction

Tobacco smoking (TS) is a leading cause to many preventable and premature deaths. Recent statistics show that about 1.3 billion people smoke worldwide [1] and six million people die annually from the consequences of TS [2]. It is anticipated that by 2030, over 8 million people will die annually due to TS related health problems, of which 80% will occur in low and middle income countries [2,3]. In addition to loss of human capital, TS can cause huge economic damage worldwide every year, especially in poor countries [2]. Unfortunately, the prevalence of TS is high among young males in low-income countries such as India (16.8%), Nepal (13.0%), Sri Lanka (12.4%), Maldives (8.5%), Pakistan (12.4%) and Myanmar (22.5%). This phenomenon may be attributed to various factors like urbanization, promotional marketing strategies of tobacco industries, westernization and misconception that associates smoking with maturity [2]. While smoking cigarettes and *bidis* are common habits among the general male population in Bangladesh, TS is also widespread among the young males (9.1%) [4–7].

Like TS, the prevalence of substance use and its impacts are increasingly serious. The consequences of illicit drug use (IDU) are particularly worrying in developing countries due to poor health infrastructure and limited resources to deal with the problem [8]. Geographically Bangladesh is highly vulnerable to IDU because of its proximity to the drug trafficking zones of the Golden Triangle and the Golden Crescent, and its common boundary with India (a heavy consumer of opium) and Myanmar (where drug abuse is serious) [8,9]. TS has long been recognized as a "gateway drug" to

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Adolescent Tobacco Use and Its Determinants: Evidence From Global Youth Tobacco Survey, Bangladesh 2007

M. A. Kabir, BSc, MSc[1], Kim-Leng Goh, MSc, PhD[1], and M. M. H. Khan, MSc, PhD[2]

Abstract

Adolescent tobacco use (ATU) is on the rise worldwide and the problem is particularly severe in developing countries. Based on nationally representative data, this study aims to investigate the association between ATU and its possible correlates for Bangladesh, where the prevalence rate of ATU is high. The data set is extracted from the Global Youth Tobacco Survey for Bangladesh conducted in 2007. The survey collected information from a total of 3113 students from 52 schools, with a response rate of 100% at the school level, while a response rate of 88.9% was achieved from the students. Students covered in the survey were in grades 7, 8, 9, and 10, with age ranging from 11 to 17 years. The prevalence rate of ATU at the time of the survey was 8.4%, while 35.6% of the students had used at least a type of tobacco products before. Logistic regressions were used to obtain the odds ratios (ORs) in favor of ATU for each of the possible determinants and the confidence intervals (CIs) of these ratios. Use of tobacco among friends (OR = 3.46; CI = 2.37-5.05), the experience of seeing others smoking at home (OR = 2.10; CI = 1.36-3.22) or other places (OR = 1.6; CI = 1.02-2.57), receiving pocket money (OR = 7.6; CI = 4.59-13.28), receiving free tobacco from vendors (OR = 2.3; CI = 1.44-3.78), and exposure to advertisements and promotions of tobacco products (OR = 1.83; CI = 1.23-2.79) were associated with a higher likelihood of ATU. Increased awareness of health hazards of tobacco use through education in schools helped mitigate the problem of ATU. The findings of this study have ramifications for tobacco control prevention strategies in Bangladesh.

Keywords

adolescents, Bangladesh, school students, theory of triadic influence, tobacco use

[1]Department of Applied Statistics, Faculty of Economics and Administration, University of Malaya, Kuala Lumpur, Malaysia
[2]Bielefeld University School of Public Health, Bielefeld, Germany

Corresponding Author:
M. A. Kabir, Department of Applied Statistics, Faculty of Economics and Administration, University of Malaya, 50603 Kuala Lumpur, Malaysia
Email: alamgirfa_juniv@yahoo.com

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Tobacco Consumption and Illegal Drug Use Among Bangladeshi Males: Association and Determinants

M. A. Kabir, BSc, MSc[1,2], Kim-Leng Goh, MSc, PhD[1], and M. M. H. Khan, MSc, PhD[3]

Abstract

This article aimed to identify the determinants of tobacco consumption and illegal drug use (IDU) as well as to examine the association between these two variables using a representative sample of 3,771 Bangladeshi males aged 15 to 54 years. Data were collected through Bangladesh Demographic and Health Survey 2007. To identify the determinants, the patterns of tobacco consumption and IDU were analyzed by age, education and occupation, residence, mass media, premarital sex, wealth, and sexually transmitted infections (STIs). Prevalence of smoking cigarette and *bidi* was roughly 60%. However, the prevalence of IDU was 3.4%, and this proportion is statistically significant ($Z = 11.32$, $p = .000$). After bivariate analysis, almost all variables except STIs were significantly associated with tobacco consumption. Similarly, all variables except residence and mass media were associated with IDU. Based on multivariable adjusted logistic regression analysis, the likelihood of using IDU was approximately twofold (odds ratio [OR] = 1.8, 95% confidence interval [CI] = 1.23-2.53) among *bidi* smokers and fourfold (OR = 3.8, 95% CI = 2.62-5.56) among cigarette smokers as compared with nonsmokers.

Keywords

Bangladesh, illicit drugs, tobacco consumption, demographic and health survey

Introduction

Tobacco consumption is one of the biggest global public health problems, causing more than 5 million deaths annually. Although tobacco-related deaths between 2002 and 2030 were projected to decline gradually in developed countries, such deaths were anticipated to increase from 3.4 million to 6.8 million in developing countries (Ezzati et al., 2002; Mathers & Loncar, 2006). Research on tobacco consumption in developing nations by sociodemographic and economic groups is limited as well as diverse depending on the nature and types of population reported. In South Asia, different types of tobacco consumption, such as cigarettes, *bidis*,[1] *hookah*,[2] and smokeless tobacco (usually consumed orally or nasally, without burning or combustion), such as chewing tobacco,[3] are more common (Chadda & Sengupta, 2002; Eriksen, Mackay, & Ross, 2012). Various socioeconomic factors are found to be associated with these tobacco patterns. Studies regarding tobacco consumption in developing countries provided mixed results. For instance, tobacco consumption was more among people of the poorest socioeconomic status in terms of poverty, low education, and manual or lower paid occupation in countries such as Bangladesh and India (Aekplakorn et al., 2008; Khan, Khandoker, Kabir, Kabir, & Mori, 2006; Schaap, van Agt, & Kunst, 2008). However, in some low- and middle-income countries, tobacco consumption, especially smoking cigarette, is more prevalent among the more affluent groups, which is not the case in high-income countries (Jha & Chaloupka, 2000).

The high level of tobacco consumption in many developing countries is alarming (Shafey, Eriksen, Ross, &

[1]Faculty of Economics and Administration, University of Malaya, Kuala Lumpur, Malaysia
[2]Department of Statistics, Jahangirnagar University, Dhaka, Bangladesh
[3]Bielefeld University School of Public Health, Bielefeld, Germany

Corresponding Author:
M. A. Kabir, Faculty of Economics and Administration, Department of Applied Statistics, University of Malaya, 50603 Kuala Lumpur, Malaysia
Email: alamgirfa_juniv@yahoo.com