Economic evaluation of tobacco control in Asia

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CHAPTER 1

General Introduction

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Tobacco was introduced to Europe in the late fifteenth century.(1) The rapid spread of tobacco use in the form of cigarettes occurred in Western countries at the time of World War II. Approximately 40 years after its spread in Western countries, the practice of cigarette smoking became more prevalent in Asia. (2) Particularly in Asian countries that opened their market economy during the 1990's, consumption of cigarettes per person significantly increased. Partly driven by this rise, the number of tobacco-related deaths is projected to increase from about 7 million deaths to more than 8 million annually by 2030, with the largest share occurring in Asia.(3-5) Currently, Asia houses about half of the world's smokers and is the largest tobacco consumer as well as producer. The tobacco smoking epidemic is still in its early stages and will remain a major public health threat for the coming decades. (6-8)

Mongolia is a middle-income country, located in Central Asia. Like many countries in Asia, the country has experienced rapid economic growth over the past decade, which has contributed to a demographic and epidemiological transition. (9) From 1990 to 2020, its total population has increased from 2.2 million to 3.3 million and average life expectancy at birth rose from 63 years to 70 years. (10) However, disparities in life expectancy have risen as well – men live almost ten years shorter than women (66 years versus 76 years). Mongolia has a relatively young population; about 60% of the total population was under 35 years in 2018. Smoking prevalence has remained unchanged during the past decade. Among people aged 15 and over, 27% are current smokers and almost half of men smoke compared with 5% of women, an important explanation for the large difference in life expectancy. (11) Similar to many other countries in Asia, death due to noncommunicable diseases (NCDs) such as cardiovascular diseases and cancers is now the most common cause of death, responsible for almost 80% of total mortality. (12)(13)

Numerous studies, primarily in Western countries, have shown that tobacco smoking is a major risk factor not only for lung cancer but also for different types of cancer, cardiovascular diseases and respiratory diseases. (14-16) In addition to the harmful effects of smoking on morbidity and mortality, smoking also imposes substantial economic costs on individuals, society and

the health system. (17) Smoking-related health care accounts for about 6% of global health care costs or 1.8% of the world's GDP. (18)

As part of global, regional and local tobacco control strategies, a range of tobacco control interventions have been introduced to reduce tobacco use, smoking related deaths, disease burdens, and economic costs. (19-21) To accelerate implementation of tobacco control measures, the WHO encourages countries to realize at least one evidence-based measure included in the MPOWER package at the highest level of achievement in their context. The measures include: **M**onitor tobacco use and prevention policies; **P**rotect people from tobacco smoke; **O**ffer help to quit tobacco use; **W**arn about the dangers of tobacco; **E**nforce bans on tobacco advertising, promotion, and sponsorship; and **R**aise taxes on tobacco.

Choosing one intervention over another is challenging. It requires robust and comparable estimates for all relevant interventions regarding their health benefits and net costs. Decision analytic models are used to estimate the cost-effectiveness of policies and interventions. (22)(23) Decision analytic models serve to combine evidence from different sources and to extrapolate to ensure that the time horizon and setting match the required decision making context. As such a valid model, using input data that properly reflect the local situation is important. In practice, cost-effectiveness results depend on the type of model chosen and sources of information being used. (24-26) Various modeling approaches have been used to assess the cost-effectiveness of tobacco control interventions, but most models were developed in Western settings. (27)(26)

A limited number of studies on the cost-effectiveness of tobacco control interventions in an Asian setting are available. Even when studies compared the cost-effectiveness of a range of interventions for countries in Asia, the estimates were heterogeneous regarding the decision analytic models used and input data included. (28) Therefore, it is important to estimate a range of alternative interventions using locally relevant sources of information that reflect the particular context of Mongolia as much as possible, combined with the help of a dynamic model structure for health impact assessment. Several

chapters in this thesis addresses issues encountered when striving for such an overall comparison of the cost-effectiveness of several tobacco control measures. The introduction will now discuss the background against which these evaluations were performed.

Tobacco smoking worldwide, in Asia and in Mongolia

Around 25% of the global population aged 15 years and older were tobacco users in 2015. This number is projected to decline further to around one fifth (21%) by 2025, assuming that current efforts in tobacco controls are maintained in all countries. (3)(4) Smoking prevalence has declined steadily in the past few decades in many Western countries.

In contrast, for Asia, the estimated increase was the highest among all WHO regions. By 2020, the prevalence of smoking was about 28% in Asian countries compared to 12% in African countries and 18% in the Americas. (3)

As in many other LMICs in Asia, tobacco smoking is still high in Mongolia. The consumption of tobacco was historically heavily influenced by the two neighboring countries, Russia and China. (9) In the late sixteenth century, tobacco was introduced to Mongol leaders as a diplomatic gift by the Chinese. In the next century, it became a much-demanded commodity, popular not only with the Mongols themselves, but also with Russians, Uzbeks, Kazakhs, Kyrgyz, and Turks. (17)

Since the economic transition in the early 1990's, the Mongolian population has experienced aggressive marketing of tobacco products. Consequently, changes in lifestyle, including smoking of cigarettes, have adversely affected people's health. (9) The use of cigarettes increased when they became widely available in the market. (29)

The WHO's Stepwise approach to surveillance (STEPS) survey was first conducted in Mongolia in 2006 and later in 2009, 2013 and 2019. This resulted in reliable and easily comparable estimates of the prevalence of smoking. Table 1 summarizes the main findings from these surveys over the period 2006 to 2019. (30-33) The survey showed that the prevalence of current smoking has remained around 24% among people aged 15-64 years from 2006 to in

2019. However, population aged over 15 years has been grown around 18% over the past decade in Mongolia. Conversely, the country has experienced an aggressive tobacco market; the quantity of tobacco products at the local market increased by almost 52%, which contributed to the increase of per capita cigarette consumption by 41% in this period.

Table 1. Trends in cigarette consumption, smoking prevalence and smokers in Mongolia. (source: STEP surveys, 2006-2019)

Year	Population aged 15+ (in million)	Prevalence of current smoking ** 15+	Total quantity of cigarettes* (in million pack)	Per capita consumption (in per pack)
2006	1.85	24.2%	89	48.2
2007	1.87	26.1%	146	78.2
2008	1.92	27.2%	172	89.5
2009	1.97	27.6%	144	73.3
2010	2.01	27.8%	135	67.3
2011	2.06	27.7%	176	85.5
2012	2.09	27.5%	177	84.6
2013	2.13	27.1%	160	75.4
2014	2.15	26.6%	166	77.3
2015	2.15	26.1%	152	70.7
2016	2.18	25.5%	162	74.2
2017	2.21	25.0%	199	90.1
2018	2.24	24.5%	175	78.1
2019	2.26	24.2%	185	81.8
Percentage change (2006-2019)	18%	-	52%	41%

*Imported and domestic cigarettes. ** data from STEP surveys.

A substantial difference in smoking by gender exists. Figure 1 shows smoking by sex, over the period from 2006 to 2019. Almost half of men in Mongolia smoke in contrast to about 5% of women in Mongolia. (30-33)

In addition, surveys found that men start at earlier age and smoke more cigarettes per day than women. The recent global youth survey found that about 8% of boys and about 3% of girls aged between 13 and 15 years old smoked tobacco in 2014. (34)

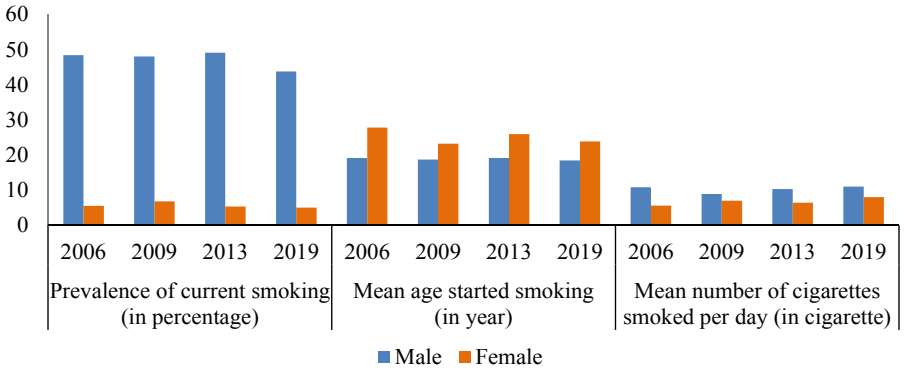

Figure 1. Comparison of smoking patterns by gender over time

The significantly higher rate of male smokers compared to female smokers is a trend found in many other Asian countries such as China (49% versus 2%), the Republic Korea (37% versus 5%), India (40% versus 11%), Thailand (43% versus 4%) and Japan (31% versus 9%). (34)

A pooled meta-analysis based on individual participant data from 20 cohort studies in Asian countries highlighted that the burdens associated with tobacco smoking continues to increase among Asian men, indicating that tobacco smoking will remain a major public health problem in Asian countries for the coming decades, especially when women catch up with men in this respect. (6) (7)

Effects of tobacco use on health and health care costs

Globally, tobacco accounts for over 7 million deaths every year. (36) Tobacco smoking is a major risk factor for many noncommunicable diseases (NCDs), including cardiovascular disease, chronic respiratory disease, diabetes and

many types of cancer. The proportion of deaths attributable to tobacco smoking was 38% for ischemic heart disease, 71% for lung cancer and 42% for chronic obstructive pulmonary disease (COPD). (37) In South East Asia, an estimated 1.3 million people die every year from smoking-related diseases, also placing a huge burden on health care systems. (38)

To get to these numbers, the effect of tobacco smoking on the risk of death is needed. Typically, this is done by using smoking-associated relative risks (RRs). However, smoking patterns, histories of previous smoking (number of pack years typically smoked) and hence the magnitude of this relative risk among smokers are much lower in most Asian populations than in a typical Western population as often used to inform these relative risks. (39) For instance, the RR of lung cancer was almost fivefold smaller in Asian countries than the estimates using cohorts from Western countries. (6)(7)(40) This might partly be a temporary effect, related to the early stage of the tobacco epidemic in Asia. It may also be partially related to a relative lack of long-term follow-up data. (16)(41)

A pooled analysis of 21 cohort studies in Asia has shown that the mortality associated with tobacco smoking has continued to rise in recent birth cohorts. For example, the RR associated with lung cancer death rose from 3.4 to 4.8 among birth cohorts who were born before and after 1930 respectively. This study also shows that RRs are smaller in women than in men, reflecting a difference in smoking intensity.

Like in many other Asian countries, NCDs are a major cause of morbidity and mortality in Mongolia. The prevalence of smoking-related diseases is expected to increase, mainly due to the plateaued prevalence of tobacco smoking and population growth. Currently, more than half of men die at an age when they could still contribute to the labor-force (under 60 years old) as compared to 30% of women. (12) It is hence relevant to investigate what part of these early deaths is attributable to tobacco smoking and potentially preventable.

Chapter 2 analyzes the population attributable fraction of tobacco smoking in lung cancer related disability adjusted life years (DALY) lost for

the past decade. Reducing tobacco use will reduce the number of DALY lost as well as avoid future health care costs associated with NCDs. (42-44) The costs associated with NCDs consistently pose a huge economic burden on health systems, consuming a substantial part of scarce health care resources. (45) (46) Previous studies highlighted that health care spending on NCDs in Mongolia was similar to spending observed in HICs, and that it was dominated by inpatient care use. (47) Chapter 3 examines inpatient costs associated with three smoking-related diseases: COPD, Stroke and IHD, and investigates key cost drivers. In the absence of cost-effective prevention policies focusing on common NCD risk-factors such as tobacco smoking, these costs might rise further in the future.

Tobacco control interventions

To help countries to implement tobacco control policies, the WHO introduced six MPOWER measures in 2008 that have proven to be effective. (19) Countries are encouraged to implement at least one measure at the highest level of achievement. Figure 1 presents the share of the world population covered by the selected tobacco control policies in 2018. Only 14% of the global population living in 38 countries had a sufficiently high tobacco tax.

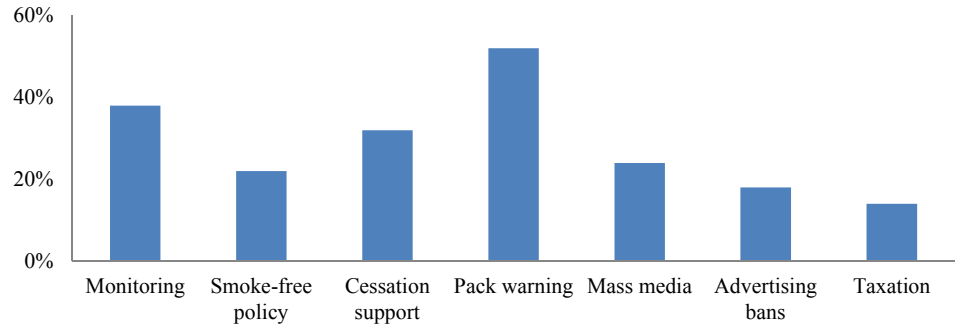

Figure 2. Share of the world population covered by selected tobacco control policies, 2018

According to WHO assessments, some of these measures have not reached the global recommended level in Mongolia. Table 2 shows the assessment of the MPOWER measures for Mongolia in 2019. The first tobacco control law was approved in 1993. (29) Subsequently, several policies, including the Law on tobacco control in 2005, the National program on noncommunicable disease (2017-2020) in 2005, and the National tobacco control strategy (2014-2020), were introduced. The latter started in 2013 with a set of measures to control tobacco use in line with the WHO FCTC provisions. (21)(48)(49)

Since 2012, the key measures adopted under the tobacco control law were to require large picture warnings on packs with text in the local language; to introduce smoke-free public places; to restrict the age for buying tobacco to 21 years and over; and to prohibit selling of tobacco products within 50 m of schools, kindergartens, dormitories or hospitals and on any type of public transportation.

Table 2. Summary of MPOWER measures in Mongolia, in 2018

M	P	O	W	E	R
Monitoring	Smoke-free policies	Cessation program	Health warning/ mass media	Advertising ban	Taxation/ cigarette affordability
Complete policy	Minimal policy	Minimal policy	Moderate policy	Complete policy	Minimal policy

Although tobacco taxation is considered the most effective measure to reduce tobacco use, non-tax measures have been the main approach in current tobacco control policy in Mongolia. (50) A previous study estimated that the largest number of future smoking attributable deaths averted was thanks to increased tobacco taxes (7 million), followed by comprehensive smoke-free laws (5.4 million), large graphic health warning (4.1 million), comprehensive marketing bans (3.8 million) and comprehensive smoking cessation support (1.5 million). (40)

However, the share of total tobacco taxes in the retail price of cigarettes was significantly lower in Mongolia than recommended by the WHO (about 47% in 2018, while the recommended level is 70%). (51) Hence, in this thesis, a 75% price increase intervention is evaluated to investigate the health benefits of reaching the recommended level. (Chapter 5)

Economic evaluation of tobacco control interventions

Economic evaluations (EE) can support priority-setting for efficient resource allocation in health care. (23) An EE compares at least two interventions in terms of costs and consequences. Many countries now require an EE study as part of a Health Technology Assessment (HTA) dossier, to inform whether alternative interventions represent sufficient value for money. (52) Evidence on the cost-effectiveness of tobacco control interventions in Asian countries is still quite limited, and was predominately conducted in the most high-income countries in Asia.

A review of 64 studies on economic evaluations of smoking cessation identified only two Asian studies, both of which were conducted in high-income countries (Japan and South Korea).(26) Another study which reviewed cost-effectiveness studies of tobacco control mass media campaigns found just one Asian study (conducted in Vietnam) out of 10 studies. (53) Given that most existing studies on the costs effectiveness of tobacco control interventions originated in Western countries or in the most affluent settings in Asia, transferring these results to other Asian countries, and in particular to more resource limited settings, is not straightforward. (54) Especially in Mongolia, where smoking patterns, demography and costs are different, the cost-effectiveness of tobacco interventions cannot be adopted directly from studies in a Western setting. Therefore, Chapter 6 performs a cost-effectiveness study of several MPOWER recommended tobacco control measures for Mongolia.

Simulation models used to estimate the long term impact of tobacco controls

Various decision analytic models have been applied in the field of tobacco control research to predict the future impact of tobacco interventions in terms of health benefits and costs. (55) In these analytic models, data from a range of sources are combined with a simulation model with a different structure. (22) A review found the benefit of smoking cessation on outcome (BENESCO) model, a Markov model, and the tobacco policy model were the most applied model structures to examine the cost-effectiveness of tobacco control interventions. (55) All of these were developed in HICs.

These, as well as most existing simulation models, were developed and validated in a limited range of countries, often high-income and located in the West. The transferability of these models and model-based analyses was not addressed in most applied studies. Welte et al. pointed out that several aspects of simulation models and the input data used to populate the models may need consideration when a cost-effectiveness study is to be transferred to another setting. (54) It remains unclear, therefore, whether current study results are relevant to inform policy in other settings, particularly in LMICs in Asia with their different baseline risks, costs, health care systems, and demography.

To support robust and accurate cost-effectiveness analysis, several checklists have been established and their use encouraged, including checklists for quality of model parameter, model structure, and reporting standards. (24) (56)(57) Chapter 5 reviews existing economic evaluation studies in an Asian setting and analyzes whether and how they take into account their differences to Western countries in their modeling approach, level of input data and type of model structure used.

AIM OF THIS THESIS

The overall aim of this thesis is to provide more insight into the health benefits and economic consequences of tobacco controls in a lower- middle income setting in Asia. More specifically, this thesis works towards a quantification of the long-term costs and effects of four tobacco control interventions advised as part of MPOWER: cessation support, school programs, a mass media campaign and increased tobacco taxes. In doing so, it aims to illustrate the use of the population dynamic health impact assessment approach, based on local and regional data. Mongolia serves as an illustrative example.

OUTLINE OF THIS THESIS

Chapter 2 investigates the burden of lung cancer attributable to tobacco smoking over time and by gender in Mongolia. Specifically, the study used patient-level data on lung cancer cases, combined with region-specific estimates for the relative risk of tobacco smoking, and smoking exposure information based on a STEPwise approach to surveillance (STEPS) national survey. The results could provide valuable information about the burden of tobacco smoking on population health in Mongolia.

Chapter 3 estimates the hospitalization costs associated with three smoking-related noncommunicable diseases (COPD, Stroke and IHD) over three recent years and investigates cost drivers. More specifically, the effect on costs of official or unofficial treatment referral patterns was investigated.

Chapter 4 provides an overview of model-based economic evaluation studies that have estimated the long-term costs and effects of tobacco control interventions in Asian countries. This systematic review focused on methodological assessments of the decision analytic models used in these evaluations. Using established checklists, risks of bias related to model structure, data and consistency were systematically assessed.

Chapter 5 presents the evaluation of the health benefits of a one-time tobacco tax increase in Mongolia. Particularly, the chapter quantifies smoking prevalence and the smoking-related burden of disease for different levels of price increase using the DYNAMO-HIA model that was developed and

validated in Western countries, but filled with local and regional input data.

Chapter 6 assesses the long-term cost-effectiveness of four tobacco control interventions, including tobacco tax increases, a mass media campaign, a secondary school program and cessation support for adult smokers, as compared to continuing current tobacco control policies in Mongolia.

Chapter 7 provides a general discussion in which insights from the previous chapters are synthesized, and their implications are discussed. Methodological challenges met are identified and perspectives for further research are sketched.

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