博士論文

論文題目　Global tobacco use trends and projections, 1990 to 2025:
an analysis of four tobacco use indicators

（たばこ使用における1990年から2025年の世界的傾向と将来予測

ーたばこ使用四指標の分析ー）

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Abstract

Objective: Tobacco control is a global health priority. Despite global progress in reducing tobacco use, country disparities in tobacco control persist. To track progress in tobacco control efforts, this study aimed to provide an up-to-date, comprehensive and consistent assessment of tobacco use trends and projections and of achievement of WHO 30% relative tobacco use reduction targets for as many countries as feasible.

Methods: A Bayesian hierarchical modeling approach was developed using tobacco use prevalence data from the WHO Comprehensive Information Systems for Tobacco Control. Trends for current tobacco smoking, daily tobacco smoking, current cigarette smoking, and daily cigarette smoking were assessed from 1990 to 2010, baseline projections were made to 2025 and probabilities for decreasing trends, increasing trends, and achievement of tobacco use reduction targets were obtained from posterior distributions.

Results: During 2000–2010, tobacco smoking prevalence fell in 125 countries (72%) for men and in 155 countries (87%) for women. Even if such global declines continue, only 37 countries (21%) are on track to achieve targets for men and 88 (49%) for women. These translate to more than one billion current tobacco smokers in 2025. If such trends continue, country disparities would persist and rapid increases are predicted in African and Eastern Mediterranean developing settings.

Conclusion: Globally, smoking prevalence trends are decreasing but tobacco use reduction targets remain unreachable for many countries, especially developing ones. If immediate, effective and sustained action is undertaken, desirable trajectories may be attained and maintained towards global convergence in tobacco use elimination.

Keywords: tobacco control, smoking prevalence, tobacco use trends, tobacco use projections, tobacco use targets, Bayesian hierarchical models

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List of abbreviations

AFR	WHO African Region
AMR	WHO Region of the Americas
BIC	Bayesian information criterion
BRFSS	Behavioral Risk Factor Surveillance System
CDC	Centers for Disease Control and Prevention
CIC	Comprehensive Information Systems for Tobacco Control
CTUMS	Canada Tobacco Use Monitoring Survey
DAG	Directed acyclic graph
DALY	Disability-adjusted life-year
DHS	Demographic and Health Surveys
EMR	WHO Eastern Mediterranean Region
ENDS	Electronic nicotine delivery systems
EUR	WHO European Region
FCTC	Framework Convention on Tobacco Control
GATS	Global Adult Tobacco Surveys
GBD	Global Burden of Disease
GTCR	Global Tobacco Control Report
GTSS	Global Tobacco Surveillance System
HEALTH	Help End Addiction to Lethal Tobacco Habits

IARC	International Agency for Research on Cancer
IHME	Institute for Health Metrics and Evaluation
LMI	Low- or middle-income
MCMC	Markov Chain Monte Carlo
NCDs	Non-communicable Diseases
RMSEs	Root-mean-squared-errors
RYO	Roll-your-own
SEAR	WHO Southeast Asian Region
SHS	Second-hand smoke
SIDS	Sudden infant death syndrome
SIR	Smoking impact ratio
STEPS	STEPwise approach to surveillance
UN	United Nations
USSG	US Surgeon General
WHO	World Health Organization
WPR	WHO Western Pacific Region

1. INTRODUCTION

Tobacco use is a global public health problem. Smoking kills six million people worldwide every year [1], accounting for one death every six seconds, and one of every two smokers die from their habit [2]. Although progress has been made worldwide in reducing tobacco use, disparities in tobacco control and tobacco use measurement persist and continued vigilance is required to eliminate tobacco use.

1.1. Tobacco control: context and challenges

Tobacco control is a global health priority. In 2003, the global tobacco control commitment was formalized with the adoption of the Framework Convention on Tobacco Control (FCTC). The FCTC is an international treaty that embodies worldwide prioritization of public health protection from the consequences of tobacco use and is aimed towards substantial and continuous tobacco use reduction. It stipulates obligations for the development, enactment, monitoring and evaluation of national tobacco control strategies, and includes measures for reducing tobacco consumption and availability with accompanying provisions and guidelines for implementation. In addition to concrete tobacco control measures, the treaty mandates up-to-date and comparable surveillance of the tobacco epidemic [3]. In 2011, the United Nations (UN) adopted the Political Declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases (NCDs) which placed the control of tobacco use and other NCD risk factors high on the international agenda [4]. The resolution recommended accelerated implementation of the full range of FCTC measures and called for the World Health Organization (WHO) to develop a comprehensive global framework for trends monitoring and progress assessment [4]. This framework, adopted in 2013, is comprised of indicators that allow internationally comparable time trend assessments and provides voluntary country-level targets that would represent significant progress if achieved by 2025. These targets include a 30% relative reduction in current tobacco use [5].

1.1.1. Global milestones in tobacco control

Since the first US Surgeon General's (USSG) report on the harmful effects of tobacco use, there have been significant advancements in the knowledge and tools for tobacco control. The 1964 USSG report conclusively established a causal association between tobacco smoking and lung cancer [6] and led to further research on the consequences of tobacco use and interventions to reduce it. Landmark endeavors to comprehensively quantify tobacco-related health outcomes include Peto et al.'s study in the early 1990s [7] and the first incarnation of the Global Burden of Disease (GBD) studies in the latter part of that decade [8]. These assessments estimated about two million tobacco-attributable deaths in 1985 in developed settings alone [7] and 40 million tobacco-attributable disability-adjusted life-year (DALY) losses in 1990 worldwide [8], emphasizing tobacco use as a major global risk factor. Key evidence for combating the tobacco epidemic was provided in a comprehensive WHO cost-effectiveness analysis which identified a number of cost-effective interventions requiring government action [9]. Such evidence on both the magnitude of the tobacco epidemic and on cost-effective means to curb it were instrumental in the development and negotiation of the

FCTC [9, 10], which has been ratified by 180 countries since coming into effect in 2005 [11, 12]. The WHO subsequently launched the MPOWER policy package in 2008. This consists of six components: “monitor tobacco use and prevention policies, protect people from tobacco smoke, offer help to quit tobacco use, warn about the dangers of tobacco, enforce bans on tobacco advertising, promotion and sponsorship, and raise taxes on tobacco” [13], and is aimed at assisting country-level FCTC implementation.

1.1.2. Tobacco control measures

Tobacco control can be categorized into demand reduction and supply reduction measures [3, 14]. Major evidence-based demand reduction interventions stipulated in the FCTC and endorsed by the WHO include smoking bans, cessation support, health warnings, marketing regulations, and taxation [3, 13].

Smoking bans involve enactment of legislation for establishing smoke-free environments, which diminish opportunities to smoke [13]. There is evidence of the effectiveness of bans in public places for reducing exposure to second-hand smoke [15], cutting consumption among smokers [16], and even encouraging voluntary smoke-free policies in households [17]. Because having designated smoking areas can undermine impact [18] and weak enforcement can damage the credibility of smoking bans [19], the WHO recommends complete prohibition of smoking in all indoor environments with clear and reliably-imposed sanctions for violations [13].

Cessation support, on the other hand, involves provision of services to help smokers overcome nicotine addiction and quit smoking. Forms of cessation support with evidence of effectiveness include pharmacological treatment, quit lines and integration of cessation services into primary health care [13]. Pharmacological treatment can help lessen withdrawal symptoms (e.g. nicotine replacement therapy), reduce cravings (e.g. bupropion) or diminish the pleasure response to nicotine (e.g. varenicline) [13, 20, 21]. Quit lines and primary care-level integration can reinforce these cessation efforts through counseling and active referral [22, 23]. To support these measures, the WHO recommends public funding for the costs of nicotine replacement therapy and/or clinical cessation services [13].

Health warnings on tobacco product packaging serve to increase awareness of the risks and to reduce the desirability of tobacco use to encourage cessation and prevent initiation [24]. The FCTC stipulates health warnings that cover at least 30% of the principal display area of tobacco product packaging [3]. Marketing restrictions consist of bans on tobacco product advertising (e.g. on television and radio) and promotion in order to protect non-users of tobacco products—especially young people—from tobacco companies' efforts to attract new consumers and expand sales [13, 25-28]. These measures work in conjunction with health warnings to protect tobacco product users from the industry's efforts to reinforce or even exacerbate their habits. Advertising bans have been found to be effective in reducing tobacco use [25, 29, 30] and the WHO recommends complete prohibition of all forms of advertising, promotion and sponsorship [13, 19, 25].

The final demand reduction measure is increased taxation, which reduces demand by raising tobacco product prices beyond affordability, and has been found to be the single most effective means of decreasing consumption and encouraging cessation [19]. The WHO recommends >75% of the retail price of tobacco products be composed of taxes [13, 31]. Although the tobacco industry asserts that increased taxation causes illicit trade, a comprehensive review of evidence from the experience of many countries shows that any post-tax-increase shift to illegal tobacco products is minor and transient, and that the health and economic benefits of reduced tobacco use and increased tax revenues outweigh potential illicit trade consequences. Furthermore, assessments have shown that supply-side factors such as weak enforcement, corruption and organized crime are more important drivers of illicit trade and in any case, the appropriate solution is not to lower taxation but rather to strengthen anti-illicit trade measures [32].

A recent demand reduction innovation, plain cigarette packaging, strips cigarette packs of all branding and design in order to reduce appeal and enhance prominence of health warnings [33, 34]. This approach is based on evidence that packaging is an important element in how tobacco is perceived by users and non-users alike [33, 35]. Plain packaging was first implemented in Australia [36, 37], and is also underway in a number of other countries such as Ireland [38] and the United Kingdom [33, 34, 39].

The FCTC also recommends supply reduction measures, which include action against illicit trade of tobacco products and crop substitution for tobacco farmers [3, 14]. In addition, several supply-side innovations have been proposed in the past decade but have yet to be implemented [40]. These include novel frameworks within which tobacco products would be supplied such as Borland's Regulated Market Model [41] and Callard and Collishaw's "non-profit enterprise with public health mandate" [42]. Other innovations include Gilmore et al.'s proposed creation of the Office for Smoked Tobacco Regulation for imposing price controls at the production level [43] and Sugarman's "performance-based regulations" involving legislated industry public health targets [44]. Eventual abolition of commercial tobacco sales through phasing-out in a "Sinking-Lid" approach [45] and absolute commercial bans [46] have also been proposed.

1.1.3. Progress and remaining challenges

Despite worldwide progress in the implementation of tobacco control measures and reductions in tobacco use prevalence, country disparities persist and tobacco smoking remains a leading global risk factor [47]. The 2013 WHO *Global Tobacco Control* Report (GTCR) estimates one-third of the world's population—about 2.3 billion people in 92 countries—to be covered by at least one MPOWER tobacco use reduction measure at the highest recommended level. This represents an increase in global tobacco control coverage of almost 1.3 billion people and 48 countries since 2007 [48].

However, population coverage and progress vary across individual MPOWER components. For instance, smoke-free policies covered 16% of the global population in 2012 due to adoption of complete smoking bans by 32 countries, corresponding to an increase of about

1.1. billion people protected since 2007. In contrast, the most cost-effective strategy of taxation to >75% of the retail price covered only 8% of the world population in 2012 and is the measure on which least progress has been made. Only ten countries raised taxes to the recommended rate, corresponding to an increase of 40 million people covered [48].

Furthermore, the comprehensiveness and level of implementation of MPOWER measures vary across settings. For instance, a number of low- or middle-income countries in the WHO region of the Americas have all MPOWER measures in place and have achieved the highest recommended level for more than one intervention. In contrast, many vulnerable countries in the WHO African region lack several measures and those in place are mostly below the recommended levels [48]. Tobacco control efforts are also impeded by industry interference and vested government interests [49, 50]. Tobacco industry interference includes threats of expensive litigation such as those brought by large multinational tobacco companies like Philip Morris International against the resource-poor countries of Togo and Uruguay [49, 51, 52]. Government ownership of tobacco companies such as Japan Tobacco can also impede implementation of strong tobacco control policies through conflicts of interest between commercial and public health imperatives [49, 50].

Such country-level variation in tobacco control progress despite advances in global tobacco control efforts is also reflected in tobacco use prevalence patterns. Globally, daily tobacco smoking prevalence is estimated to have decreased from 41.2% to 31.1% among men and from 10.6% to 6.2% among women within the period 1980 to 2012 [53]. However, the rate of decline has slowed in recent years due to growth in daily tobacco smoker numbers in populous countries like Bangladesh, China, Indonesia and Russia and the number of daily tobacco smokers increased from 721 million to 967 million within the same timeframe. A number of countries also continue to experience very high daily tobacco smoking prevalence in 2012 among both men (>50%) and women (>30%) [53].

Such continued tobacco use pervasiveness in turn translates to health outcomes. The most recent global burden of disease estimates attribute 18% of NCD deaths and 11% of NCD burden to tobacco smoking. These correspond to about 7 million NCD deaths and 144 million NCD DALY losses attributable to tobacco smoking in 2010, with the majority in developing settings [54]. Tobacco control efforts must be intensified in order to avert this health burden, and continuous monitoring is key to understanding what works and how to implement tobacco control measures.

1.2. Challenges in monitoring tobacco use trends

Monitoring tobacco use is crucial for assessing tobacco control efforts, and the FCTC mandates continuous surveillance and evaluation of control strategies [3]. However, various aspects of the tobacco epidemic present challenges for its measurement.

1.2.1. Forms of tobacco use

Tobacco is smoked or used in a smokeless manner. Tobacco smoking refers to inhalation of the smoke produced from combustion of dried or cured tobacco plant leaves. Smokeless tobacco use refers to consumption not involving combustion such as chewing, placement within the oral cavity or sniffing [13, 55]. Both forms of tobacco use have been linked to harmful health effects although data on the less globally prevalent smokeless use is severely limited [55]. Tobacco smoking has been associated with cancer, lung disease and cardiovascular disease. Up to 90% of lung cancers have been found to be attributable to smoking [56] which has also been linked to oral, pharyngeal, laryngeal, esophageal and gastric malignancies [57-59]. Smoked tobacco use has also been associated with tuberculosis and lung dysfunction and injury [59], and has been shown to significantly increase risks for cerebrovascular disease [13, 57] and fatal myocardial infarction [13]. Though relatively limited in availability, studies on smokeless tobacco use have also provided evidence of associations with oral, esophageal, pancreatic and lung cancers [60]. Beyond the adverse consequences for its users however, tobacco smoking also poses health risks to non-users in the form of second-hand smoke (SHS) [61]. Such extended effects of smoked tobacco include mortality from lung cancer and cardiovascular disease [62] and adverse perinatal and pediatric outcomes such as pre-term deliveries [63], low birth weight [64], sudden infant death syndrome (SIDS) [65] and childhood asthma episodes [63]. Globally, tobacco smoking is the most prevalent form of tobacco use, and monitoring of trends in tobacco smoking is essential to understand the current and future risk profile that it poses. However, monitoring tobacco smoking requires an understanding of smoked product types.

1.2.2. Smoked tobacco product types

Smoked tobacco product types include cigarettes, cigars, pipes and water pipes. Cigarettes include manufactured types, roll-your-own (RYO) and local variants such as *bidis*, *brus* and *kreteks* [55, 66]. Modern manufactured cigarettes typically consist of a thin paper cylinder of finely-shredded non-fermented tobacco leaf blends. Most include reconstituted tobacco plant materials and additives—such as menthol for flavor—and contain cellulose acetate filters at the tip [55, 67]. RYO cigarettes are prepared by the user from loose tobacco and rolling paper [55]. *Bidis* consist of a small amount of tobacco flakes hand-wrapped and string-tied in leaves of the *tendu* or *temburni* plant which is native to Asia [55, 66, 68]. *Brus* contain sun-cured tobacco [55, 66] while *kreteks* contain a mixture of tobacco and cloves [55, 68]. Cigars on the other hand, typically consist of a roll of a single type of air-cured and fermented tobacco wrapped in tobacco leaf [55, 69, 70]. Pipes are devices consisting of a chamber for tobacco placement and combustion, and a hollow stem for smoke inhalation [55]. Water pipes consist of a perforated head for tobacco burning, a body for smoke passage, a water bowl for smoke filtration and a flexible hose and mouthpiece for smoke inhalation [55, 71].

Although manufactured cigarettes are the most prevalent globally [55], other cigarette variants and smoked tobacco product types cannot be discounted due to their health risks and characteristic geographical distributions. Smoke from *bidis* and *kreteks* has higher nicotine, tar and carbon monoxide concentrations relative to that of conventional cigarettes [68, 72]. *Bidis* are also associated with increased risks of cancers (oral, esophageal, stomach and lung), cardiovascular disease (coronary heart disease and acute myocardial infarction) and lung disease (emphysema and chronic bronchitis), while *kreteks* are associated with increased risks of lung dysfunction and acute lung injury [59, 68]. Smoking other product types such as cigars and water pipes also involves a multitude of health risks similar to cigarette use [58, 59, 71]. Geographically, RYO cigarettes are prevalent in Europe and New Zealand [55], *bidis* are common in South Asia and heavily consumed in India [55, 68, 73], *brus* are local to Papua New Guinea [55], *kreteks* are widespread in Indonesia [55, 68, 73] and water pipes are customary in Northern Africa and the Eastern Mediterranean [55, 71, 73].

1.2.3. Electronic nicotine delivery systems

Electronic nicotine delivery systems (ENDS), popularly known as e-cigarettes, are emerging tobacco use-related products that have garnered much attention and debate. E-cigarettes are battery-powered devices designed to provide an aerosol containing nicotine—the addictive substance in tobacco—for inhalation [74-77]. Since its development in China in 2003 [74], the ENDS industry has expanded into an estimated three billion US dollar market in 2014 [77]. The sparse literature on its uptake shows, however, that lifetime use of ENDS is rare among those who have never smoked and prevalence of current use remains concentrated in current smokers and is very low relative to conventional tobacco smoking. Nationally representative samples of adults in the US and the UK estimate that less than one percent (0.8% in 2010 [78] and 0.5% in 2012 [79] respectively) of never-smokers have ever tried ENDS. The International Tobacco Control Four-Country Survey estimated 2.9% of current or former smokers (1.0% in Australia and in Canada, 4.0% in the UK, 6.0% in the US) were current ENDS users in 2010-2011 [80]. An estimated 6.7% of adult current smokers in the UK were also current ENDS users in 2012 [79]. There is only sparse evidence for both the potential benefits and risks of e-cigarette use and their long-term consequences cannot yet be concluded. Reviews have found evidence of its benefit as a smoking cessation aid.

E-cigarette vapors also contain carcinogenic and toxic substances, at lower levels than conventional cigarette smoke, but the risk of regular and prolonged exposure is difficult to estimate at present [74, 77, 81, 82].

1.2.4. Frequency of tobacco use

Tobacco smoking frequency falls into two general categories: daily and non-daily. The WHO defines daily tobacco smokers as "individuals who smoke any tobacco product at least once a day, including those who smoke every day except days of religious fasting" [83, 84]. Non-daily or occasional smokers are in turn defined as "individuals who smoke any tobacco product, but not every day" [83, 84].

Both frequency categories carry significant health risks, although daily smokers typically comprise the majority of current tobacco users. Daily smoking even at low levels of consumption (e.g. one to four cigarettes per day) has been associated with significantly increased mortality risks from cancer, heart disease and all causes [85, 86]. However, even occasional smoking has been shown to significantly increase cardiovascular and all-cause mortality risks relative to non-smokers [87]. There is also evidence that occasional smoking can become a persistent and regular habit [88, 89] and that lengthy duration of such behavior significantly heightens the risk of lung cancer. Lung cancer risk has been shown to be more dependent on smoking duration rather than intensity. The exposure-risk relationship has been found to plateau with increasing intensity but to continue to increase with longer duration [90, 91].

Occasional smokers can also comprise substantial proportions of current tobacco users in both developed and developing settings. In the US for instance, non-daily smoking has increasingly become an established pattern in recent years with about one-third of those who currently smoke doing so occasionally [92]. The fraction of non-daily smokers can be even higher in developing settings, even comprising the majority of tobacco smoking in some countries. In Mexico for example, non-daily smokers comprised 64.4% of current smokers for men and 70.2% for women in 2003 [93], and 52.4% of current smokers for men and 52.6% for women in 2009 [94]. Likewise in 2011, 55.0% of men and 59.3% of women who currently smoke did so occasionally [95]. It is thus important to account for both daily and non-daily frequency in measuring tobacco use.

1.2.5. Measurement of tobacco use

Tobacco use may be measured in terms of prevalence and/or consumption. Prevalence, measuring the proportion of the population who smoke, is a straightforward yet meaningful indicator of the extent of the smoking epidemic in a population. Prevalence estimation among subpopulations provides crucial information on the progression and differential uptake of smoking behavior among sexes and within age groups. Consumption on the other hand, measures the average number of tobacco products smoked per individual over a certain period of time. It can provide a more detailed description of smoking intensity, which indicates the amount and frequency of tobacco product consumption.

Of these two measures however, prevalence is a more comprehensive indicator of population exposure to smoking hazards and is also more important for public health purposes. Consumption measures cannot be used to track the diffusion of smoking behavior throughout a population nor approximate the extent of SHS exposure. Consumption is also more strongly influenced by disposable income such that fluctuations are not always entirely attributable to tobacco control interventions [83, 96]. Although smoking intensity determines magnitude of health risks, even very low levels of consumption carry significant health hazards to both users and non-users [85-87], and thus promoting cessation or preventing initiation altogether are the ultimate goals of public health efforts.

For public health purposes, prevalence of current use is deemed the most important indicator by the International Agency for Research on Cancer (IARC) [83] and is also rated as a key outcome indicator by the US Centers for Disease Control and Prevention (CDC) [97]. It is determined primarily by rates of initiation and cessation which are the major focus of tobacco control strategies in order to reduce the hazards of tobacco use or exposure to its smoke [83]. Reduction of prevalence of current use is also the target set in the WHO global monitoring framework [5].

In addition, WHO tobacco control monitoring guidelines recommend that frequency of use be measured such that current users are divided into daily and non-daily subgroups [83]. Daily and non-daily use prevalence information is useful because frequency is a predictor of cessation [98]. Finally, the IARC also deems prevalence of use of different product types to be important due to the varied geographical distributions of different tobacco products [83]. Both frequency and product type should thus be taken into account in monitoring efforts.

1.3. Previous tobacco use assessment efforts

Although literature on tobacco use prevalence estimates, trends and projections for certain regions and countries are available, there remains a need for a comprehensive and consistent assessment of various tobacco use prevalence indicators encompassing historical trends, future projections and target achievement based on the most up-to-date information.

Early endeavors to assess the extent of the tobacco epidemic were limited by data scarcity, especially in developing settings. The 1997 WHO *Tobacco or Health: Global Status* Report attempted to provide comprehensive and comparable country-specific tobacco use indicator estimates for the early 1990s. However, the assessment was based on prevalence data from 87 countries involving only 29.4% of developing nations, and there were striking regional disparities in data availability at the time. For instance, relatively few countries from the WHO African and Eastern Mediterranean regions had usable prevalence information. Only daily smoking prevalence estimates could be provided due to data limitations despite WHO recommendations to include current and non-daily smokers in tobacco use assessments, and uncertainty was not quantified [66].

However, data availability has improved substantially since then, especially in developing settings. Over the first decade of the 2000's for instance, 49 Demographic and Health

Surveys (DHS) including tobacco use information were implemented in low- or middle-income countries, including 25 African nations [73], and the WHO STEPwise approach to surveillance (STEPS) NCD Risk Factor Surveys were conducted in 94 countries across all WHO regions, including 36 countries from Africa [99]. Furthermore, the Global Tobacco Surveillance System (GTSS), including the Global Adult Tobacco Surveys (GATS), was launched in 2007 and has since been implemented in 19 of the highest tobacco burden low- or middle-income nations [100].

More recent tobacco use assessments have capitalized on such improved data availability. The WHO GTCR series has provided country-specific smoking prevalence estimates considering both product type and frequency but only for individual time points with the most recent available data. These reports do not provide a systematic assessment of time trends or uncertainty intervals [48]. Estimates have also been based on an old model that relies heavily on regional patterns—even for countries with good data—for assessing product type and frequency characteristics and for describing age patterns in prevalence [101]. The Institute for Health Metrics and Evaluation (IHME) estimated tobacco use prevalence trends from 1980 to 2012 but only for a measure of daily smoking that does not account for all current tobacco users [53]. Assessment of only daily smoking prevalence may underestimate the magnitude and threat of the tobacco epidemic in crucial settings such as developing countries with substantial proportions of non-daily smokers at higher risk of greater tobacco use addiction and intensity [93-96]. Neither this study nor the WHO GTCR series made projections [48, 53].

A 2012 Mendez et al. study developed global smoking prevalence trajectory estimates for 2020 and for 2030, but this study only focused on 60 countries and current cigarette use and did not make separate assessments by sex. Including only the ten nations with the highest number of current cigarette smokers in each WHO region overlooks countries with low smoking prevalence at present but which are at risk of full-blown tobacco epidemics in the future. By looking only at current smokers, this study neglected changes in frequency of tobacco use, which is a useful indicator of smoking epidemic stages or tobacco control effectiveness. Assessing only cigarette use in this study underestimates prevalence due to other forms of smoked tobacco and non-sex-specific estimates could overlook diverging trends in population subgroups [102].

A 2014 modeling exercise by Kontis et al. made global projections to 2025 but did not assess country-specific tobacco use reduction target achievement. The study also used an indirect measure of smoking exposure based on lung cancer mortality called the smoking impact ratio (SIR) [103], which does not provide a comprehensive understanding of trends in tobacco use. Although the SIR captures accumulated smoking exposure involving various smoking behavior characteristics, its measurement involves additional assumptions such as applicability of the choice of reference population [104]. It is also a less sensitive and timely measure of the full extent of smoking exposure and hazards in a population compared to current, daily and occasional smoking prevalences which are of higher interest for tobacco control programs [83, 96]. This is because lung cancer mortality rates can continue to increase or plateau even though smoking prevalence or frequency is declining [90, 96].

1.4. Objectives

To maintain global progress and reduce country disparities in averting preventable tobacco-attributable health burden, up-to-date, comprehensive and consistent country-level assessment of trends and projections of key tobacco use indicators and of target achievement are indispensable. Country-level trend monitoring is required by the FCTC [3] and is a component of the WHO MPOWER policy package [13, 105]. It is essential for identifying transitions in the state of the tobacco epidemic, assessing local tobacco control progress, benchmarking against peers or global leaders, and setting national goals. Projections are helpful in determining whether countries are on track towards achievement of goals and in gauging remaining challenges that must be overcome. Measurement of different tobacco use indicators—such as those involving frequency and product types—provides a more informative picture of the situation in various settings and ensures that smoking hazards in countries with idiosyncratic tobacco use characteristics (e.g. popularity of local cigarette type, high proportion of occasional smoking) are not neglected.

To achieve these goals, this study aimed to provide a comprehensive and consistent assessment of recent trends and projections for four tobacco use indicators and of target achievement under the WHO global monitoring framework for as many countries as feasible. The specific objectives were to:

- Describe time trends from 1990 onwards in four tobacco use indicators: current tobacco smoking, daily tobacco smoking, current cigarette smoking and daily cigarette smoking

- Make projections to 2025 for all four indicators assuming recent trends persist
- Estimate the probabilities of decreasing tobacco use, increasing tobacco use and achieving a 30% reduction in current tobacco smoking by 2025 relative to 2010 levels

This information can provide valuable insights for prioritization, resource allocation, intervention design and implementation, and formulation of national policies and future tobacco control strategies. Assessment of target achievement probabilities under the WHO global monitoring framework is useful for reinforcement of political commitment, awareness raising and advocacy, and can provide motivation for accelerating action and progress. A comprehensive and consistent global perspective is helpful in identifying not only countries and regions in need of greater tobacco control support but also those that can serve as models. These assessments provide important tools for maintaining and accelerating progress towards global convergence in target achievement and tobacco use elimination.

2. METHODS

A Bayesian hierarchical modeling approach was developed using tobacco use prevalence data from the WHO Comprehensive Information Systems for Tobacco Control (CIC). Trends for four tobacco use indicators—current tobacco smoking, daily tobacco smoking, current cigarette smoking, and daily cigarette smoking—were assessed from 1990 to 2010, baseline projections were made to 2025 and probabilities for decreased tobacco use, increased tobacco use, and achievement of tobacco use reduction targets were obtained. This chapter presents details on data, inclusion and exclusion criteria, operational definitions and analytic approach.

2.1. Data

Data on tobacco use prevalence was obtained from the WHO-CIC unit which performs tobacco-related risk and outcome surveillance and monitoring using publicly-available, high quality survey data collected at the national level.

2.1.1. Data sources

The WHO-CIC, with involvement of WHO Region and Country Offices, conducts an extensive search for surveys that measure tobacco use in some form. For this project, identified data sources include:

- Internationally-standardized surveillance systems and surveys—such as the GATS [100] component of the WHO GTSS, the WHO STEPS [99], the World Health Surveys [106], and the DHS [107]

- Region- or country-wide surveillance systems and surveys such as the Eurobarometer Surveys [108], the US Behavioral Risk Factor Surveillance System (BRFSS) [109], the Canada Tobacco Use Monitoring Survey (CTUMS) [110], the Japan National Health and Nutrition Surveys [111], and the Indonesian Basic Health Research surveys [112], and
- Country reports of survey estimates, submitted to the WHO FCTC Secretariat, which are used to identify original survey sources to extract data from

All data sources obtained are in the public domain.

2.1.2. Data quality control

Data quality control was conducted by the WHO-CIC unit with the involvement of WHO Region and Country Offices. Identified surveys were assessed according to WHO standards for adequacy of sample size and appropriateness of sampling methodology before results were used in order to ensure reliability of estimates and national representativeness. Data entry into the CIC database was conducted centrally to ensure consistency and compliance with WHO definitions and data requirements for the different tobacco use indicators. Prevalence estimates were entered into the dataset at the most disaggregated level (e.g. age-sex-specific) available. WHO Region and Country Offices were also engaged to provide more detailed information where feasible when reported estimates were highly aggregated (e.g. across all ages). Checking, investigation with corresponding country representatives and, if necessary, corrections were conducted for potential duplicates and errors. These involve extreme values (e.g. zeroes or >60% prevalences), higher reported prevalence values for women relative to men, and inconsistencies between different indicators such as daily smoking prevalences higher than corresponding current smoking values for the same tobacco product type and cigarette smoking prevalences higher than corresponding all-tobacco smoking values for the same frequency category (i.e. current or daily). Some within-country prevalence variability due to differences in survey design over time however—such as changes in questionnaires or in outcome definitions even within survey waves as in the case of the Japan National Health and Nutrition Surveys—may not have been fully accounted for by the data quality control efforts.

2.2. Inclusion and exclusion criteria

For this analysis, a data source was included if it: provided country survey prevalence estimates for one or more of four tobacco use indicators (current tobacco smoking, daily tobacco smoking, current cigarette smoking, daily cigarette smoking); involved randomly-selected participants representative of the general population; and was officially recognized by the national health authority. A data source was excluded if it: was earlier than 1990, was not nationally representative (e.g. urban/rural only, geographic/political subdivision, subpopulations such as students only) or if the maximum age of target participants was below 15 years. The dataset for this analysis encompasses 896 surveys, 180 countries, and years from 1990 to 2014, amounting to 26,153 country-year-sex-age-specific datapoints. Details of surveys used in this analysis are provided in the WHO *global report on trends in prevalence of tobacco smoking* [113].

2.3. Operational definitions

This study calculated tobacco use for four indicators, and used groupings of countries for analytical purposes. Tobacco use indicators were defined in terms of product type and frequency, and country groups were defined based on tobacco epidemiology and geography.

2.3.1. Product type

Tobacco products in this study are classified into two subcategories: cigarettes and non-cigarettes. "Tobacco" refers to the overall outcome envelope inclusive of all smoked tobacco product types encountered in the surveys such as cigarettes, cigars, pipes, and water pipes. "Cigarette" refers to a subcategory of "tobacco" which excludes non-cigarette types (e.g. cigars, pipes, water-pipes) and includes only cigarette types encountered in the surveys such as manufactured cigarettes, roll-your-own cigarettes, or local cigarette variants (e.g. *bidis* in South Asia, *brus* in Papua New Guinea, *kreteks* in Indonesia). Such categorization capitalizes on the availability of cigarette-only survey data and although cigarettes tend to be the most commonly used form, estimation of both the overall "tobacco" envelope and its "cigarette" subcategory also provides an estimate of the complement "non-cigarette" subcategory which comprise a considerable proportion of tobacco use in certain settings (e.g. water-pipes in the Eastern Mediterranean). ENDS, although colloquially known as "electronic cigarettes," do not contain tobacco [74] and are thus excluded from the tobacco use definition.

2.3.2. Frequency

This study used the two commonest definitions of frequency, current and daily smoking. Current is defined as smoking at least once in the 30 days prior to the survey. Daily is defined as smoking at least once per day during the same 30-day period. The majority (>75%) of surveys included in this analysis measure only established tobacco use. Use is deemed to be established when a cumulative lifetime threshold is breached, in order to exclude those who are only experimenting [83].

2.3.3. Analytic country groupings ("Regions")

For analytic purposes, countries were categorized into 21 regions reflective of tobacco epidemiology and geography. These combined tobacco use patterns and control history with the United Nations geoscheme subregions [48, 53, 114]. For example, Central Asian countries which were former states of the Soviet Union were grouped together with Russia and other Eastern European nations due to their geographical proximity and similar tobacco use culture and control history. The detailed country groupings are provided in Table 1.

The choice of country groupings was decided on the basis of sensitivity analyses conducted to compare different ways of supplementing country data with regional information before the final model runs. The sensitivity analyses compared country groupings based only on tobacco control policies irrespective of geography (e.g. having Australia, New Zealand and Canada in the same group) against groupings which accounted for both tobacco epidemiology and geography (e.g. good tobacco control countries such as Australia and New Zealand grouped together but separated from nearby developing nations in the Western Pacific with high smoking prevalences such as Papua New Guinea). For each of these two main types of country groupings, different assumptions about within-group variability were also compared. One assumption was low within-group variability, with a consequent strong group influence on country estimates. A contrasting assumption was moderate within-group variability, such that countries with good data were robust to group influences while countries with scarce data followed group trends to a certain extent.

Diagnostics summarized in Appendix E showed that models based on country groupings accounting for both geography and tobacco use epidemiology with moderate within-group variability performed best overall. Although some countries with different socioeconomic histories such as China and Japan were grouped together, such a grouping reflects a general East Asian tobacco use pattern of high prevalence among men and relatively very low prevalence among women. Furthermore, final model diagnostics displayed good model performance, as shown by high coverage and low RMSEs.

Table 1: Analytic country groupings

Region	Countries
Africa, Central	Cameroon, Congo, Democratic Republic of the Congo, Gabon, Sao Tome and Principe, Chad
Africa, East	Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Mozambique, Malawi, Rwanda, United Republic of Tanzania, Uganda, Zambia, Zimbabwe
Africa, East Islands	Comoros, Madagascar, Mauritius, Seychelles
Africa, North	Algeria, Egypt, Libya, Morocco, Tunisia
Africa, South	Botswana, Lesotho, Namibia, Swaziland, South Africa
Africa, West	Benin, Burkina Faso, Cabo Verde, Cote d'Ivore, Ghana, Guinea, Gambia, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo
America, Central	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama
America, North	Canada, United States of America
America, South	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela

Table 1: Analytic country groupings (continued)

Region	Countries
Asia, East	China, Japan, Republic of Korea, Mongolia
Asia, South	Bangladesh, India, Iran, Maldives, Nepal, Pakistan, Sri Lanka
Asia, Southeast	Brunei Darussalam, Cambodia, India, Lao People's Dem. Rep., Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Viet Nam
Asia, West	United Arab Emirates, Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, West Bank and Gaza Strip, Qatar, Saudi Arabia, Syrian Arab Republic, Yemen
Australasia	Australia, New Zealand
Caribbean	Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Granada, Haiti, Jamaica, Saint Kitts and Nevis, Trinidad and Tobago, St. Vincent and the Grenadines
Europe, East	Armenia, Azerbaijan, Bulgaria, Belarus, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Lithuania, Latvia, FYR Macedonia, Poland, Romania, Russian Federation, Slovakia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan

Table 1: Analytic country groupings (continued)

Region	**Countries**
Europe, North	Denmark, Finland, Ireland, Iceland, Norway, Sweden, the United Kingdom
Europe, South	Albania, Andorra, Bosnia and Herzegovina, Croatia, Cyprus, Greece, Israel, Italy, Malta, Portugal, Serbia, Slovenia, Spain, Turkey
Europe, West	Austria, Belgium, France, Germany, Luxembourg, Netherlands, Switzerland
Greenland	Greenland
Polynesia	Cook Islands, Fiji, Kiribati, Marshall Islands, Niue, Nauru, Palau, Papua New Guinea, Solomon Islands, Tonga, Tuvalu, Vanuatu, Samoa

2.4. Analysis

2.4.1. Analytic challenges

The analysis for this research involved several challenges. Data was scarce for a number of countries especially in developing settings; available data was in non-standard age categories; and information from different studies and for different tobacco use indicators had to be incorporated into a single analytical framework. Furthermore, estimates were required to have consistency between indicators, meaning current tobacco smoking must serve as the overall envelope for prevalence, daily tobacco smoking and current cigarette smoking must not be greater than that envelope, and daily cigarette smoking must not be greater than any of the other indicators.

The former statistical model used by the WHO-CIC for tobacco use prevalence estimation employed classical or frequentist regression [101] and the general methodological approach had a number of shortcomings. The frequentist framework involved inability to produce robust estimates for countries with scarce data. Other limitations included excessive influence of regional tobacco use patterns on country-specific prevalence estimates even for settings with good data due to crude methods for selecting regional age patterns. There was also no internal mechanism for adequately preventing inconsistent or illogical estimates for the various tobacco use indicators (e.g. daily smoking values higher than current smoking values or cigarette smoking values higher than all-tobacco smoking values). Furthermore, the previous methodological approach did not account for differences in sampling design of data from different surveys. To overcome these problems, a constrained Bayesian meta-regression modeling approach was developed that enabled robust estimation even with scarce data, provided more control over the influence of regional tobacco use patterns, incorporated meaningful constraints on the relationship between indicators and adjusted implicitly for sampling design.

2.4.2. Analytic approach

To address this study's analytic challenges, a Bayesian hierarchical meta-regression modeling approach incorporating a flexible age structure was developed. Bayesian statistics utilizes observed data together with additional information about the theoretical distribution of parameters in the statistical model, usually represented through a distribution of the parameter called a "prior distribution", which expresses the current state of knowledge about the mathematical form and likely values of that parameter. The priors are combined with the assumed probability distribution of the data, termed the "likelihood", to arrive at "posterior" distributions from which are obtained summary measures for the quantities of interest. Hierarchical modeling is a modeling framework where distribution parameters are themselves assigned probability distributions determined by "hyperparameters" [115, 116]. In standard Bayesian statistical models, this enables a statistical model to be adjusted based on information obtained about the parameters of the model from pre-existing statistical, medical or other literature that can inform interpretation of the data. In this study, prior distributions were generated based on each country's region, and these priors allowed us to supplement scarce country data with regional information, and to specify constraints for simultaneous and consistent estimation of different tobacco use indicators. The meta-regression component enabled incorporation of data from various studies and addressed systematic differences between data sources. To utilize data from different studies with non-standard age categories, the model used a flexible spline structure for age, from which estimation was performed at desired age intervals.

Compared to the previous WHO method, this Bayesian hierarchical meta-regression modeling approach had several advantages. These improvements provided a formal statistical framework for using regional information to supplement country data in such a way that estimates followed observed country-specific tobacco use patterns more accurately for settings with good data and also allowed robust estimation for countries with scarce data. Unlike the former model, this new approach also featured a built-in mechanism for ensuring logical and epidemiologic consistency between the different tobacco use indicators. Finally, the meta-regression component accounted for differences in sampling design encountered when using data from different surveys which were not addressed by the previous method.

2.4.3. Bayesian hierarchical framework

The Bayesian hierarchical framework used for this analysis is summarized in the directed acyclic graph (DAG) shown in Figure 1.

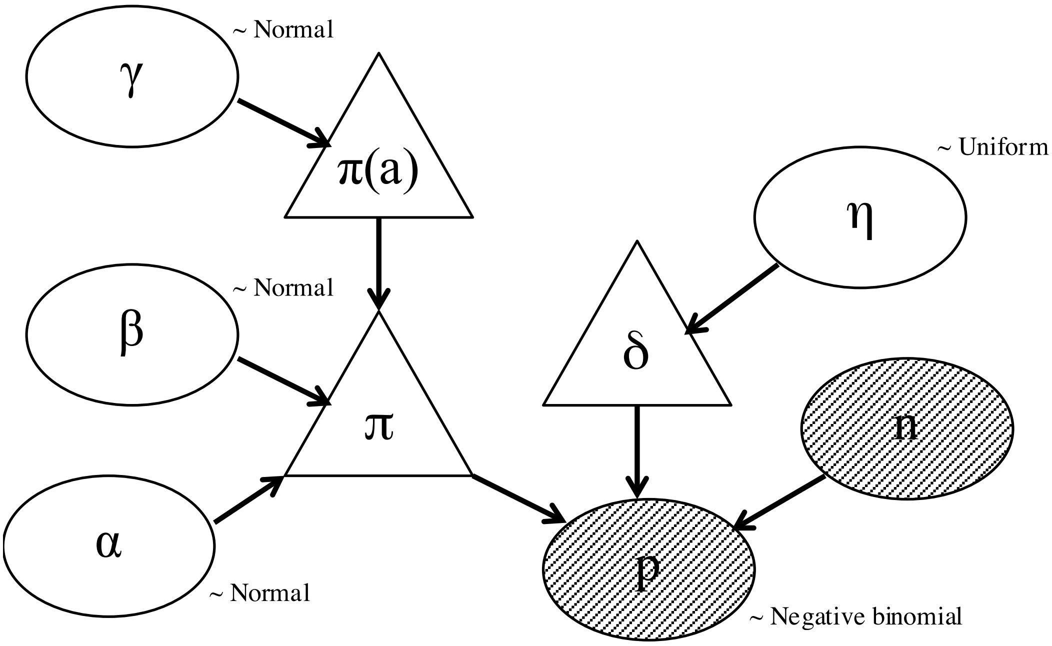

Figure 1: DAG of Bayesian hierarchical framework for tobacco use modeling

In the DAG, model variables are represented by nodes drawn as geometric shapes following the PyMC notation [117]. Stochastic quantities (i.e. variables that are assigned probability distributions) are represented by ovals and deterministic quantities (i.e. those defined by mathematical functions) are represented by triangles. Shaded shapes are observed quantities [117]. Arrows represent dependence between quantities, described as "parent-child relationships". Parents are nodes from which arrows emanate and children are nodes where arrows terminate [116, 117]. For example, the nodes γ and π(a) are in a "parent-child" relationship with the deterministic quantity π(a) as the "child" being dependent on the value of and uncertainty around its "parent" stochastic quantity γ. In turn, π(a) is also a "parent" with a "child" π which depends on it and π's other "parents" β and α.

The expected prevalence π is the prime objective for estimation and projection in this study.

The observed value of the prevalence, p, is assumed to have a negative binomial distribution with parents π, δ and n. π is the expected value of prevalence, δ is the dispersion parameter and n refers to effective sample size. δ has parent η, the base overdispersion parameter, which is assigned a uniform prior. The parents of π are the set of α, β and $\pi(a)$. The α country-level random effects and β regression fixed-effect coefficients are assigned normal priors. The function $\pi(a)$ denotes an age-specific piecewise linear spline which has a set of parent γ's. These γ's are fixed-effect age coefficients that also have normally distributed priors.

2.4.4. Data likelihood and regression model structure

Model specification was conducted using DisMod-MR software, which is a Bayesian meta-regression tool originally developed by the IHME for the Global Burden of Disease (GBD) 2010 studies. Meta-regression here refers to analyzing data from different studies involving weighting with their effective sample sizes. DisMod-MR was used for efficient estimation at desired age-intervals in order to handle inputs in non-standard age categories. Technical details of the tool have been published elsewhere [118, 119] and are also provided below. In this implementation, data on the number of smokers, pn, was modeled using a generalized negative binomial likelihood. The negative binomial is a robust alternative to the conventional Poisson model for count data and is able to handle situations involving zero counts as well as overdispersion. In the DisMod-MR package, the probability density function for the negative binomial distribution was reparameterized such that the observed number of successes is equal to the product of the observed value of the prevalence and the effective sample size, $p_i n_i$, as given in Equation 1.

$$\mathrm{p}(p_i|\pi_i, \delta_i, n_i) \propto \frac{\Gamma([p_i n_i]+\delta_i)}{\Gamma(\delta_i)} \left(\frac{\delta_i}{\pi_i n_i+\delta_i}\right)^{\delta_i} \left(\frac{\pi_i n_i}{\pi_i n_i+\delta_i}\right)^{[p_i n_i]} \qquad (1)$$

Where p is the observed value of the prevalence, π is the expected value of the prevalence, δ is the dispersion, n is the effective sample size and Γ is the gamma function. Effective sample size accounts for sampling design and is the sample size that would provide the same precision obtained in the study as would have been produced by a simple random sample [120].

To address the lack of a theoretical upper bound for the negative binomial, expert priors were specified to constrain prevalence within 0 and 1. Technical details of the implementation of expert priors in DisMod-MR are provided elsewhere [118, 119]. Although it is possible for the variance to continue to increase with the mean for the negative binomial distribution and potentially overstate the uncertainty around estimates, this risk is only a significant concern for prevalences greater than 50%, which are rare in the dataset (6% of datapoints).

In this analysis, δ was determined by an informative prior on the base overdispersion parameter η (Equation 2), which specifies how much the model is restricted from following what is deemed to be “noise” in the data [118, 119].

$$\delta_i = e^{\eta} \qquad (2)$$

With prevalence as outcome, the regression model included several features. First, it involved time trend assessment for two decades of analysis that allowed for shifts in the most recent period. Also, it enabled simultaneous and consistent estimation for four tobacco use indicators. Finally, the model used a flexible age structure that allowed for diverse age patterns in different settings. The regression functions determining π in this analysis are shown in Equations 3 and 4 for regional and country models respectively.

$$\pi_i = \int_{a=a_{s_i}}^{a_{e_i}} \pi(a)\, da\; e^{\sum_{j=1}^{K} \alpha_j + \beta_{time} X_1 + \beta_{period} X_2 + \beta_{time\times period} X_3 + \beta_{smkd} X_4 + \beta_{cigc} X_5 + \beta_{cigd} X_6} \quad (3)$$

$$\pi_i = \int_{a=a_{s_i}}^{a_{e_i}} \pi(a)\, da\; e^{\beta_{time} X_1 + \beta_{period} X_2 + \beta_{time\times period} X_3 + \beta_{smkd} X_4 + \beta_{cigc} X_5 + \beta_{cigd} X_6} \quad (4)$$

In the exponential function, α_j's are random effects at the country level to allow for variability between countries due to unmeasured factors. β_{time} and β_{period} are regression fixed-effect coefficients for time (X_1) and period (X_2) variables. The period variable represents a split between two decades of analysis at the year 2000. $\beta_{timexperiod}$ is an interaction term between time and period (X_3) allowing for potential shifts due to country-level changes in time-varying factors such as tobacco control measure implementation.

β_{smkd}, β_{cigc} and β_{cigd} are regression fixed-effect coefficients for dummy variables (X_4, X_5, X_6) for daily tobacco smoking, current cigarette smoking and daily cigarette smoking respectively using current tobacco smoking as the reference category. The assumption of parallel trends over time across all four tobacco use indicators may not hold true for every setting. However, data limitations preclude the robust estimation of time and tobacco use indicator interactions at our analytical levels of interest and sensitivity analysis pooling data at the global level in previous research found no significant differential time trends across tobacco use definitions [53].

In equations (3) and (4), π(a) is an age-specific piecewise linear spline with knots specified at 15, 20, 30, 40, 50, 60, 70, 80 and 100 chosen in consultation with WHO tobacco and statistical experts in order to capture diversity and detail in age patterns in different settings. The knots have corresponding regression fixed-effect coefficients for age (γ's). Technical details of the age-specific piecewise linear spline are provided elsewhere [118, 119]. Given a set of model-specific knots $\{a_1, \ldots, a_K\}$, π(a) is defined in DisMod-MR as

$$\pi(a) = \gamma_0 + \sum_{k=1}^{K} \gamma_k a \mathbf{I}[a \geq a_k] \qquad (6)$$

where $\mathbf{I}[a \geq a_k] = \begin{cases} 1, if\ a \geq a_k \\ 0, otherwise \end{cases}$

γ_k's are age fixed-effect parameters

Integrating over π(a) from the start (a_{si}) to the end (a_{ei}) of the age interval for the ith observation gives the expected value of prevalence for that age interval which is further modified by the exponential function to yield the expected value of prevalence for the ith observation π_i. While the age-specific piecewise linear spline enables the model to fit non-standard input age categories and provides flexibility in modeling age patterns, its current implementation in the DisMod-MR package precludes incorporation of an interaction between age and time. Although the assumption of a general age pattern over time may not be ideal for settings with rapidly changing age trends in prevalence, predictive accuracy checks show that our modeling strategy performs well for the majority of countries.

2.4.5. Consistency between indicators

To ensure consistency between the different indicators, constraints were implemented in the form of priors on the dummy variable coefficients. Three indicators (daily smoking, current cigarette smoking, daily cigarette smoking) were constrained to be no greater than current smoking. Furthermore, daily cigarette smoking was constrained to not be greater than either daily smoking or current cigarette smoking. Technical specifications of the constraints are provided in Table 2.

2.4.6. Model-building algorithm

The model-building algorithm developed for this analysis was conducted separately for men and women and involved three consecutive model-fitting stages as follows:

1. First-stage regional parameter estimates were fitted with the model structure given in Equation 3. Constraints were implemented in the form of priors on the dummy variable coefficients to ensure that daily tobacco smoking, current cigarette smoking and daily cigarette smoking cannot be greater than current tobacco smoking. This step generated regional estimates for informing time trend and tobacco use indicator relationships for subsequent country fits.
2. Second-stage country estimates were then generated using the model structure given in Equation 4 and the same constraints on dummy variable coefficients as step 1. Time trends and tobacco use indicator relationships were informed by priors from the regional fit by using regional estimates from step 1 as hyperparameters for assumed distributions of the parameters in Equation 4. This step generated additional priors

restricting the value of daily cigarette smoking relative to both daily smoking and current cigarette smoking.

3. Final models for all countries were fitted with the same model structure as, and similar constraints to step 2. Time trends and tobacco use indicator relationships were informed by priors from previous steps with a modified constraint to ensure that daily cigarette smoking cannot be greater than either daily smoking or current cigarette smoking.

Details of the country groupings and of the prior assumptions used in the analysis are provided in Table 1, Table 2, Appendix A and Appendix B. Hyperparameters for η, $\pi(a)$, γ's and the regional fit parameters were assumed a priori while those for the country-level models were mainly derived from previous fits.

Table 2: Prior specifications

Parameter	**Assumed distribution**	**Hyperparameters**		**Type**
General				
η	Uniform	a	1	Informative
		b	9	
$\pi(a)$	N/A	γ_{15}	15	Informative
		γ_{20}	20	Informative
		γ_{30}	30	Informative
		γ_{40}	40	Informative
		γ_{50}	50	Informative
		γ_{60}	60	Informative
		γ_{70}	70	Informative
		γ_{80}	80	Informative
		γ_{100}	100	Informative
γ's	Normal	μ	0	Non-informative
		σ	1	
Regional fits				
α_j's, β_{time}, β_{period}, $\beta_{timexperiod}$	Normal	μ	0	Non-informative
		σ	1	
β_{smkd}, β_{cigc}, β_{cigd}	Truncated normal	μ	0	Non-informative
		σ	1	
		Upper	0	

Table 2: Prior specifications (continued)

Parameter	Assumed distribution	Hyperparameters		Type
Country fits				
β_{time}, β_{period}, $\beta_{timexperiod}$	Normal	μ	Appendix A Appendix B	Informative
		σ	0.25	
β_{smkd}, β_{cigc}, β_{cigd}	Truncated normal	μ	Appendix A Appendix B	Informative
		σ	0.25	
		Upper	0 (second-stage) Country priors	

2.4.7. Model-fitting and implementation

Calculations were performed in log space. Models were fitted by applying Markov Chain Monte Carlo (MCMC) methods with 10,000 iterations, discarding the first 5,000 and keeping every fifth iteration thereafter. Resulting final sets of 1,000 iterations approximated the posterior distributions of the parameters of interest. MCMC simulations were implemented in the Python programming language using the PyMC package [117].

2.4.8. Prevalence estimation, projections and probabilities

Models by country and sex were fitted separately to allow for potentially diverging trends between men and women. Trend estimates were obtained for the period 1990-2000 and 2000 onwards, carrying the post-2000 trend forward to provide projections for all four indicators to 2025. One thousand draws per year of age were generated from the resulting posterior distributions of parameters. Numbers of smokers were obtained by multiplying prevalence and population estimates [121]. The WHO standard population [122] was used to obtain aggregated, age-standardized prevalences for ages 15 years and older. Means and uncertainty intervals from 2.5th and 97.5th percentiles were estimated from the distributions of these replicates. Quintiles of mean prevalence were calculated for 2000, for 2010 and for 2025. Relative percentage changes from 2000 to 2010 and from 2010 to 2025 were calculated. Posterior probabilities of decrease, increase and target achievement were obtained from the 2010-2025 relative change distributions. A ≥95% posterior probability of decrease means that at least 95% of the simulated percentage changes are below zero. Summaries were reported by WHO region and World Bank income category as described in Table 3.

Table 3: WHO region descriptions

WHO region	Acronym	Income category	Countries with model results
WHO African Region	AFR	High-income	None
		Low- or middle-income	Algeria, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cabo Verde, Chad, Comoros, Congo, Cote d'Ivoire, Democratic Republic of the Congo, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, Swaziland, United Republic of Tanzania, Togo, Uganda, Zambia, Zimbabwe
WHO Region of the Americas	AMR	High-income	Bahamas, Barbados, Canada, Chile, Saint Kitts and Nevis, Trinidad and Tobago, United States of America, Uruguay
		Low- or middle-income	Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Vincent and the Grenadines, Suriname, Venezuela

Table 3: WHO region descriptions (continued)

WHO region	Acronym	Income category	Countries with model results
WHO Eastern Mediterranean Region	EMR	High-income	Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates
		Low- or middle-income	Djibouti, Egypt, Iran, Iraq, Jordan, Lebanon, Libya, Morocco, Pakistan, Syrian Arab Republic, Tunisia, West Bank and Gaza Strip, Yemen
WHO European Region	EUR	High-income	Andorra, Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom
		Low- or middle-income	Albania, Armenia, Azerbaijan, Belarus, Bosnia Herzegovina, Bulgaria, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Republic of Moldova, Romania, Serbia, Tajikistan, Turkey, Turkmenistan, Ukraine, Uzbekistan
WHO Southeast Asian Region	SEAR	High-income	None
		Low- or middle-income	Bangladesh, Indonesia, India, Sri Lanka, Maldives, Myanmar, Nepal, Thailand, Timor-Leste

Table 3: WHO region descriptions (continued)

WHO region	Acronym	Income category	Countries with model results
WHO Western Pacific Region	WPR	High-income	Australia, Brunei Darussalam, Japan, Republic of Korea, New Zealand, Singapore
		Low- or middle-income	Cambodia, China, Cook Islands, Fiji, Kiribati, Lao People's Dem. Rep., Malaysia, Marshall Islands, Mongolia, Nauru, Niue, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, Viet Nam

2.4.9. Model selection

Comparison between models with and without an interaction between time and period was conducted using the Bayesian information criterion (BIC). Given a set of candidate models, selection of the model with the lowest BIC is equivalent to choosing the model with the highest posterior probability—that is, the most plausible model given the dataset. The BIC approximates a transformation of the posterior probability while incorporating a penalty against overfitting as shown in Equation 7.

$$BIC = -2 \ln \hat{L} + k \ln n \quad (7)$$

Where $\hat{L}$ is the maximized likelihood of the model, k is the number of parameters to be estimated and n is the sample size. In practice, a BIC less than six provides no strong evidence of a difference between candidate models [123-125].

2.4.10. Model diagnostics

Models were assessed for convergence, predictive accuracy and robustness. Formal convergence diagnostics were conducted using Gelman-Rubin statistics [126]. Predictive accuracy tests involved calculation of root-mean-squared-errors (RMSEs) and coverage of 95% posterior predictive intervals. Checks for robustness in out-of-sample prediction were conducted via hold-out cross-validation.

The Gelman-Rubin diagnostic assesses convergence by comparing multiple sets of iterations ("chains") of MCMC simulations. If the chains have reached acceptable approximations of the posterior distributions of the parameters of interest, then they should be very similar to one another. This similarity is quantified through the potential scale reduction measure ($\hat{R}$) given in Equation 8.

$$\hat{R} = \sqrt{\frac{\widehat{Var}(\theta|y)}{W}} \quad (8)$$

$\widehat{Var}(\theta|y)$ is an estimate of the marginal posterior variance of the parameter θ given in Equation 9.

$$\widehat{Var}(\theta|y) = \frac{n-1}{n}W + \frac{1}{n}B \qquad (9)$$

Where n is the number of iterations, W is the within-chain variance and B is the between-chain variance given in Equations 10 and 11 respectively.

$$W = \frac{1}{m}\sum_{j=1}^{m}\left[\frac{1}{n-1}\sum_{i=1}^{n}\left(\theta_{ij} - \bar{\theta}_{.j}\right)^2\right] \quad (10)$$

$$B = \frac{n}{m-1}\sum_{j=1}^{m}(\bar{\theta}_{.j} - \bar{\theta}_{..})^2 \qquad (11)$$

Where m is the number of chains. In practice, values of $\hat{R}$ close to one mean that lack of convergence was not detected [126, 127].

Predictive accuracy checks were conducted for each country-sex model using RMSEs and coverage of 95% posterior predictive intervals for individual age-sex-country-year specific datapoints. Cross-validation was conducted by holding-out datapoints for the years 2005 or later starting from the first-stage regional fits until the final country fits. The training dataset on which models were fitted consisted of datapoints from 1990 to 2004 and the test dataset against which model predictions were compared consisted of datapoints from 2005 onwards. Low RMSEs and high coverage values mean more accurate predictions in comparison with observed data. Small differences in RMSE and coverage between different datasets show robustness of estimates to dataset changes. Low RMSEs and high coverage test dataset results mean more accurate projections.

3. RESULTS

Models could be built and results obtained for 173 countries for men and 178 countries for women. Model estimates could not be obtained for a few country-sex groups because some countries have data only for one of the sexes. Generally, there are more countries with available data for women because of investments in multi-country survey programs which assess women's reproductive and maternal health and include health risks such as smoking. This section presents results for model selection, tobacco use trends and projections and model diagnostics.

3.1. Model selection

Country- and sex-specific estimates of smoking prevalence from 1990 to 2010 were best estimated by a model that included an interaction between time and period, indicating a change in trends in smoking at the turn of the century. Models—by country and sex—with and without an interaction term between the time and period variables were compared using the BIC [125]. For men, the average change in BIC was 4.3 and ΔBIC values ranged from 0.6 to 117.5. For women, the average change in BIC was 3.9 and ΔBIC values ranged from 0 to 45.4. Summaries of the model comparisons for men and for women are provided in Figure 2 and Figure 3 respectively.

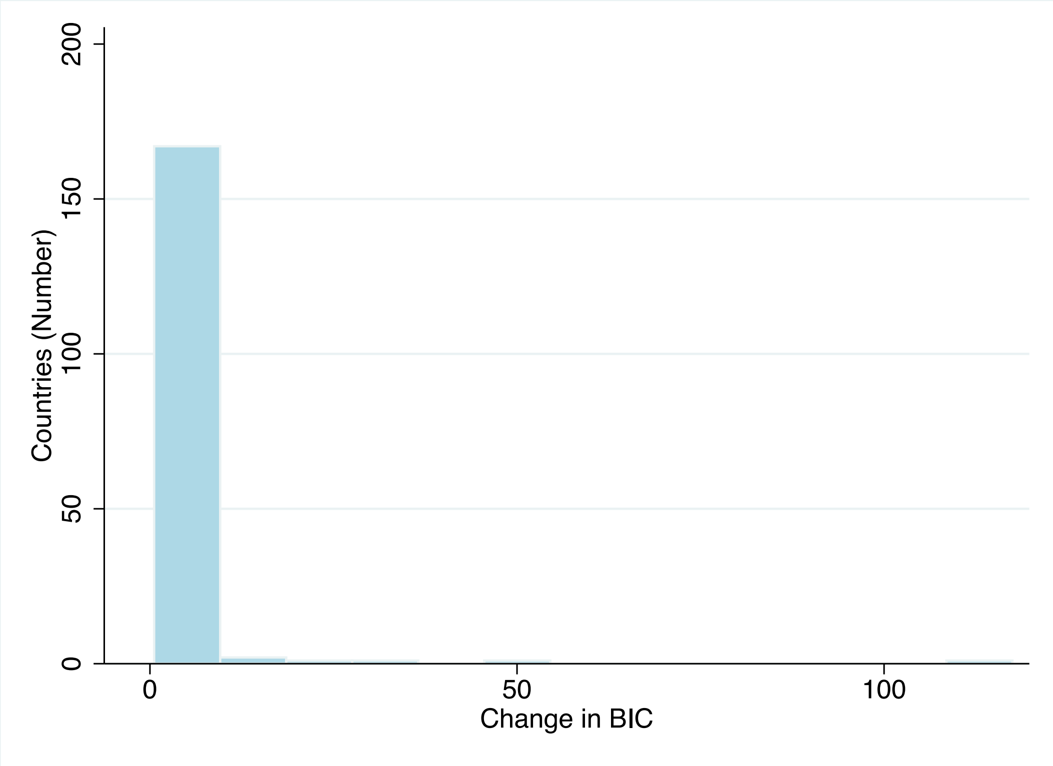

Figure 2: Change in BIC between models with and without interaction terms for men

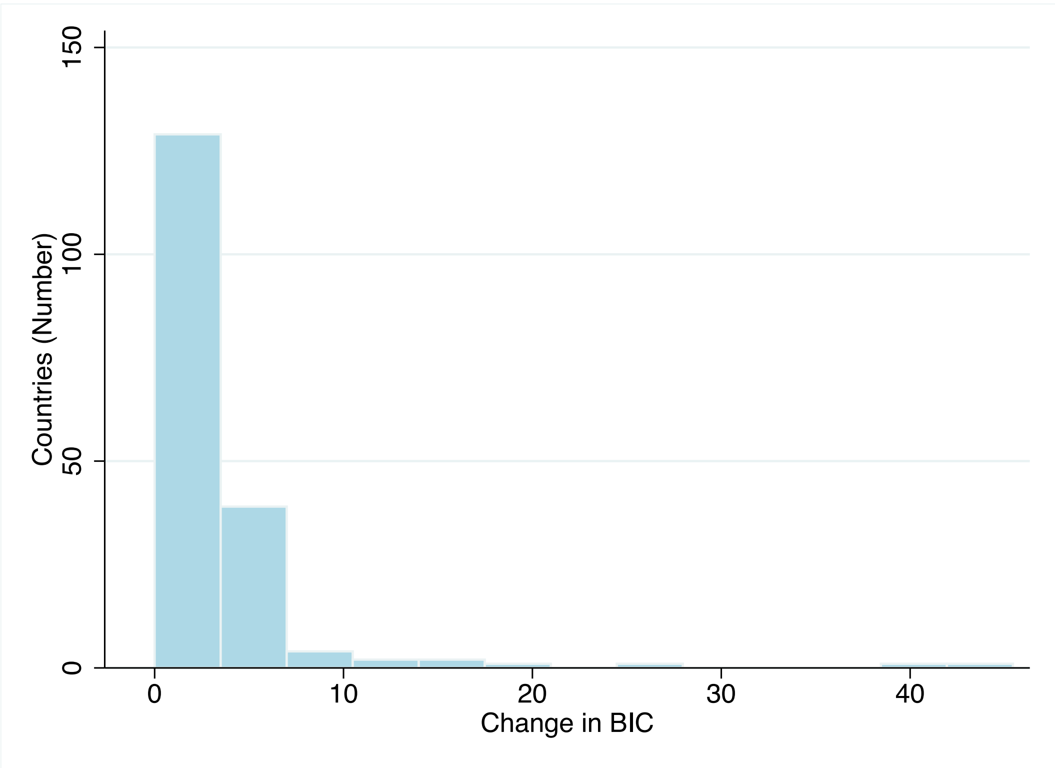

Figure 3: Change in BIC between models with and without interactions terms for women

Given that the vast majority of country-sex models—95% for men and 94% for women—had no strong evidence (ΔBIC <6) [125] against the inclusion of an interaction term, and accounting for the epidemiologic plausibility of a slope change in time trends, the model with an interaction between time and period was selected, and all results in the remainder of this chapter are derived from this model.

3.2. Tobacco use trends and projections

Results were obtained for 173 countries for men and 178 countries for women. This section focuses on current tobacco smoking, which encompasses occasional and daily smoking for all smoked tobacco product types and is the most important indicator of tobacco use globally [83]. Country-specific estimates of current tobacco smoking prevalence in 2000, 2010 and 2025 are provided in Appendix C. Country-specific estimates of relative percentage changes and posterior probabilities of reduction, increase and target achievement for current tobacco smoking are provided as Appendix D. Country-specific estimates of prevalence in 2010 and 2025 for the three other indicators—daily tobacco smoking, current cigarette smoking, daily cigarette smoking—are included in the WHO *global report on trends in prevalence of tobacco smoking* [113].

3.2.1. Recent global prevalence estimates and projections to 2025

Quintiles of mean prevalence by sex were obtained for 2000, 2010 and for 2025. The first quintile is comprised of countries with the lowest prevalences, while the fifth quintile contains countries with the highest prevalences. Prevalence estimates in 2000 ranged from less than 25% in the first quintile to 56% or greater in the fifth quintile for men, and from less than 3% in the first quintile to 27% or greater in the fifth quintile for women. For men, 21 countries (57%) in the first quintile were low- or middle-income (LMI) countries in Africa and the fifth quintile was concentrated in Europe and the Western Pacific. For women, the first quintile was comprised mostly (84%) of 26 LMI countries from diverse geographies including 14 (45%) African nations. Conversely, countries in the fifth quintile were concentrated mainly in Europe and the Western Pacific. By 2010, estimated prevalences ranged from less than 24% in the first quintile to 48% or greater in the fifth quintile for men, and from less than 2% in the first quintile to 22% or greater in the fifth quintile for women. For men, 24 of the first quintile (67%) were LMI countries in Africa and the Americas with several African nations increasing in prevalence. The composition of the fifth quintile remained similar to 2000. For women, patterns in the first and the fifth quintiles also remained similar to 2000. Prevalence quintiles in 2010 by WHO region and World Bank income categories are provided in Table 4 for men and Table 5 for women.

Table 4: Prevalence quintiles in 2010 by WHO region and World Bank income category for men

		Mean prevalence, 2010, %										
		<24		24 to <31		31 to <40		40 to <48		≥48		
Region	**Countries**											**Region total**
	N†	**N†**	**%‡**	**N†**	**%‡**	**N†**	**%‡**	**N†**	**%‡**	**N†**	**%‡**	
Low- or middle-income												
AFR	40	14	35	9	23	12	30	4	10	1	3	40
AMR	23	10	32	4	13	5	16	2	6	2	6	31
EMR	13	0	0	2	11	0	0	6	32	5	26	19
EUR	17	1	2	1	2	1	2	6	13	8	17	48
SEAR	9	0	0	2	22	2	22	3	33	2	22	9
WPR	20	1	4	0	0	1	4	8	31	10	38	26
Subtotal	122	26	21	18	15	21	17	29	24	28	23	
High-income												
AFR	0	0	0	0	0	0	0	0	0	0	0	40
AMR	8	4	13	1	3	1	3	2	6	0	0	31
EMR	6	1	5	3	16	1	5	1	5	0	0	19
EUR	31	3	6	8	17	12	25	4	8	4	8	48
SEAR	0	0	0	0	0	0	0	0	0	0	0	9
WPR	6	2	8	2	8	0	0	1	4	1	4	26
Subtotal	51	10	20	14	27	14	27	8	16	5	10	
TOTAL	173	36	21	32	21	35	21	37	21	33	21	173

†number of countries

‡proportion of the regional population

Table 5: Prevalence quintiles in 2010 by WHO region and World Bank income category for women

		Mean prevalence, 2010, %										
		<2		**2 to <4**		**4 to <11**		**11 to <22**		**≥22**		
Region	**Countries**											**Region**
	N[†]	**N[†]**	**%[‡]**	**N[†]**	**%[‡]**	**N[†]**	**%[‡]**	**N[†]**	**%[‡]**	**N[†]**	**%[‡]**	**total**
Low- or middle-income												
AFR	42	15	36	15	36	10	24	2	5	0	0	42
AMR	25	2	6	7	21	10	30	4	12	2	6	33
EMR	13	4	21	4	21	2	11	2	11	1	5	19
EUR	18	5	10	1	2	4	8	3	6	5	10	49
SEAR	9	2	22	4	44	2	22	1	11	0	0	9
WPR	20	3	12	1	4	3	12	6	23	7	27	26
Subtotal	127	31	24	32	25	31	24	18	14	15	12	
High-income												
AFR	0	0	0	0	0	0	0	0	0	0	0	42
AMR	8	2	6	1	3	1	3	2	6	2	6	33
EMR	6	2	11	2	11	2	11	0	0	0	0	19
EUR	31	0	0	0	0	0	0	14	29	17	35	49
SEAR	0	0	0	0	0	0	0	0	0	0	0	9
WPR	6	0	0	1	4	2	8	3	12	0	0	26
Subtotal	51	4	8	4	8	5	10	19	37	19	37	
TOTAL	178	35	20	36	20	36	20	37	21	34	19	178

[†]number of countries

[‡]proportion of the regional population

If recent trends remain unchanged, the global distribution of projected prevalence in 2025 will be as shown in Figure 4 for men and in Figure 5 for women. Such tobacco use patterns translate to an estimated 1.1 billion current smokers (700 million—1.6 billion) in 2025.

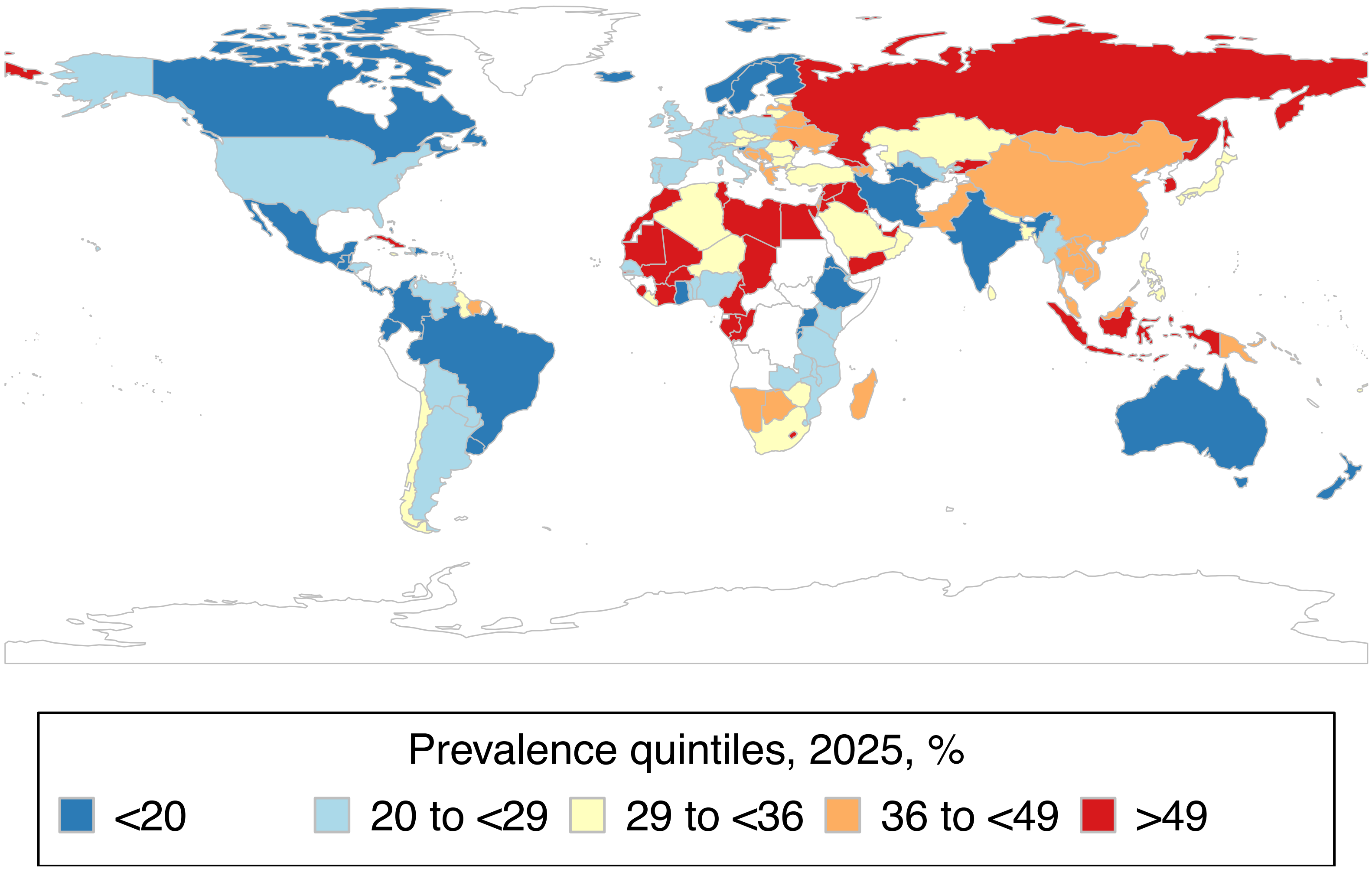

Figure 4: Estimated mean 15+ age-standardized current tobacco smoking prevalence in 2025 for men

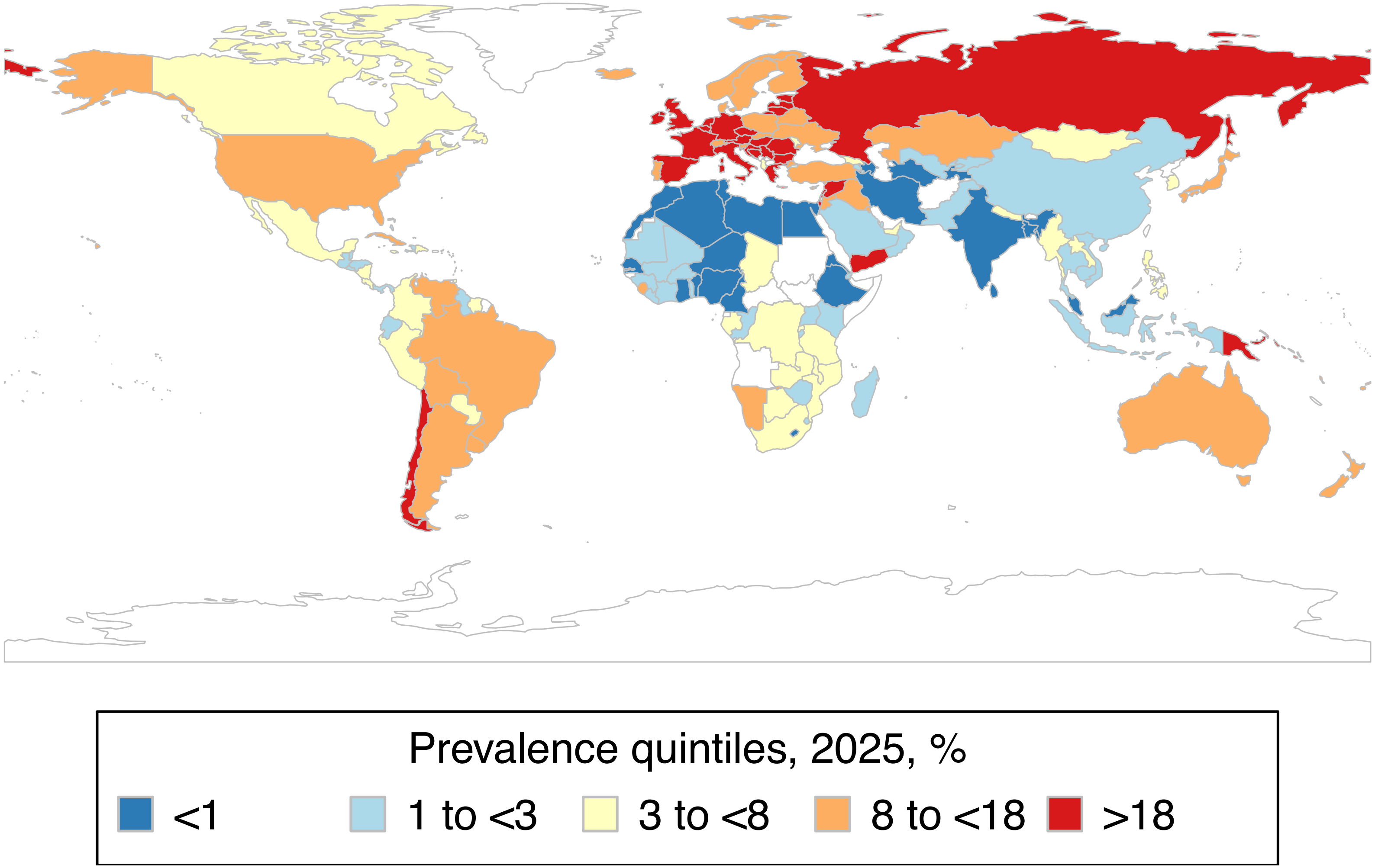

Figure 5: Estimated mean 15+ age-standardized current tobacco smoking prevalence in 2025 for women

Prevalence quintiles in 2025 by WHO region and World Bank income categories are provided in Table 6 for men and Table 7 for women. It is projected that the highest smoking quintile among men will shift from LMI countries in Europe and the Western Pacific to those in Africa and the Eastern Mediterranean, indicating a rapidly growing epidemic of tobacco smoking in this region and a major additional burden of non-communicable disease in these countries. For women, 2025 prevalence patterns will remain similar to baseline with the first quintile comprised mostly of LMI settings from diverse geographies including 12 African nations (34%), and the fifth quintile concentrated in Europe and the Western Pacific.

Table 6: Prevalence quintiles in 2025 by WHO region and World Bank income category for men

		Mean prevalence, 2025, %										
		<20		20 to <29		29 to <36		36 to <49		≥49		
Region	Countries											Region total
	N†	N†	%‡	N†	%‡	N†	%‡	N†	%‡	N†	%‡	
Low- or middle-income												
AFR	40	6	15	11	28	6	15	6	15	11	28	40
AMR	23	11	35	6	19	4	13	1	3	1	3	31
EMR	13	1	5	1	5	0	0	1	5	10	53	19
EUR	17	1	2	2	4	4	8	7	15	3	6	48
SEAR	9	1	11	1	11	4	44	1	11	2	22	9
WPR	20	1	4	1	4	4	15	12	46	2	8	26
Subtotal	122	21	17	22	18	22	18	28	23	29	24	
High-income												
AFR	0	0	0	0	0	0	0	0	0	0	0	40
AMR	8	5	16	1	3	1	3	1	3	0	0	31
EMR	6	0	0	0	0	2	11	0	0	4	21	19
EUR	31	6	13	13	27	6	13	5	10	1	2	48
SEAR	0	0	0	0	0	0	0	0	0	0	0	9
WPR	6	2	8	1	4	2	8	0	0	1	4	26
Subtotal	51	13	25	15	29	11	22	6	12	6	12	
TOTAL	173	34	20	37	21	33	19	34	20	35	20	173

†number of countries

‡proportion of the regional population

Table 7: Prevalence quintiles in 2025 by WHO region and World Bank income category for women

		Mean prevalence, 2025, %									
		<1		1 to <3		3 to <8		8 to <18		≥18	
Region	Countries										Region
	N†	N†	%‡	N†	%‡	N†	%‡	N†	%‡	N†	%‡	total
Low- or middle-income												
AFR	42	12	29	17	40	11	26	2	5	0	0	42
AMR	25	3	9	8	24	9	27	5	15	0	0	33
EMR	13	5	26	2	11	1	5	2	11	3	16	19
EUR	18	5	10	1	2	3	6	4	8	5	10	49
SEAR	9	4	44	3	33	2	22	0	0	0	0	9
WPR	20	3	12	1	4	4	15	5	19	7	27	26
Subtotal	127	32	25	32	25	30	24	18	14	15	12	
High-income												
AFR	0	0	0	0	0	0	0	0	0	0	0	42
AMR	8	2	6	1	3	2	6	2	6	1	3	33
EMR	6	1	5	2	11	2	11	1	5	0	0	19
EUR	31	0	0	0	0	0	0	11	22	20	41	49
SEAR	0	0	0	0	0	0	0	0	0	0	0	9
WPR	6	0	0	1	4	2	8	3	12	0	0	26
Subtotal	51	3	6	4	8	6	12	17	33	21	41	
TOTAL	178	35	20	36	20	36	20	35	20	36	20	178

†number of countries

‡proportion of the regional population

3.2.2. Recent and future trajectories and prevalence changes

From 2000 to 2010, 125 countries experienced declines in prevalence for men (72%), and 155 countries (87%) for women, showing that tobacco control efforts have been successful. Even if such trends continue however, only 43 countries (25%) for men and 93 (52%) for women will have ≥95% probability of decline from 2010 to 2025, and 21 countries (12%) will have ≥95% probability of increase among men over the same period. Patterns in trend estimates from 2000 to 2010 and probabilities of reduction and increase in prevalence from 2010 to 2025 by region and income category are summarized in Table 8 for men and Table 9 for women. High (≥95%) probabilities of decline were found for the majority of countries in the Americas for both men and women. In contrast, high probabilities of increase were estimated for about a third of countries in Africa and the Eastern Mediterranean for men. For European men, 15 high-income countries (48%) had a high probability of reduction, compared to only four low- or middle-income countries (24%), indicating that within-region income inequalities remain an issue in tobacco control.

Maps of relative percentage changes from 2010 to 2025 are provided in Figure 6 for men and in Figure 7 for women. Declines are projected for the majority of countries in almost all regions except Africa for men and the Eastern Mediterranean for both men and women.

Table 8: Relative change in 15+ age-standardized current tobacco smoking prevalence by WHO region and World Bank income category for men

Region	Countries	Direction of trend, 2000-2010				≥95% probability, 2010-2025			
		Decrease		Increase		Decrease		Increase	
	Number (N)	N	% pop[a] covered	N	% pop[a] covered	N	% pop[a] covered	N	% pop[a] covered
Low- or middle-income									
AFR	40	15	44	25	56	1	5	15	37
AMR	23	22	57	1	1	13	54	0	0
EMR	13	2	14	11	73	0	0	2	2
EUR	17	16	27	1	<1	4	12	0	0
SEAR	9	7	86	2	14	3	80	0	0
WPR	20	20	89	0	0	1	5	0	0
Subtotal	122	82	80	40	20	22	40	17	5
High-income									
AFR	0	0	0	0	0	0	0	0	0
AMR	8	7	42	1	<1	3	39	0	0
EMR	6	0	0	6	13	0	0	4	5
EUR	31	31	73	0	0	15	25	0	0
SEAR	0	0	0	0	0	0	0	0	0
WPR	6	5	11	1	<1	3	8	0	0
Subtotal	51	43	94	8	6	21	56	4	2
TOTAL	173	125	83	48	17	43	43	21	5

[a]% pop covered refers to the proportion of the regional population

Table 9: Relative change in 15+ age-standardized current tobacco smoking prevalence by WHO region and World Bank income category for women

Region	Countries	Direction of trend, 2000-2010				≥95% probability, 2010-2025			
		Decrease		Increase		Decrease		Increase	
	Number (N)	N	% pop[a] covered	N	% pop[a] covered	N	% pop[a] covered	N	% pop[a] covered
Low- or middle-income									
AFR	42	36	88	6	12	21	50	0	0
AMR	25	25	60	0	0	24	60	0	0
EMR	13	7	74	6	18	6	74	0	0
EUR	18	16	27	2	1	6	11	0	0
SEAR	9	9	100	0	0	9	100	0	0
WPR	20	20	88	0	0	7	87	0	0
Subtotal	127	113	96	14	4	73	88	0	0
High-income									
AFR	0	0	0	0	0	0	0	0	0
AMR	8	8	40	0	0	7	38	0	0
EMR	6	1	4	5	3	0	0	0	0
EUR	31	27	56	4	16	9	16	0	0
SEAR	0	0	0	0	0	0	0	0	0
WPR	6	6	12	0	0	4	9	0	0
Subtotal	51	42	88	9	12	20	51	0	0
TOTAL	178	155	95	23	5	93	81	0	0

[a]% pop covered refers to the proportion of the regional population

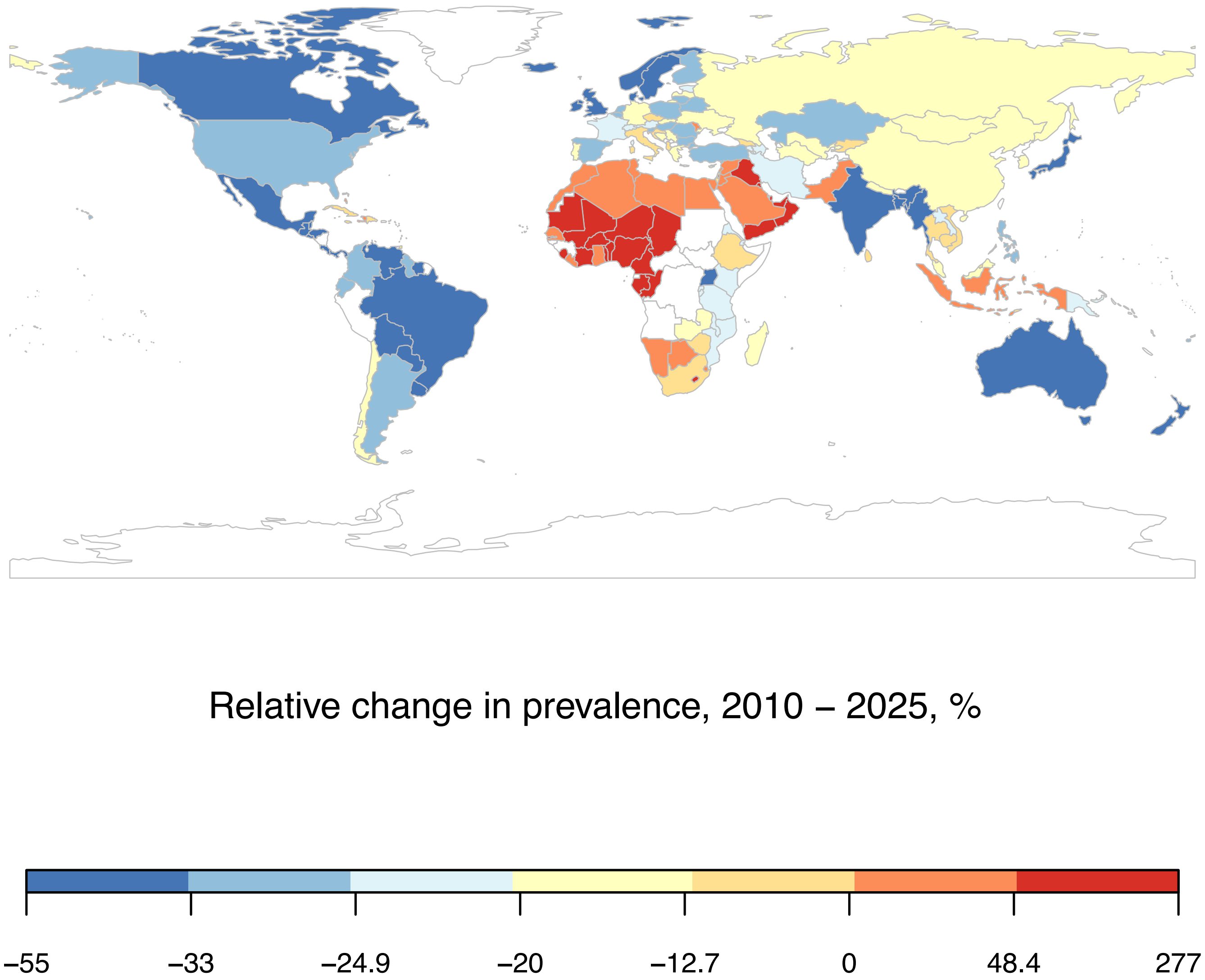

Figure 6: Relative change in 15+ age-satndardized current tobacco smoking prevalence between 2010 and 2025 for men

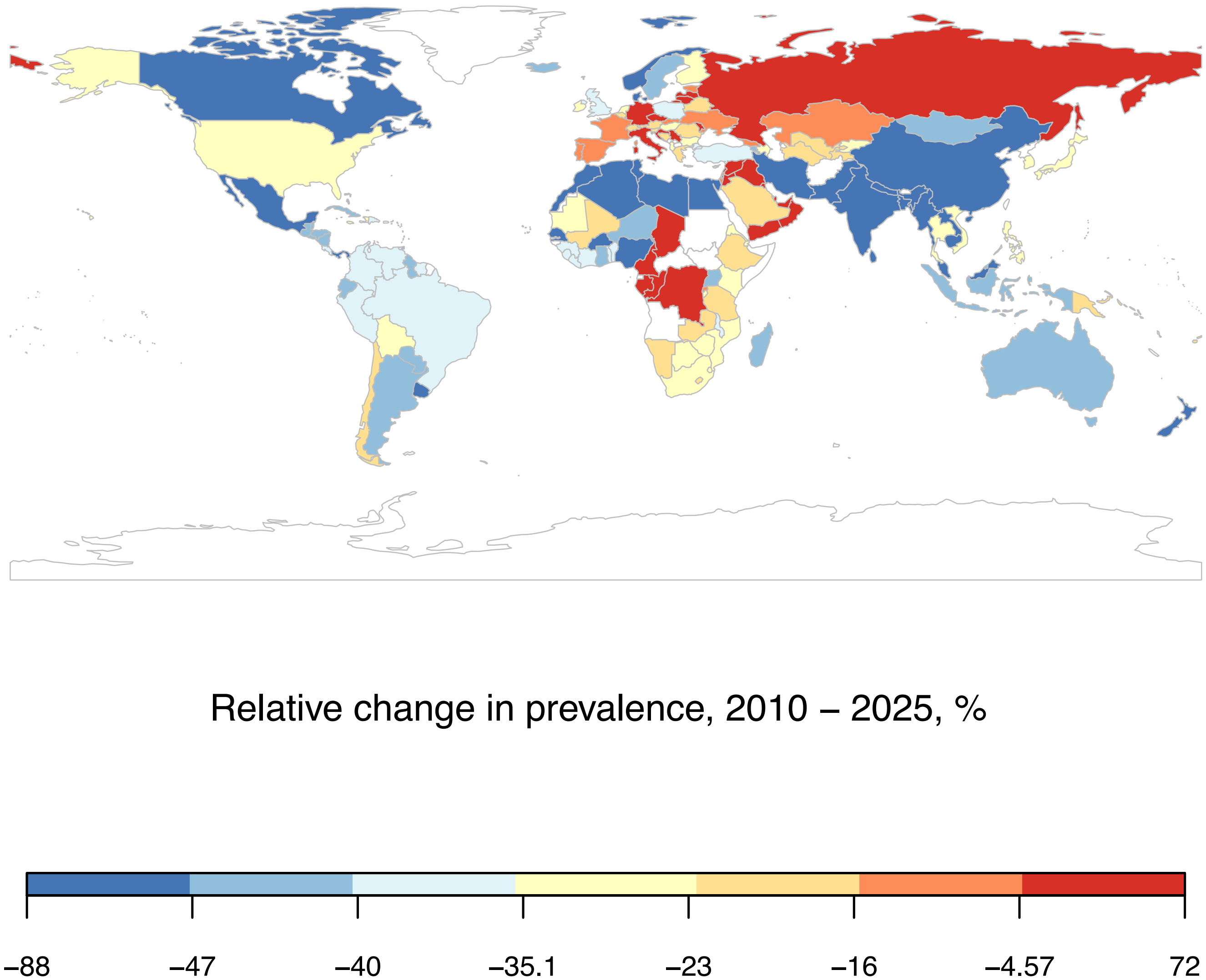

Figure 7: Relative change in 15+ age-standardized current tobacco smoking prevalence between 2010 and 2025 for women

3.2.3. Target achievement assessment and probabilities

Scatterplots of relative percentage changes from 2010 to 2025 against baseline prevalence in 2010 with countries categorized according to probabilities of achieving the 30% relative reduction in tobacco use target are provided in Figure 8 for men and in Figure 9 for women. Only 37 countries (21%) are on track to achieve their targets for men and 88 (49%) for women. Only three countries for men (2%) and 22 for women (12%) had high probabilities (≥95%) of target achievement. Relative prevalence increases of more than 100% accompanied by low (<5%) probabilities of target achievement were estimated for men in seven countries (4%) in Africa and the Eastern Mediterranean.

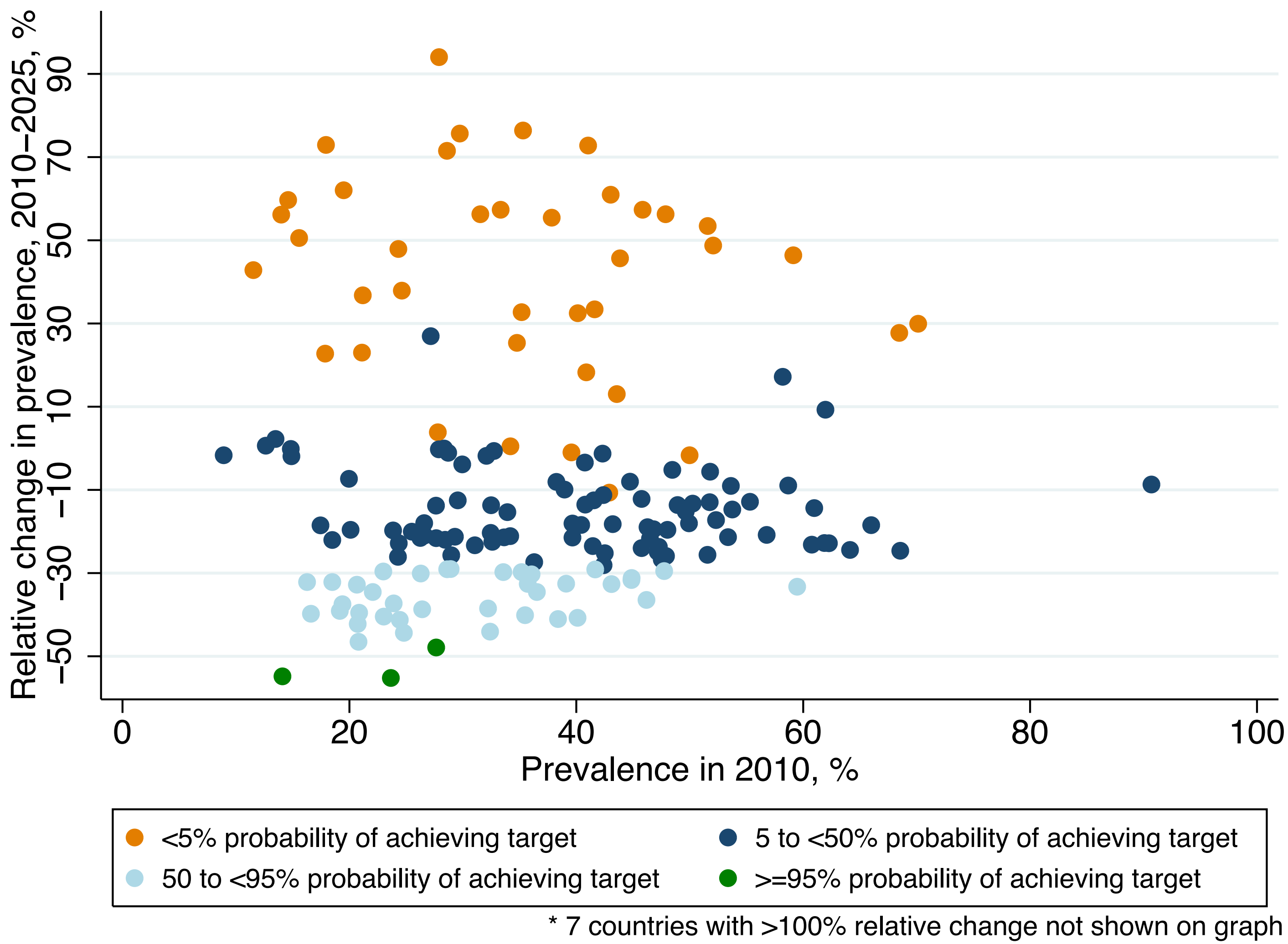

Figure 8: Relative change in 15+ age-standardized current tobacco smoking prevalence versus baseline prevalence and target achievement probabilities for men

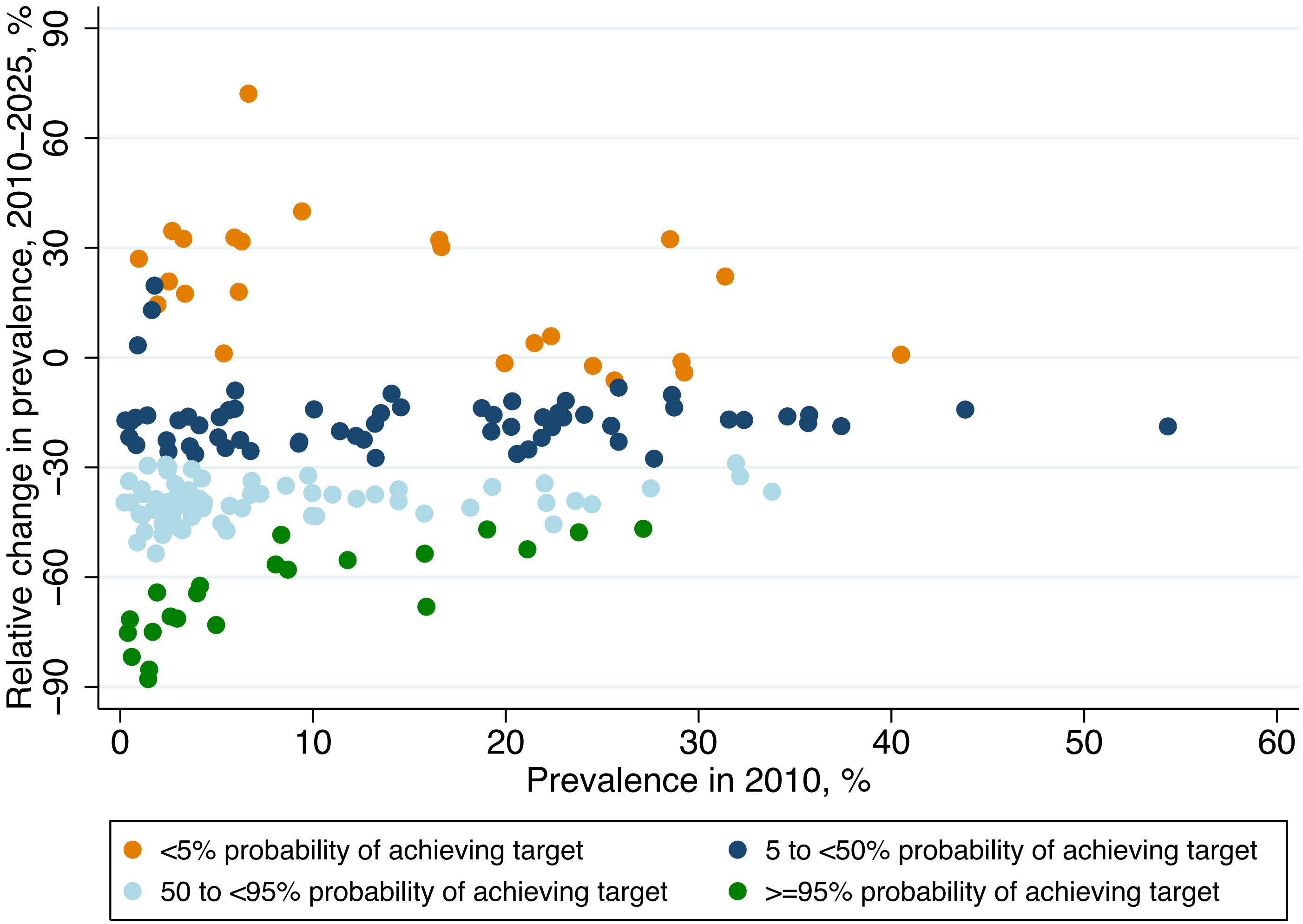

Figure 9: Relative change in mean 15+ age-standardized current tobacco smoking prevalence 2010-2025 versus baseline prevalence and target achievement probabilities for women

Target achievement probabilities are mapped in Figure 10 for men and in Figure 11 for women. Low (<5%) target achievement probabilities were found in a number of countries for both sexes with several in Africa and the Eastern Mediterranean for men and in Europe for women.

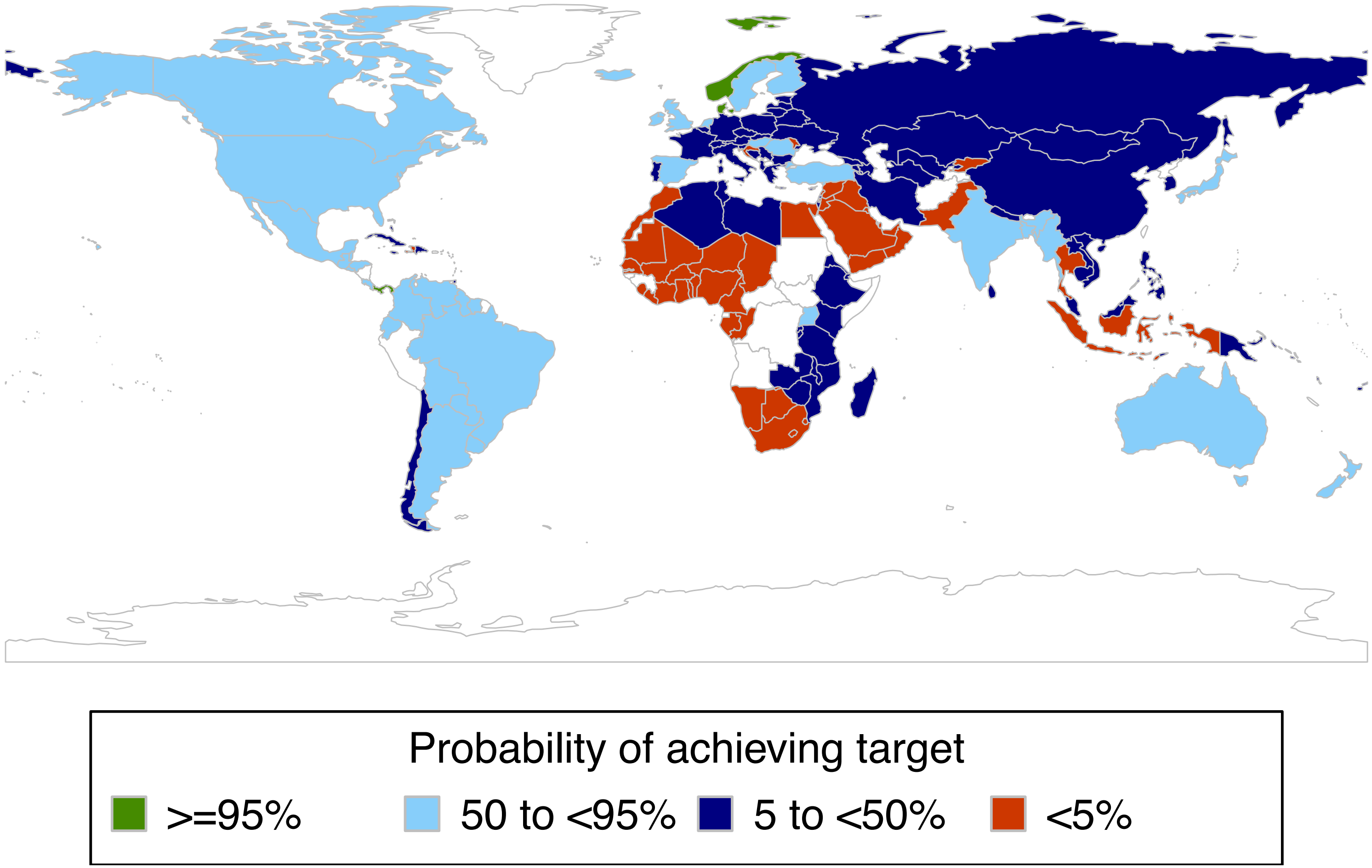

Figure 10: Map of probability of achieving 30% reduction in current tobacco smoking prevalence by 2025

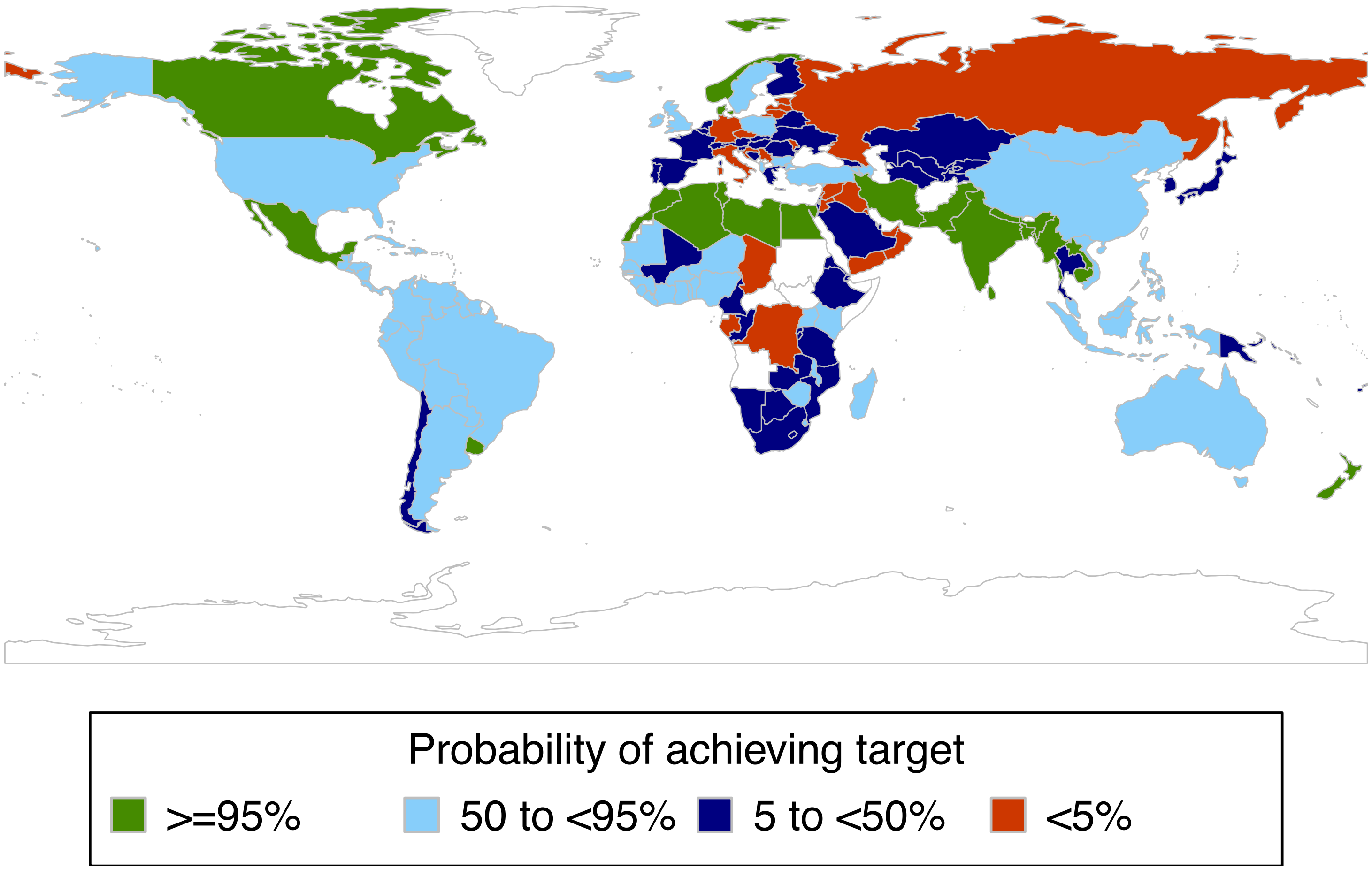

Figure 11: Map of probability of achieving 30% reduction in current tobacco smoking prevalence by 2025

Summaries of target achievement and corresponding probabilities by WHO region and World Bank income classification are given in Table 10 for men and in Table 11 for women. For men, low- and middle-income settings had a higher proportion (31%) of countries with low (<5%) target achievement probabilities compared to high-income settings (16%). Conversely for women, high-income settings had a higher proportion (24%) of countries with low target achievement probabilities compared to low- and middle-income settings (9%). These suggest continued growth of tobacco smoking among men in low-income countries and persistence of the smoking epidemic among women in high-income countries.

Table 10: Probability of achieving 30% reduction in tobacco use target by WHO region and World Bank income category for men

Region	**Countries**	**Target achievement**		**Probability of achieving target**							
				<5%		**5 - <50%**		**50 - <95%**		**≥95%**	
	Number (N)	**N**	**% reg pop[a]**	**N**	**% reg pop[a]**	**N**	**% reg pop[a]**	**N**	**% reg pop[a]**	**N**	**% reg pop[a]**
Low- or middle-income											
AFR	40	1	5	24	51	15	44	1	5	0	0
AMR	23	16	55	1	1	6	3	15	54	1	<1
EMR	13	0	0	9	70	4	3	0	0	0	0
EUR	17	2	9	2	<1	12	15	3	12	0	0
SEAR	9	3	80	2	17	4	17	3	80	0	0
WPR	20	2	<1	0	0	18	89	2	<1	0	0
Subtotal	122	24	38	38	20	59	42	24	38	1	<1
High-income											
AFR	0	0	0	0	0	0	0	0	0	0	0
AMR	8	2	4	0	0	5	2	3	39	0	0
EMR	6	0	0	6	13	0	0	0	0	0	0
EUR	31	8	16	1	<1	21	55	7	17	2	1
SEAR	0	0	0	0	0	0	0	0	0	0	0
WPR	6	3	8	1	<1	2	3	3	8	0	0
Subtotal	51	13	25	8	6	28	43	13	50	2	<1
TOTAL	173	37	35	46	17	87	42	37	40	3	<1

[a]% reg pop refers to the proportion of the regional population

Table 11: Probability of achieving 30% reduction in tobacco use target by WHO region and World Bank income category for women

Region	Countries	Target achievement		Probability of achieving target							
				<5%		5 - <50%		50 - <95%		≥95%	
	Number (N)	N	% reg pop[a]	N	% reg pop[a]	N	% reg pop[a]	N	% reg pop[a]	N	% reg pop[a]
Low- or middle-income											
AFR	42	22	50	4	9	15	36	21	50	2	5
AMR	25	25	60	0	0	0	0	24	48	1	13
EMR	13	6	74	6	18	1	<1	0	0	6	74
EUR	18	5	10	2	1	11	16	5	10	0	0
SEAR	9	8	96	0	0	1	4	2	14	6	82
WPR	20	6	82	0	0	13	<1	5	86	2	1
Subtotal	127	72	85	12	3	41	10	57	51	17	36
High-income											
AFR	0	0	0	0	0	0	0	0	0	0	0
AMR	8	7	38	0	0	1	2	5	34	2	4
EMR	6	0	0	4	3	2	5	0	0	0	0
EUR	31	6	13	8	32	16	26	5	12	2	1
SEAR	0	0	0	0	0	0	0	0	0	0	0
WPR	6	3	2	0	0	3	10	2	1	1	<1
Subtotal	51	16	40	12	24	22	36	12	36	5	4
TOTAL	178	88	76	24	7	63	15	69	48	22	30

[a]% reg pop refers to the proportion of the regional population

3.3. Model diagnostics

This section presents results of assessments for convergence, predictive accuracy and robustness.

3.3.1. Formal convergence checks

Summaries of the Gelman-Rubin statistic for parameters of models by country and sex are provided in Table 12 for men and Table 13 for women.

Table 12: Summary of Gelman-Rubin statistics for country-sex model parameters for men

Parameter	Summary measure (Number of countries = 173)	
	Mean	Standard deviation
β_{time}	1.006	0.009
β_{period}	1.007	0.012
$\beta_{timexperiod}$	1.007	0.010
β_{smkd}	1.008	0.011
β_{cigc}	1.010	0.018
β_{cigd}	1.007	0.012
η	1.003	0.006
γ_{15}	1.007	0.012
γ_{20}	1.008	0.012
γ_{30}	1.009	0.015
γ_{40}	1.009	0.013
γ_{50}	1.009	0.015
γ_{60}	1.008	0.014
γ_{70}	1.008	0.013
γ_{80}	1.007	0.012
γ_{100}	1.006	0.011

Table 13: Summary of Gelman-Rubin statistics for country-sex model parameters for women

Parameter	Summary measure (Number of countries = 178)	
	Mean	**Standard deviation**
β_{time}	1.008	0.014
β_{period}	1.007	0.012
$\beta_{timexperiod}$	1.006	0.010
β_{smkd}	1.008	0.013
β_{cigc}	1.011	0.039
β_{cigd}	1.007	0.011
η	1.003	0.009
γ_{15}	1.009	0.026
γ_{20}	1.009	0.026
γ_{30}	1.010	0.032
γ_{40}	1.011	0.039
γ_{50}	1.012	0.053
γ_{60}	1.014	0.072
γ_{70}	1.016	0.087
γ_{80}	1.015	0.088
γ_{100}	1.010	0.040

Given that the values of the Gelman-Rubin statistic for each parameter are generally close to one [127], there was no lack of convergence detected.

3.3.2. Predictive accuracy and robustness checks

Summaries of predictive accuracy checks and cross-validation results are provided in Table 14, Figure 12, Figure 13, Figure 14 and Figure 15. In Table 14, the full dataset is comprised of all datapoints included in this analysis from 1990 to 2014, the training dataset contains datapoints from 1990 to 2004, and the test dataset is composed of datapoints from 2005 onwards. Cross-validation could only be conducted for a subset of countries in the analysis due to data limitations.

Table 14: Summary of predictive validity results

Measure	**Dataset**	**Summary statistics**					
		No. of countries	**Mean**	**SD**	**Min**	**Median**	**Max**
Men							
RMSE	Full	173	.065	.028	.021	.058	.185
	Training	111	.091	.106	.019	.068	.944
	Test	111	.118	.078	.031	.101	.662
Coverage	Full	173	.994	.014	.938	1.000	1.000
	Training	111	.996	.012	.944	1.000	1.000
	Test	111	.925	.147	.125	1.000	1.000
Women							
RMSE	Full	178	.031	.024	.001	.024	.111
	Training	115	.043	.033	.001	.037	.187
	Test	115	.072	.095	.001	.050	.702
Coverage	Full	178	.985	.023	.893	1.000	1.000
	Training	115	.988	.026	.889	1.000	1.000
	Test	115	.861	.198	.000	.941	1.000

In general, small RMSEs and high coverage values indicate that the models estimate accurately, and predicted values lie close to the observed data. RMSE always increases in the test dataset compared to the full or training datasets, indicating the challenges of out-of-sample prediction, but the RMSEs in the test dataset remain low. Low RMSEs and high coverage in comparison in the test dataset mean the models are not overfitted, retain accuracy in out-of-sample prediction, and are suitable for projection.

Distributions of the coverage of posterior predictive intervals of individual country-sex models fitted using the full dataset are shown in Figure 12 for men and Figure 13 for women respectively.

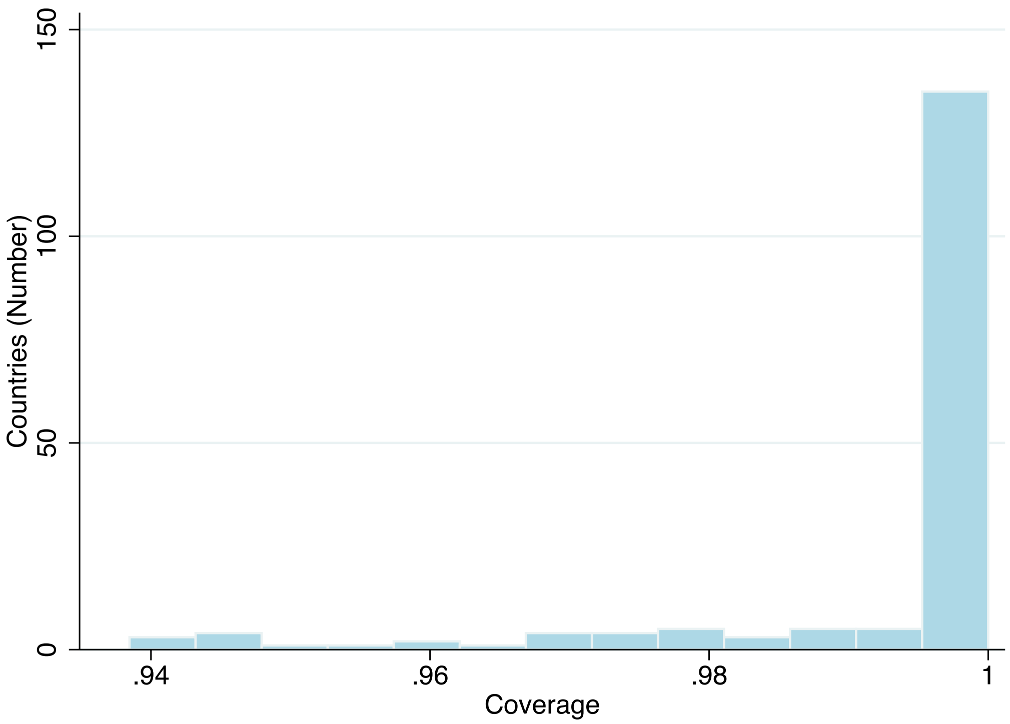

Figure 12: Coverage of posterior predictive intervals for country-sex models for men

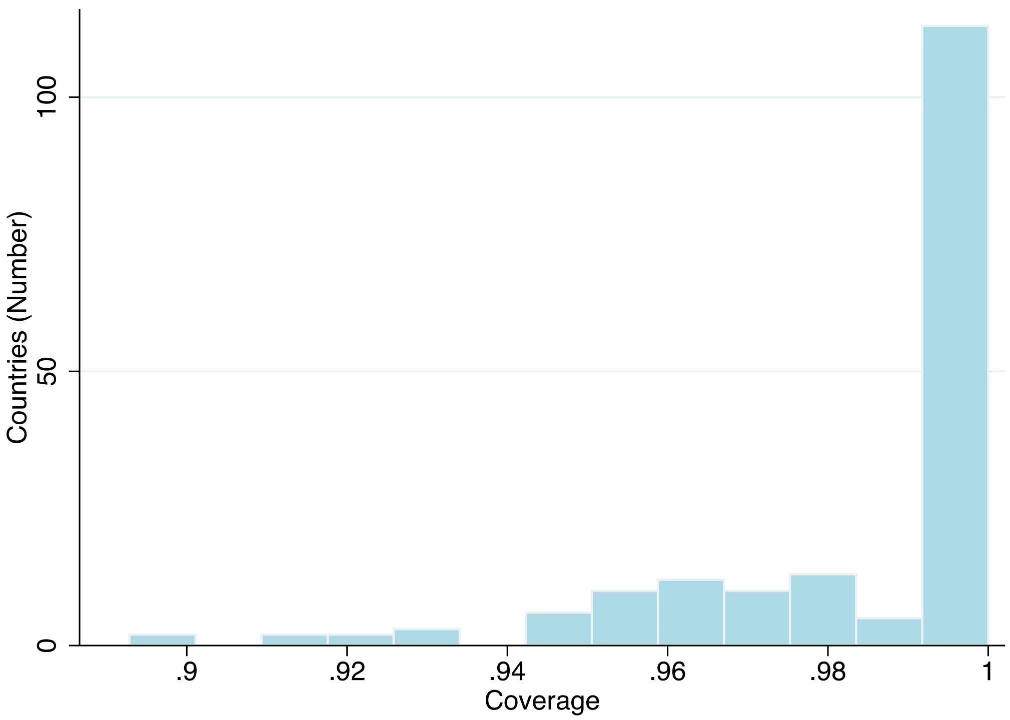

Figure 13: Coverage of posterior predictive intervals for country-sex models for women

The vast majority of countries have high coverage of posterior predictive intervals for men and for women, indicating that predicted values from most country-sex models lie close to the observed data.

Distributions of the RMSEs of individual country-sex models fitted using full datasets are shown in Figure 14 for men and Figure 15 for women respectively.

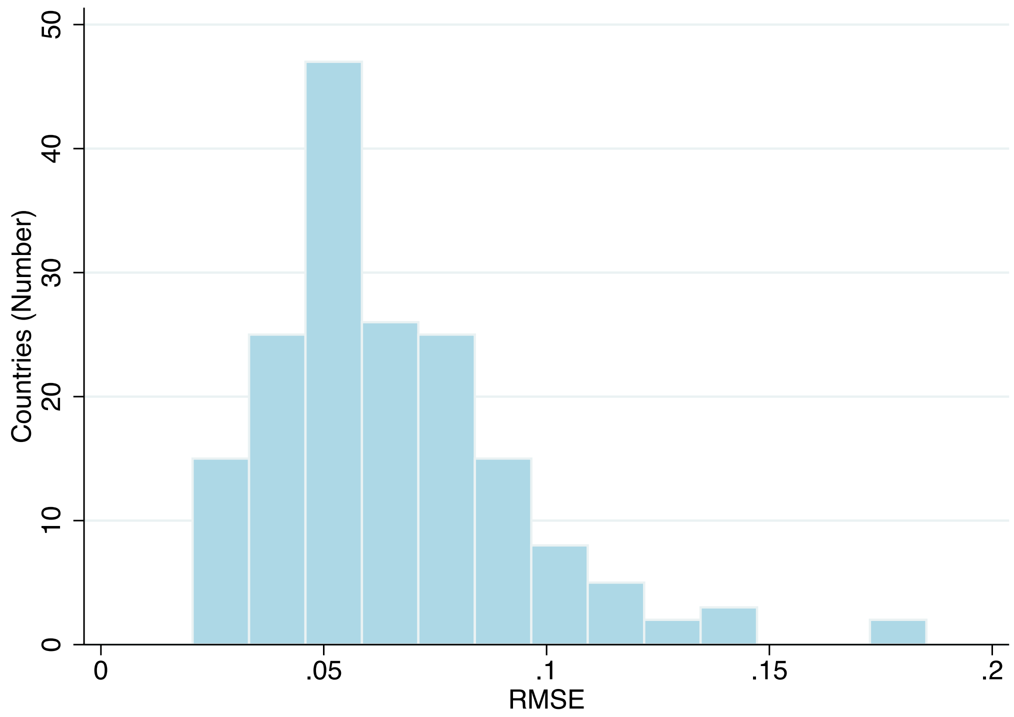

Figure 14: RMSEs for country-sex models for men

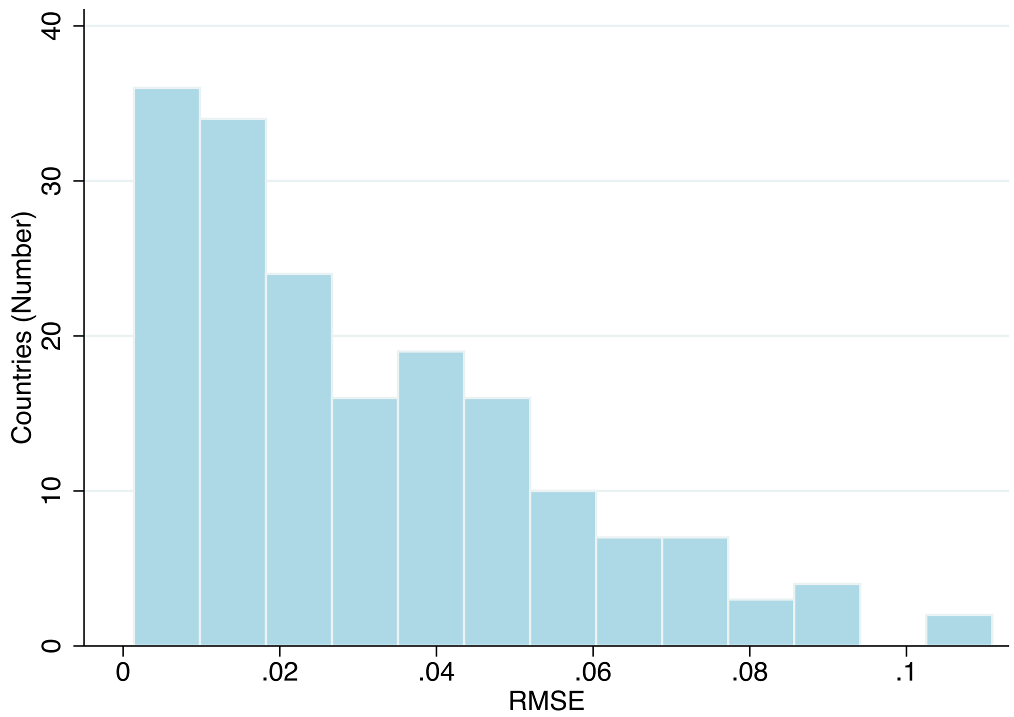

Figure 15: RMSEs for country-sex models for women

The majority of countries have small RMSEs relative to the magnitude of prevalence values in the dataset for men and for women. Generally, there was no substantial difference in predictive ability between the country-sex models for men and those for women. Although RMSEs were generally larger for country-sex models for men relative to those for women, RMSEs were calculated in the same scale as prevalence values and not normalized, thus, the apparent discrepancy in accuracy could be attributed to the higher magnitude of observed prevalences among men relative to women. Coverage of posterior predictive intervals was ≥95% for the vast majority of country-sex models for men (97%) and for women (94%) indicating that model predictions generally lie close to the observed values and adequately account for sampling variability for both sexes.

Overall, diagnostics for convergence, predictive accuracy and robustness demonstrated that the models perform well for the vast majority of countries for both sexes.

4. DISCUSSION

This study provides the most comprehensive set of comparable and consistent estimates and projections for four tobacco use indicators and for target achievement under the WHO global monitoring framework. It uses the most up-to-date dataset and a comprehensive modeling process that enables information from multiple indicators to be used directly in a single flexible model. Tobacco smoking prevalence trends were estimated from 1990 to 2010 using data available until 2014, with projections to 2025 for 178 countries. Relative percentage changes in prevalence in the most recent decade (2000-2010) and between 2010 and 2025 were estimated. Posterior probabilities of reduction, increase and target achievement for the 2010-2025 period were obtained. National authorities were engaged to ensure a comprehensive database, the latest available survey data were used, and consultation with individual countries regarding discrepancies was conducted as part of the WHO global estimation process.

During the most recent decade (2000–2010), the prevalence of tobacco smoking in men fell in 125 countries (72%), and in women fell in 155 countries (87%). Even if such global declines continue however, only 37 (21%) countries are on track to achieve their targets for men and 88 (49%) are on track for women. These translate to more than one billion current tobacco smokers in 2025 due to population growth. If such trends remain unchanged, striking country disparities would persist and rapid increases are predicted in Africa for men and in the eastern Mediterranean for both men and women.

4.1. Global prevalence and control strategies

There was wide variation in baseline prevalence, reflective of differences in tobacco epidemic stages and in control efforts between countries. Prevalence projections suggest that such disparities are likely to persist. Countries already at mature stages of the smoking epidemic at baseline and which are projected to retain high prevalence in 2025 require immediate and effective implementation or strengthening of measures for inducing cessation, avoiding relapse and deterring further initiation. These could include Indonesia for example, which is in the highest quintile in 2010 at >65% prevalence for men and is projected to retain high prevalence in 2025 with a >90% probability of increase. In Indonesia at present, cessation services are not publicly-funded, the tobacco industry enjoys considerable marketing freedom, tobacco taxation is only at 51% and smoke-free legislation does not cover all types of public places [48]. Improvement of such weak tobacco control policies could help curb the nation's immense smoking problem. Countries where the smoking epidemic has not gained a foothold or is in its early stages are mostly in LMI settings where tobacco control may not currently be prioritized due to limited resources for addressing pressing health concerns. However, such situations present opportunities for these countries' governments, in cooperation with the international community, to invest in or strengthen cost-effective prevention strategies before tobacco companies establish and expand their markets. Togo for instance has low smoking prevalence for both men (14%) and women (2%) at baseline. However, demand-reduction measures other than health warnings are severely lacking [48] and the country is also experiencing threats of expensive litigation from Philip Morris International. However, if Togo makes the most of global tobacco control initiatives such as the Anti-Tobacco Trade Litigation Fund, [51] then pre-emptive action against a smoking epidemic could be taken.

4.2. Trajectories and socioeconomic tobacco control factors

Global, regional and intra-regional patterns in country trajectories identified in this study reflect patterns in tobacco control efforts. This study found downward trajectories in prevalence in 72% (125) of countries for men and in 87% (155) of countries for women. This is consistent with the findings of other analyses [53, 103] as a consequence of growing tobacco control efforts over the past two decades [48]. Regional patterns were observed, such as high (≥95%) probabilities of reduction estimated for the majority of countries in the Americas. These included 52% (16) of countries for men and 94% (31) of countries for women involving a mix of high- and low- or middle-income economies such as the United States and Mexico respectively. Lessons could be taken from these countries with success stories. The success of tobacco control in the United States, evidenced by a ratio of former to current smokers in middle age greater than one [128], shows the value of sustained state-level funding for model comprehensive tobacco control programs that have been running since the early 1990s [129]. Mexico's success is backed by an estimated reduction in smoking prevalence of more than 50% over three decades and by strong civil society support for implementation of tobacco control policies [53, 130]. This study's findings are also consistent with significant progress in smoke-free policy implementation among several LMI Latin American countries after FCTC ratification in the region and are suggestive of the potential to build regional momentum in tobacco control [131]. Within-region disparities were also found however, such as greater proportions of high-income (15 or 48%) relative to low- or middle-income countries (4 or 24%) with high (≥95%) estimated probabilities of reduction for European men. To prevent widening tobacco-related regional health inequalities, sharing of best practices by model countries, intraregional assistance and comprehensive regional tobacco control strategies should undergo immediate and effective implementation.

4.3. Target achievement and MPOWER implementation

This study found that 136 countries (79%) for men and 90 countries (51%) for women will not achieve the 30% reduction target if current trends remain unchanged, and more effort is required to attain or to maintain desirable trajectories. For this, the WHO MPOWER [13, 105] tobacco control policy package serves as a good starting point. Aimed at assisting country-level FCTC implementation, it consists of six components: “monitor tobacco use and prevention policies, protect people from tobacco smoke, offer help to quit tobacco use, warn about the dangers of tobacco, enforce bans on tobacco advertising, promotion and sponsorship, and raise taxes on tobacco” [13]. Although the FCTC has been ratified by 180 countries to date [132], completeness of implementation of MPOWER measures, and compliance with MPOWER standards, varies greatly across countries [48]. The importance of immediate and extensive MPOWER implementation is exemplified by Uruguay, which we project will achieve a greater than 40% reduction in current smoking prevalence, representing an annual 2.7% decrease over 15 years, with high probabilities of reduction (≥95%) for both men and women. After FCTC ratification in 2004 and initiation of FCTC-based measures in 2005, Uruguay achieved high levels of MPOWER implementation and an estimated annual rate of decrease greater than 3% in tobacco use prevalence over the period 2005 to 2011 even though it had no significant reductions in tobacco use before 2005 [133]. If sustained, such a declining trend would be sufficient to attain the 2% annual reduction over 15 years required by the target. Even countries on track towards target achievement should be vigilant however, and exert efforts to maintain desirable trajectories. Norway provides an example of the importance of vigilance in maintaining tobacco control efforts. This study estimated that Norway will achieve a 45% reduction in current smoking prevalence, representing a 3% annual decrease over 15 years with high probabilities (>95%) for both men and women. After waning tobacco control prioritization in the 1980s and stalled prevalence reductions, tobacco use reductions were again achieved after reinvigoration of the national tobacco control program in the 1990s, and have been maintained [134]. Norway was able to achieve 30% tobacco use reduction within a decade [135] and its national tobacco control strategy continues to evolve [136]. These countries offer lessons in effective tobacco control, and show the potential value of the MPOWER package for countries that we have identified are at risk of increasing or static trends in current smoking prevalence.

4.4. Contextual tobacco use factors

While tobacco control strategies are at the forefront of changes in tobacco use prevalence, smoking trends may also be reflective of other factors. Similar to Norway, Sweden is projected to achieve ≥37% relative reduction in current smoking prevalence, representing annual decreases over 15 years for both men and women of approximately 2.4%. In both countries however, consumption of a smokeless oral form of tobacco called snus has been increasing in recent years [137-139]. While it is suggested that use of snus may be helpful in smoking cessation, its health effects remain controversial and debate about its role as a tobacco cessation strategy is ongoing [138, 140, 141]. Some portion of Norway and Sweden's success may therefore represent substitution to unmeasured forms rather than cessation, and for any country the particular cultural context of tobacco use remains an important consideration in interpreting the model outputs. This also holds for developing countries such as India and Myanmar, which are both projected to achieve the target for tobacco smoking for men and for women. However, smokeless tobacco use is prevalent (≥20%) in both countries and due to gaps in knowledge [55, 142], it is unclear how the trend for smokeless use would compare with the smoking trajectories for these nations.

4.5. Vulnerable populations requiring attention and action

Patterns in target achievement probabilities, trajectories and projected prevalence reveal areas for attention. Low target achievement probabilities and upward trends in prevalence were estimated for the majority of countries in the WHO African Region (AFR) for men and in the WHO Eastern Mediterranean Region (EMR) for both sexes. For men, both regions have a number of countries—6 (32%) for EMR and 15 (38%) for AFR—with high (≥95%) estimated probabilities of increase, and 37% of the population covered by the AFR region is almost certain to experience increases in tobacco smoking by 2025 if urgent action is not taken to reverse the progress of the smoking epidemic. Global inequalities in tobacco control continue to exist and international cooperation is thus called for, consistent with evidence that country capacity is a crucial mediator in tobacco control measure implementation [143].

Given increasing trends in other NCD risk factors such as blood pressure [144] and high body mass index [145], and low resources for several countries in these regions, immediate and effective action must be taken to prevent potential NCD epidemics that could burden already fragile health systems. Tobacco is the most policy-responsive NCD risk factor [103] and with price the key determinant of initiation and cessation, high specific excise taxes on all brands could prevent increases and induce reductions in prevalence as well as generate revenues for health financing [128] for these countries.

4.6. More ambitious and context-specific targets

Synthesis of target achievement probabilities and projected prevalence also provide impetus for stronger tobacco control strategies even for high-income countries. Projected target achievement must not be taken as cause for complacency as some countries like Japan with >50% probability of achieving the target would still belong to the third highest quintile of current tobacco smoking prevalence (29 to <36%) among men in 2025. These findings lend support to a modeling exercise that recommended a more ambitious tobacco use reduction target in order to achieve corresponding goals in reducing premature NCD mortality [103]. While a 30% relative reduction is feasible based on previous experience and is useful for benchmarking progress [5], it should not hold countries back from aspiring to more challenging yet efficient pathways towards tobacco use elimination. Recently, global tobacco control experts have proposed a goal of less than 5% tobacco use prevalence among adults worldwide to be achieved by 2040 and have made a call to accomplish this target by phasing-out tobacco sales globally [146]. Regardless of their likelihood of achieving their

30% reduction target, national governments should consider further scaling up of tobacco control efforts to aim for this stricter absolute goal.

While global targets are relevant for political attention and commitment, public awareness, and advocacy, such goals may not be applicable in some situations. As this study found for women in Benin and Burundi in Africa, a 30% relative reduction may be unachievable for certain countries simply due to the difficulty in tackling very low baseline prevalences. In such cases, a separate national absolute reduction target or conversely, a limit below which prevalence is tolerated may be more appropriate. Taking into account other contextual factors, such as sex differences in prevalence and target achievement as this study found for China and Thailand in Asia, an absolute goal addressing low baseline prevalences among women while a relative reduction target addressing higher baseline prevalences among men could be adopted. Furthermore, in populous countries like China where prevalence was found to be declining in this study but population numbers are growing, framing targets in terms of numbers of smokers could be more suitable. Thus, while global frameworks may provide a starting point, national goals and strategies should ideally be tailored in consultation with international organizations such as the WHO, with the involvement of both local and international experts and in consideration of the local tobacco context to ensure adoption of the most appropriate policies.

4.7. Limitations

This study had several limitations. First, the study relied on self-reported data with the potential for reporting bias that could vary across settings and over time. However, validation exercises involving biomarkers in high-income settings have found self-reported smoking behavior to have high sensitivities (>90%) [147, 148], and cross-country surveys used in developing settings employ scientific and evidence-based protocols to ensure comparability across settings and over time [149]. Despite quality control efforts, residual variability due to systematic differences in survey design may persist, which could influence the magnitude of, and/or overstate uncertainty around the estimates. During model development however, external validation against IHME estimates, which involved adjustment between different survey definitions and questions, demonstrated robustness of the model estimates to such systematic variability. Second, the need to conduct projections necessarily places restrictions on the model choices. While use of a functional form in the model enabled projection beyond the timeframe of the data, all projection estimates are subject to the standard limitations of projections based on a functional assumption regardless of the sophistication of the Bayesian hierarchical approach. Third, the study does not include estimates for smokeless tobacco, which is an important form of tobacco use in some countries and time periods. Unfortunately more severe limitations in availability and quality of data on smokeless relative to smoked forms [55] and the analytic complications of incorporating and ensuring consistency in a larger number of tobacco use indicators in the model precluded the inclusion of smokeless tobacco in this study. However, smokeless tobacco may have very different risk factors and use profiles than smoked tobacco [142], and may be better modeled in a separate study focusing on countries known to have appreciable prevalence of this form, rather than as a single indicator in a global study. Fourth, there may also be misclassification bias among users of electronic cigarettes which were excluded, but given the very recent and still limited uptake of these devices in most countries and that use is predominantly among current smokers [74], any potential impact on the estimates is likely to be negligible. Lastly, while a formal impact evaluation of the FCTC has not been conducted, there is some evidence that it accelerated adoption of certain tobacco control measures [150] and it is possible for a future shift to occur after country ratification which may not be fully captured in our basis period for projection. However, varying lags in actual tobacco control implementation after and existing tobacco control policies in place before FCTC ratification also preclude using year of FCTC country ratification as the base point for projections. Instead, a common starting point was used that allows for a more straightforward comparison of projections and provides a common reference point from which to examine country differences in actual implementation of tobacco control measures.

5. CONCLUSIONS AND RECOMMENDATIONS

Global progress in tobacco control has been achieved but remaining challenges require effective policy and action.

5.1. Conclusions

Globally, smoking prevalence trends are decreasing but tobacco use reduction targets remain out of reach for many countries, especially in the developing world. Global tobacco control efforts over the past decades have been successful, and the majority of countries have experienced declines in smoking prevalence for both men and women. Despite global progress, there currently remains wide variation in national smoking prevalence reflective of differences in tobacco epidemic stages and in control efforts between countries. Even if global declines continue, many countries will not achieve the 30% reduction target for either men or women, and because of population growth, there will be more than one billion smokers by 2025. Striking country disparities in smoking prevalence will also persist, with several low-income and middle-income nations in Africa and in the Eastern Mediterranean at risk of worsening smoking epidemics. Such cross-national differences in tobacco control scenarios at times also render the WHO global monitoring framework inadequate or inappropriate as national goals.

5.2. Recommendations

Tobacco control challenges can be addressed by effective policy and action. While the WHO global monitoring framework is valuable for political attention and commitment and for civil society involvement, targets set globally should be reviewed for country implementation and national tobacco control strategies should be tailored in consultation with international organizations such as the WHO, with the involvement of both local and international experts and in consideration of the local tobacco context to ensure adoption of the most appropriate policies. Whether targets are locally tailored or designed to align with global goals, certain general courses of action can be taken to achieve tobacco control goals at the national level. Countries in the initial stages of the smoking epidemic should take pre-emptive action and invest in tobacco control strategies. Those with smoking prevalence trends on the rise or not declining fast enough to meet reduction targets must intensify efforts to curb the smoking epidemic. Even countries with desirable trajectories are required to maintain the effectiveness of their tobacco control measures. Given evidence for the effectiveness of FCTC-based policies in smoking prevalence reduction [133, 150], immediate and comprehensive implementation of MPOWER measures to the highest WHO-endorsed levels [13, 48] and their strong and sustained enforcement is recommended. These demand reduction strategies include:

- Comprehensive smoking bans in public places. The WHO endorses enactment of complete smoke-free legislation in all public places inclusive of healthcare, educational and government facilities, indoor workplaces, restaurants, pubs and bars and public transport. Completeness entails no allowances for exemptions such as designated smoking areas [48] since evidence shows that more comprehensive legislation is associated with larger positive health impacts [151]. Lebanon's comprehensive national 100% smoke-free legislation of 2012 [48] could serve as a template.

- Tobacco dependence treatment reimbursable from the government. The WHO recommends smoking cessation programs integrated in the health-care system and in coordinated national tobacco control programs. Nicotine replacement therapy should also be included in the national Essential Medicines list and free national cessation hotlines be made available. Thailand's effective approach to cost-covered cessation services including its nationwide toll-free quit line 1600 set-up in 2009—which increased smoking cessation rates [48]—could serve as an example.
- Health warnings on tobacco product packaging covering at least 30% of the principal display areas [48]. Large picture-based designs are evidenced to be significantly more effective than smaller text-based warnings [152].
- Marketing restrictions involving bans on both direct advertising on national media and on indirect advertising such as promotion and sponsorships. Bans on indirect advertising are recommended to cover point-of-sale, free product distribution, discounts, tobacco branding on non-tobacco products and events including corporate social responsibility initiatives. Iran's enactment of a complete tobacco advertising ban entailing financial sanctions within its Comprehensive National Tobacco Control Act 2006 [48] is a good illustration.
- Taxation. The WHO currently endorses >75% of the retail price as tax as the highest level of achievement. Excise taxes applied exclusively to tobacco have the strongest influence on substantially increasing tobacco product prices and thereby reducing consumption. Levying other indirect taxes—import duties and value added taxes—is

also preferred over direct taxation such as corporate tax [48]. Evidence also suggests that a uniform and specific taxation structure is most effective for consumption and prevalence reduction [153]. The Philippine sin tax bill of 2012 enacting a restructuring of the local tobacco taxation system demonstrates a step in the right direction [154].

To further accelerate declines and to avoid potentially stagnating trends, development of and prudent implementation of innovative demand-side and supply-side tobacco control measures would be helpful. Recently-developed demand reduction measures with initial evidence of effectiveness such as plain cigarette packaging [155] should be scaled-up at a global level. Implementation of supply-side innovations such as restructuring the tobacco market, production price controls, phasing-out of commercial tobacco sales or legislated industry public health targets should be initiated. The "Help End Addiction to Lethal Tobacco Habits (HEALTH) Act" proposed in the United States senate [40] could serve as a starting point for implementing performance-based regulations.

Finally, international cooperation and multisectoral approaches should be fostered in order to overcome tobacco industry interference [49, 50] and enhance country capacity, which is a factor in tobacco control implementation [143]. Rallying civil society support [130] and creating initiatives to aid countries, especially those most vulnerable to tobacco company pressure, in overcoming tobacco industry tactics are strongly encouraged. Civil society engagement was instrumental in the progress of tobacco control among developing settings in

Latin America [131, 156]. In the aftermath of international media attention on tobacco industry threats against severely resource-limited African governments, the global fund to help countries defend tobacco control unveiled by Bloomberg Philanthropies and the Bill and Melinda Gates Foundation at the 2015 World Conference on Tobacco or Health [51] is one potential milestone in international and mutltisectoral collaboration in tobacco control. Finally, public-private partnerships aimed at enhancing country capacity, such as the African Capacity Building Foundation, are one pathway that should be well-utilized by governments especially in vulnerable regions [157].

5.3. Future research directions

Effecting policy and action entails awareness, advocacy and reinvigoration of political commitment. For such purposes, research is important to further characterize the tobacco epidemic, to assess its impact and to identify the most efficient pathways for curbing it. Future research directions include:

- Smokeless tobacco use trends estimation and projection. The health effects of smokeless tobacco use cannot be discounted and their impact on countries where smokeless forms are common should be assessed while ensuring consistency with smoking prevalence estimates.
- Country-specific assessment of major tobacco use determinants via modeling approaches to identify and/or quantify the influence of drivers such as income, sociocultural aspects of tobacco use initiation and cessation, and the effect of specific tobacco control measures on tobacco use prevalence.

- Tobacco-attributable mortality estimation and projection under a comparative risk assessment framework.
- Tobacco use projections under different intervention scenarios. Dynamic mathematical models or Bayesian hierarchical models may be developed to assess the impact of implementing different combinations of tobacco control policies on tobacco use prevalence.

Tobacco control remains a global priority. Remarkable achievements have been made in global tobacco control efforts but challenges remain in reaching tobacco use reduction targets and resolving striking country disparities in smoking prevalence. If immediate, effective and sustained action is undertaken, desirable trajectories may be attained and maintained towards global convergence in tobacco use elimination.

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Appendix A: Regional priors for men

Region	Mean					
	β_{time}	β_{period}	$\beta_{timexperiod}$	β_{smkd}	β_{cigc}	β_{cigd}
Africa, Central	0.95	-0.30	0.95	-0.30	-0.40	-0.45
Africa, East	-0.17	-0.30	-0.22	-0.31	-0.10	-0.30
Africa, East Islands	0.03	-0.23	-0.28	-0.21	-0.08	-0.30
Africa, North	-0.02	0.01	0.19	-0.09	-0.16	-0.29
Africa, South	0.00	-0.39	0.29	-0.16	-0.20	-0.41
Africa, West	0.15	-0.59	0.48	-0.11	-0.30	-0.37
America, Central	-0.19	-0.55	-0.41	-0.53	-0.05	-0.46
America, North	-0.06	-0.15	-0.66	-0.29	-0.03	-0.27
America, South	-0.41	-0.03	-0.22	-0.31	-0.07	-0.34
Asia, East	0.04	-0.27	-0.42	-0.09	-0.05	-0.10
Asia, South	0.65	-0.60	-0.92	-0.15	-0.37	-0.53
Asia, Southeast	-0.13	0.04	0.05	-0.13	-0.06	-0.18
Asia, West	0.57	-0.41	0.06	-0.06	-0.13	-0.25
Australasia	-0.08	-0.24	-0.52	-0.13	-0.04	-0.10
Caribbean	0.08	-0.54	-0.15	-0.25	-0.12	-0.45
Europe, East	-0.88	0.24	0.56	-0.14	-0.02	-0.14
Europe, North	-0.41	-0.17	-0.38	-0.34	-0.20	-0.31
Europe, South	-0.43	0.10	0.16	-0.07	-0.03	-0.10
Europe, West	0.24	-0.02	-0.74	-0.18	-0.03	-0.20
Polynesia	-0.18	0.04	-0.21	-0.17	-0.10	-0.32

Appendix B: Regional priors for women

Region	Mean					
	β_{time}	β_{period}	$\beta_{timexperiod}$	β_{smkd}	β_{cigc}	β_{cigd}
Africa, Central	0.09	-0.14	0.09	-0.40	-0.66	-1.15
Africa, East	-0.13	0.02	-0.32	-0.50	-1.22	-1.22
Africa, East Islands	-0.34	0.00	-0.55	-0.33	-0.37	-1.01
Africa, North	-0.71	-0.16	-0.83	-0.42	-0.61	-1.08
Africa, South	-0.23	-0.01	-0.24	-0.23	-0.48	-0.68
Africa, West	-0.67	-1.37	-0.10	-0.19	-1.34	-1.35
America, Central	-0.48	-0.43	-0.25	-0.57	-0.09	-0.56
America, North	0.00	-0.12	-1.07	-0.30	-0.03	-0.28
America, South	0.15	0.08	-0.92	-0.36	-0.06	-0.54
Asia, East	0.67	-0.67	-1.31	-0.21	-0.06	-0.23
Asia, South	-0.61	0.28	-0.95	-0.18	-0.57	-0.79
Asia, Southeast	0.15	-0.08	-0.78	-0.25	-0.08	-0.33
Asia, West	1.73	-1.05	-1.46	-0.32	-0.31	-1.39
Australasia	-0.24	-0.17	-0.45	-0.12	-0.04	-0.10
Caribbean	0.15	-0.58	-0.88	-0.18	-0.17	-0.38
Europe, East	-0.04	0.10	-0.30	-0.27	-0.06	-0.22
Europe, North	-0.28	-0.20	-0.42	-0.33	-0.14	-0.21
Europe, South	-0.02	0.03	-0.30	-0.15	-0.08	-0.17
Europe, West	0.62	0.00	-0.98	-0.14	-0.03	-0.11
Polynesia	-0.05	-0.04	-0.25	-0.25	-0.19	-0.37

Appendix C: Current tobacco smoking prevalence estimates (15+ age-standardized)

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Albania	Men	57.5	44.7	68.6	53.6	42.5	66.6	48.9	29.0	73.8
Albania	Women	11.6	8.6	15.0	8.6	6.1	11.5	5.6	2.6	9.2
Algeria	Men	24.7	12.5	38.3	27.2	18.2	37.2	34.4	12.5	60.0
Algeria	Women	4.6	1.9	7.6	1.7	1.0	2.5	0.4	0.1	0.7
Andorra	Men	42.9	31.4	56.0	39.0	30.3	51.3	35.3	17.9	56.0
Andorra	Women	31.1	21.2	41.5	28.6	19.9	38.2	25.9	12.5	43.0
Argentina	Men	43.3	32.5	54.6	33.6	27.8	39.5	23.5	14.5	33.1
Argentina	Women	34.3	26.4	44.0	22.5	18.3	27.1	12.2	7.6	16.9
Armenia	Men	67.1	54.3	79.3	56.8	46.7	66.3	44.9	30.9	59.4
Armenia	Women	2.6	2.1	3.3	1.8	1.5	2.2	1.1	0.7	1.6
Australia	Men	26.9	21.6	31.9	19.4	16.2	22.8	12.1	8.5	15.9
Australia	Women	23.2	18.8	27.9	15.8	12.9	18.5	9.0	6.2	11.7
Austria	Men	47.5	34.3	61.9	39.7	28.8	53.8	31.3	16.2	47.2
Austria	Women	40.3	28.4	51.5	35.7	25.2	46.3	30.3	15.4	45.1
Azerbaijan	Men	56.2	28.2	90.0	48.0	24.6	75.6	38.9	14.1	69.9
Azerbaijan	Women	0.6	0.3	1.1	0.5	0.2	0.8	0.3	0.1	0.6
Bahamas	Men	13.1	7.1	22.0	12.6	6.3	20.1	13.0	3.7	27.8
Bahamas	Women	3.9	1.6	6.9	2.6	1.0	4.4	1.5	0.2	3.2
Bahrain	Men	17.9	13.3	22.2	34.7	25.7	43.3	85.3	53.5	100.0
Bahrain	Women	4.8	3.3	6.1	6.7	4.5	9.4	11.7	3.7	20.9
Bangladesh	Men	63.5	49.6	78.8	46.2	38.5	55.1	29.3	17.6	40.2
Bangladesh	Women	6.2	4.0	8.4	1.5	1.0	1.9	0.2	0.0	0.3

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Belgium	Men	35.6	25.1	47.9	29.0	19.1	37.8	21.6	12.3	34.1
Belgium	Women	24.9	15.9	34.8	21.9	13.4	31.2	18.4	9.5	30.5
Belize	Men	33.6	10.9	67.5	23.0	8.0	46.4	14.0	2.5	32.9
Belize	Women	3.4	0.7	7.4	2.2	0.5	4.6	1.2	0.2	2.9
Benin	Men	12.3	7.7	17.3	15.6	11.7	19.5	23.3	13.2	36.7
Benin	Women	1.6	0.8	2.4	1.1	0.7	1.6	0.7	0.3	1.2
Bolivia	Men	50.7	32.1	70.4	35.5	19.9	53.4	21.9	7.4	42.3
Bolivia	Women	26.4	17.4	38.2	19.3	11.7	28.8	12.7	4.6	23.7
Bosnia Herzegovina	Men	57.8	43.4	73.3	49.9	36.7	63.7	41.2	21.9	66.6
Bosnia Herzegovina	Women	36.4	28.7	46.9	31.6	23.7	40.6	26.5	13.4	42.7
Botswana	Men	30.8	20.1	43.8	34.8	24.3	46.0	43.7	19.4	71.3
Botswana	Women	8.5	4.9	13.2	6.8	4.2	10.2	5.0	1.9	8.5
Brazil	Men	29.8	22.3	37.6	22.1	17.7	26.3	14.4	8.4	21.3
Brazil	Women	18.4	14.1	23.1	13.2	10.7	16.4	8.3	4.8	12.4
Brunei Darussalam	Men	28.6	14.4	45.2	27.9	12.8	45.9	29.1	6.6	67.4
Brunei Darussalam	Women	4.9	2.6	8.0	3.4	1.5	6.0	2.2	0.4	5.1
Bulgaria	Men	59.7	42.2	78.3	47.5	38.7	58.7	34.7	20.4	52.6
Bulgaria	Women	42.6	29.0	56.7	32.1	25.2	40.5	21.7	11.3	33.0
Burkina Faso	Men	24.0	16.9	31.8	31.5	22.1	41.6	50.0	21.7	85.3
Burkina Faso	Women	8.5	5.1	12.5	5.5	3.0	8.3	3.0	0.9	5.8
Burundi	Men	22.6	9.0	38.5	18.5	8.7	30.6	14.3	4.9	26.3
Burundi	Women	4.5	1.4	8.8	3.6	1.3	6.8	2.7	0.9	5.6
Cambodia	Men	51.5	35.2	68.3	45.8	35.0	57.0	40.4	20.3	68.7
Cambodia	Women	8.0	6.1	10.0	4.0	3.2	4.9	1.4	0.8	2.1
Cameroon	Men	12.2	6.0	19.5	27.9	17.4	40.1	85.4	57.2	100.0
Cameroon	Women	0.9	0.3	1.6	0.9	0.3	1.6	1.0	0.2	1.8

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Canada	Men	29.4	25.1	34.2	20.9	17.5	24.3	12.6	9.8	15.4
Canada	Women	26.5	22.5	30.6	15.8	13.3	18.3	7.3	5.7	8.8
Cape Verde	Men	14.6	7.9	21.7	19.5	11.7	28.5	31.7	11.0	54.9
Cape Verde	Women	5.9	3.3	8.6	4.1	2.5	5.9	2.6	1.1	4.7
Chad	Men	15.3	11.2	19.9	36.3	24.0	50.9	93.7	65.6	100.0
Chad	Women	3.1	2.0	4.3	3.4	2.0	4.8	4.0	1.5	7.7
Chile	Men	50.0	36.9	63.8	43.2	33.0	55.3	35.5	19.0	54.9
Chile	Women	43.7	31.9	55.8	37.4	27.2	47.0	30.4	16.3	46.4
China	Men	56.5	43.4	72.3	49.7	40.9	58.4	41.9	25.8	56.6
China	Women	3.5	2.6	4.6	2.2	1.8	2.7	1.1	0.7	1.7
Colombia	Men	24.8	10.0	43.5	18.5	8.5	30.4	12.5	3.5	22.6
Colombia	Women	10.2	4.3	16.7	7.3	3.4	11.9	4.6	1.5	8.8
Comoros	Men	30.3	22.0	40.3	25.5	19.6	33.9	20.5	9.9	32.0
Comoros	Women	14.4	8.6	21.4	8.1	4.7	12.1	3.6	1.0	6.8
Congo	Men	10.1	6.9	13.9	26.7	19.1	35.1	93.8	73.1	100.0
Congo	Women	1.6	0.7	2.4	1.6	0.8	2.5	1.9	0.6	3.4
Cook Islands	Men	50.7	31.7	69.7	41.5	24.1	58.0	32.4	10.5	61.4
Cook Islands	Women	40.1	26.3	58.6	34.6	22.0	51.0	29.7	11.4	57.6
Costa Rica	Men	28.0	17.0	41.0	20.7	12.7	30.6	14.2	4.4	27.5
Costa Rica	Women	14.1	7.1	22.6	10.0	5.5	15.7	6.4	1.8	12.9
Cote d'Ivoire	Men	25.7	11.7	44.2	33.3	18.1	52.4	51.5	22.6	84.4
Cote d'Ivoire	Women	2.7	1.1	4.7	1.9	0.9	3.0	1.1	0.3	1.9
Croatia	Men	40.5	30.8	50.9	39.6	30.7	47.8	39.2	24.8	58.7
Croatia	Women	28.1	21.1	35.3	31.4	24.1	37.8	38.4	23.1	55.0
Cuba	Men	54.1	34.4	76.1	51.8	31.0	81.4	50.1	20.6	100.0
Cuba	Women	31.7	18.2	47.7	22.1	11.0	34.0	13.9	3.3	28.4

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Cyprus	Men	60.6	40.7	87.1	53.8	36.4	73.9	46.0	21.3	75.8
Cyprus	Women	22.3	12.1	34.3	19.4	11.9	28.3	16.3	7.7	27.8
Czech Republic	Men	40.9	32.8	49.6	38.2	31.1	45.1	35.2	22.7	49.3
Czech Republic	Women	29.3	23.4	35.5	29.1	23.7	34.2	28.8	19.5	40.0
Democratic Republic of the Congo	Women	2.3	0.3	5.7	2.5	0.4	6.0	3.0	0.3	7.3
Denmark	Men	41.0	31.6	50.4	23.6	19.1	28.8	10.6	6.8	15.0
Denmark	Women	34.7	27.2	42.4	21.1	17.0	25.7	10.0	6.3	13.8
Djibouti	Men	31.7	16.3	52.0	26.6	12.7	45.9	21.6	5.4	42.1
Djibouti	Women	2.9	1.6	4.7	2.4	1.1	3.8	1.9	0.5	3.6
Dominica	Men	15.7	8.4	26.0	14.9	8.7	22.0	14.6	5.4	27.1
Dominica	Women	2.6	1.1	4.2	1.7	0.9	2.6	1.0	0.2	1.9
Dominican Republic	Men	21.4	15.8	26.8	20.0	13.4	25.6	18.8	8.3	33.3
Dominican Republic	Women	15.3	11.3	19.5	11.0	7.4	14.1	7.0	2.4	11.9
Ecuador	Men	21.4	15.5	28.9	16.3	10.8	22.1	11.3	4.1	19.7
Ecuador	Women	5.3	3.1	7.5	3.7	2.3	5.8	2.3	0.8	4.4
Egypt	Men	34.8	23.4	46.4	43.8	35.0	52.3	63.8	36.8	97.7
Egypt	Women	1.2	0.7	1.8	0.5	0.3	0.7	0.1	0.1	0.3
El Salvador	Men	38.1	17.0	65.9	26.4	10.8	45.0	16.7	3.1	35.2
El Salvador	Women	5.7	2.5	9.3	3.7	1.5	6.2	2.2	0.5	4.8
Eritrea	Men	23.8	8.3	39.6	20.1	8.2	34.7	16.5	3.6	31.7
Eritrea	Women	1.0	0.1	2.2	0.8	0.2	1.8	0.7	0.1	1.6
Estonia	Men	54.8	44.8	66.6	45.8	37.5	55.4	34.7	23.5	49.4
Estonia	Women	27.3	22.2	33.0	25.6	21.1	30.9	24.0	15.8	32.4
Ethiopia	Men	9.3	6.1	12.6	8.9	6.6	11.2	8.8	4.4	13.9
Ethiopia	Women	0.6	0.3	0.9	0.5	0.3	0.8	0.4	0.2	0.8

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Fiji	Men	52.1	30.0	78.6	42.5	18.6	66.9	33.1	7.1	68.1
Fiji	Women	15.4	8.4	24.0	13.2	6.7	22.1	11.3	2.9	24.1
Finland	Men	33.7	26.7	39.8	26.3	22.1	31.1	18.3	12.8	24.2
Finland	Women	25.2	20.5	30.0	20.6	17.1	24.2	15.1	11.0	19.4
France	Men	38.1	29.0	50.2	32.4	23.6	41.0	25.9	15.3	38.9
France	Women	27.8	20.6	35.9	25.8	19.7	32.6	23.8	13.3	34.9
Gabon	Men	14.7	7.9	22.0	33.6	23.1	45.3	95.1	75.6	100.0
Gabon	Women	5.7	2.4	10.2	6.1	2.6	10.2	7.2	2.8	12.8
Gambia	Men	29.0	16.6	42.3	37.8	27.3	50.0	58.4	32.5	93.1
Gambia	Women	1.7	0.8	2.8	1.2	0.6	1.8	0.7	0.3	1.3
Georgia	Men	63.6	50.3	80.0	58.7	45.7	72.6	53.6	31.9	81.3
Georgia	Women	6.5	4.8	8.1	6.0	4.6	7.5	5.5	3.0	8.3
Germany	Men	38.4	31.2	45.1	33.9	28.6	40.9	28.6	19.1	36.2
Germany	Women	30.2	24.8	35.7	29.3	23.6	34.9	28.0	19.7	36.5
Ghana	Men	9.2	6.5	12.5	11.5	7.9	16.0	16.7	6.2	28.7
Ghana	Women	0.8	0.5	1.1	0.5	0.3	0.8	0.3	0.1	0.6
Greece	Men	62.4	37.7	87.9	55.3	38.8	71.3	47.8	28.0	73.4
Greece	Women	42.1	23.5	62.7	35.7	24.3	50.1	29.2	14.0	48.1
Grenada	Men	34.8	12.6	67.4	32.8	13.2	55.9	32.0	11.3	60.8
Grenada	Women	8.5	2.3	16.4	5.7	1.8	9.8	3.3	0.8	6.7
Guatemala	Men	24.3	8.6	43.7	16.6	5.3	29.8	10.3	1.8	22.7
Guatemala	Women	4.5	1.1	9.0	3.0	0.5	5.6	1.7	0.1	3.7
Guinea	Women	4.9	1.3	9.8	3.6	0.9	7.0	2.3	0.5	5.1
Guyana	Men	60.1	36.4	90.6	44.9	30.3	64.5	30.5	13.8	51.0
Guyana	Women	6.3	2.7	10.4	4.4	2.3	7.3	2.6	1.0	4.8

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Haiti	Men	18.6	11.5	25.8	21.1	13.5	29.4	26.3	11.6	47.5
Haiti	Women	3.9	2.5	5.6	2.9	1.7	4.1	1.9	0.6	3.6
Honduras	Men	60.1	35.3	100.0	40.1	28.8	55.0	23.3	10.2	37.9
Honduras	Women	4.1	1.6	6.5	2.5	1.5	3.9	1.4	0.5	2.5
Hungary	Men	46.5	34.7	58.8	36.1	28.4	44.2	25.1	15.0	37.2
Hungary	Women	34.9	26.5	43.1	27.7	21.9	34.1	20.0	12.7	29.7
Iceland	Men	32.7	19.5	47.1	20.8	14.2	27.8	11.1	5.2	18.5
Iceland	Women	26.7	17.1	36.5	18.2	13.5	23.3	10.7	5.7	17.2
India	Men	36.3	24.7	50.1	24.4	19.6	29.9	14.4	6.9	23.3
India	Women	7.1	4.6	10.0	3.0	2.4	3.6	0.8	0.3	1.5
Indonesia	Men	56.4	43.1	73.6	68.5	55.5	82.7	87.0	64.5	100.0
Indonesia	Women	6.0	4.5	7.8	4.2	3.3	5.1	2.5	1.5	3.6
Iran	Men	29.9	20.9	40.4	24.4	19.7	29.5	18.9	8.8	30.9
Iran	Women	5.6	3.4	7.7	1.5	1.1	2.0	0.2	0.1	0.4
Iraq	Men	31.3	20.0	42.6	43.0	30.0	55.7	69.7	34.4	100.0
Iraq	Women	5.4	3.2	8.6	6.3	3.6	9.3	8.4	2.9	16.9
Ireland	Men	47.0	24.4	69.7	35.7	22.2	54.2	24.2	10.4	42.8
Ireland	Women	40.7	24.7	58.7	31.9	21.4	47.3	22.9	9.8	41.2
Israel	Men	43.4	32.9	56.1	42.3	30.4	55.3	42.2	21.9	70.3
Israel	Women	22.6	17.1	29.5	20.3	14.5	27.1	18.2	8.8	31.2
Italy	Men	32.6	27.6	39.2	29.5	24.8	34.7	25.8	19.6	33.0
Italy	Women	20.3	16.5	24.0	19.9	16.8	23.6	19.6	14.3	25.0
Jamaica	Men	28.7	19.5	40.7	28.3	17.6	42.6	29.1	9.4	54.3
Jamaica	Women	9.2	5.6	13.5	6.8	3.9	10.6	4.6	1.4	9.0
Japan	Men	56.3	44.0	67.6	43.1	35.0	53.0	29.0	19.4	40.1
Japan	Women	16.6	13.3	21.4	13.2	10.9	16.4	9.6	6.3	13.4

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Jordan	Men	42.4	25.5	59.2	59.1	41.2	78.0	85.7	52.0	100.0
Jordan	Women	7.7	4.9	11.2	9.4	6.2	12.8	13.2	5.5	22.5
Kazakhstan	Men	58.0	47.7	71.1	47.2	38.2	57.2	35.5	21.8	52.2
Kazakhstan	Women	11.4	8.7	14.5	10.1	7.5	12.7	8.7	4.7	14.6
Kenya	Men	31.2	23.7	41.4	26.3	19.7	34.0	20.7	10.0	32.8
Kenya	Women	3.1	2.1	4.2	2.4	1.6	3.4	1.7	0.6	2.9
Kiribati	Men	82.6	64.3	100.0	68.6	47.7	89.9	52.5	20.7	90.7
Kiribati	Women	50.0	34.6	66.2	43.8	31.0	57.5	38.2	16.5	70.9
Kuwait	Men	32.9	20.8	44.8	45.8	32.8	63.0	72.3	38.7	100.0
Kuwait	Women	5.1	3.0	7.1	5.9	3.6	8.2	8.0	2.6	15.8
Kyrgyzstan	Men	51.3	39.4	64.0	50.0	40.3	60.0	49.0	33.0	67.4
Kyrgyzstan	Women	4.9	3.3	6.7	3.9	2.7	5.2	2.9	1.5	4.6
Lao People's Dem. Rep.	Men	74.1	55.1	93.3	61.9	48.1	76.7	47.8	27.2	69.1
Lao People's Dem. Rep.	Women	20.6	15.2	26.6	11.8	8.7	14.7	5.3	2.8	8.0
Latvia	Men	57.3	45.8	69.2	51.8	41.6	62.4	45.1	31.2	63.6
Latvia	Women	25.1	20.0	30.3	24.5	19.8	30.1	24.0	15.4	33.1
Lebanon	Men	35.4	24.0	48.3	41.6	31.8	52.0	55.5	30.9	87.3
Lebanon	Women	24.4	16.1	34.9	28.5	20.8	35.7	37.7	17.2	58.2
Lesotho	Men	35.4	21.6	50.0	47.9	35.7	62.2	74.3	46.7	100.0
Lesotho	Women	0.6	0.2	1.0	0.5	0.2	0.8	0.4	0.1	0.7
Liberia	Men	19.4	8.8	32.6	24.3	12.9	39.5	35.8	14.1	65.5
Liberia	Women	4.1	1.9	7.2	2.9	1.4	4.7	1.8	0.6	3.2
Libya	Men	53.2	28.6	82.3	58.2	41.5	76.9	67.8	34.8	100.0
Libya	Women	1.0	0.3	1.9	0.4	0.1	0.7	0.1	0.0	0.2
Lithuania	Men	53.1	42.3	65.0	42.4	33.1	52.2	30.6	17.4	46.4
Lithuania	Women	21.3	16.8	26.2	21.5	16.9	26.7	22.4	12.8	32.6

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Luxembourg	Men	34.0	26.1	42.8	28.4	21.5	34.8	22.3	11.7	32.9
Luxembourg	Women	25.7	19.9	32.8	22.7	17.8	27.7	19.3	11.2	28.7
Madagascar	Men	47.5	28.3	69.1	41.5	29.1	54.9	36.2	18.3	58.5
Madagascar	Women	4.1	2.0	7.1	2.7	1.2	4.5	1.5	0.5	2.8
Malawi	Men	33.0	25.0	40.4	27.6	21.0	34.0	21.7	12.2	31.1
Malawi	Women	9.5	6.0	13.3	6.8	4.1	9.5	4.3	1.7	7.6
Malaysia	Men	54.8	39.7	70.7	46.3	33.9	58.7	38.0	17.2	68.7
Malaysia	Women	3.2	2.2	4.2	1.8	1.2	2.4	0.9	0.3	1.7
Maldives	Men	49.1	28.3	77.1	40.4	28.8	51.7	32.8	12.7	55.1
Maldives	Women	12.6	7.0	19.9	5.0	3.5	6.9	1.3	0.6	2.3
Mali	Men	20.6	15.7	26.9	29.7	22.6	39.6	52.6	24.7	84.8
Mali	Women	4.1	2.0	6.4	3.5	1.9	5.4	3.0	1.2	5.5
Malta	Men	39.0	29.2	48.6	32.6	24.8	40.5	25.4	12.8	39.6
Malta	Women	26.4	19.6	34.6	22.4	16.9	27.8	18.2	9.0	28.1
Marshall Islands	Men	40.0	28.8	56.4	33.6	20.5	49.2	27.3	8.3	51.9
Marshall Islands	Women	6.4	3.9	9.2	5.6	3.1	8.3	5.0	1.3	10.0
Mauritania	Men	24.0	18.3	31.1	35.3	25.6	45.6	62.9	31.8	96.1
Mauritania	Women	5.7	3.8	8.1	4.2	2.8	5.8	2.9	1.3	5.0
Mauritius	Men	46.4	35.9	56.6	42.4	32.5	52.4	37.9	18.5	57.6
Mauritius	Women	4.8	3.5	6.2	3.7	2.7	4.6	2.6	1.4	4.2
Mexico	Men	37.2	30.3	44.4	24.8	20.7	29.3	13.8	9.2	18.2
Mexico	Women	13.1	10.4	16.1	8.4	6.8	9.9	4.3	2.9	5.9
Mongolia	Men	56.9	40.3	73.6	50.3	41.2	60.3	43.4	27.2	61.3
Mongolia	Women	9.3	6.5	12.6	6.3	5.0	7.8	3.7	2.1	5.5
Morocco	Men	33.6	25.0	42.2	40.1	29.8	50.9	53.9	25.0	91.3
Morocco	Women	4.0	2.4	5.9	1.9	1.1	2.7	0.7	0.2	1.4

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Luxembourg	Men	34.0	26.1	42.8	28.4	21.5	34.8	22.3	11.7	32.9
Luxembourg	Women	25.7	19.9	32.8	22.7	17.8	27.7	19.3	11.2	28.7
Madagascar	Men	47.5	28.3	69.1	41.5	29.1	54.9	36.2	18.3	58.5
Madagascar	Women	4.1	2.0	7.1	2.7	1.2	4.5	1.5	0.5	2.8
Malawi	Men	33.0	25.0	40.4	27.6	21.0	34.0	21.7	12.2	31.1
Malawi	Women	9.5	6.0	13.3	6.8	4.1	9.5	4.3	1.7	7.6
Malaysia	Men	54.8	39.7	70.7	46.3	33.9	58.7	38.0	17.2	68.7
Malaysia	Women	3.2	2.2	4.2	1.8	1.2	2.4	0.9	0.3	1.7
Maldives	Men	49.1	28.3	77.1	40.4	28.8	51.7	32.8	12.7	55.1
Maldives	Women	12.6	7.0	19.9	5.0	3.5	6.9	1.3	0.6	2.3
Mali	Men	20.6	15.7	26.9	29.7	22.6	39.6	52.6	24.7	84.8
Mali	Women	4.1	2.0	6.4	3.5	1.9	5.4	3.0	1.2	5.5
Malta	Men	39.0	29.2	48.6	32.6	24.8	40.5	25.4	12.8	39.6
Malta	Women	26.4	19.6	34.6	22.4	16.9	27.8	18.2	9.0	28.1
Marshall Islands	Men	40.0	28.8	56.4	33.6	20.5	49.2	27.3	8.3	51.9
Marshall Islands	Women	6.4	3.9	9.2	5.6	3.1	8.3	5.0	1.3	10.0
Mauritania	Men	24.0	18.3	31.1	35.3	25.6	45.6	62.9	31.8	96.1
Mauritania	Women	5.7	3.8	8.1	4.2	2.8	5.8	2.9	1.3	5.0
Mauritius	Men	46.4	35.9	56.6	42.4	32.5	52.4	37.9	18.5	57.6
Mauritius	Women	4.8	3.5	6.2	3.7	2.7	4.6	2.6	1.4	4.2
Mexico	Men	37.2	30.3	44.4	24.8	20.7	29.3	13.8	9.2	18.2
Mexico	Women	13.1	10.4	16.1	8.4	6.8	9.9	4.3	2.9	5.9
Mongolia	Men	56.9	40.3	73.6	50.3	41.2	60.3	43.4	27.2	61.3
Mongolia	Women	9.3	6.5	12.6	6.3	5.0	7.8	3.7	2.1	5.5
Morocco	Men	33.6	25.0	42.2	40.1	29.8	50.9	53.9	25.0	91.3
Morocco	Women	4.0	2.4	5.9	1.9	1.1	2.7	0.7	0.2	1.4

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Mozambique	Men	41.7	22.4	61.3	34.2	23.4	47.7	26.7	12.5	41.5
Mozambique	Women	7.5	4.1	12.4	6.2	3.1	9.9	4.9	1.7	9.0
Myanmar	Men	56.1	41.7	74.3	38.4	28.7	49.5	23.0	10.0	39.8
Myanmar	Women	16.0	9.6	23.8	8.7	5.0	12.7	3.8	1.1	7.1
Namibia	Men	29.6	22.4	37.7	35.2	24.7	47.1	47.3	22.2	80.3
Namibia	Women	14.6	10.9	18.5	12.2	9.0	16.0	9.7	4.9	16.0
Nauru	Men	57.8	39.5	80.9	47.3	27.4	65.9	36.9	11.6	68.0
Nauru	Women	63.5	43.2	86.1	54.3	36.6	79.3	45.3	13.0	85.4
Nepal	Men	45.7	36.1	55.1	39.7	31.5	47.5	32.6	20.3	47.7
Nepal	Women	34.3	27.0	41.0	15.9	12.6	19.7	5.1	3.1	7.6
Netherlands	Men	36.7	30.5	43.5	28.9	23.9	34.5	20.5	14.1	27.7
Netherlands	Women	31.0	25.7	36.7	25.9	21.7	30.8	19.9	13.3	25.9
New Zealand	Men	30.2	24.9	36.4	20.7	17.2	23.9	11.9	8.5	15.2
New Zealand	Women	29.1	23.7	36.2	19.0	15.8	22.6	10.1	7.4	13.0
Nicaragua	Women	8.0	5.0	11.5	5.2	2.8	8.4	3.0	0.6	6.2
Niger	Men	8.8	6.0	12.6	14.7	10.9	18.2	32.1	16.4	48.5
Niger	Women	0.3	0.1	0.6	0.2	0.1	0.4	0.1	0.0	0.3
Nigeria	Men	10.9	6.0	16.9	14.6	8.1	22.7	23.6	9.2	44.7
Nigeria	Women	2.0	0.8	3.2	1.3	0.5	2.0	0.7	0.2	1.3
Niue	Men	30.6	17.5	47.1	23.0	15.5	29.8	16.0	7.2	25.2
Niue	Women	15.9	8.0	24.7	12.6	8.4	18.4	9.8	3.8	16.7
Norway	Men	43.2	35.4	51.1	27.6	23.8	32.6	14.4	10.9	18.3
Norway	Women	41.5	33.2	48.5	27.1	22.6	31.7	14.4	10.7	17.9
Oman	Men	12.6	9.1	16.4	17.9	11.2	25.5	31.9	10.6	61.7
Oman	Women	0.8	0.4	1.3	1.0	0.4	1.6	1.3	0.3	2.5

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Pakistan	Men	37.4	26.8	48.2	40.9	32.0	51.9	48.6	23.4	76.1
Pakistan	Women	8.3	5.6	11.5	4.1	2.9	5.5	1.6	0.6	2.7
Palau	Men	54.9	23.0	90.1	46.5	18.8	89.5	38.0	5.6	92.4
Palau	Women	25.2	7.9	50.1	23.1	6.1	49.0	21.5	3.4	55.9
Palestine	Men	29.4	15.9	44.5	41.0	28.4	53.4	70.0	40.5	100.0
Palestine	Women	2.9	1.6	4.6	3.3	2.2	4.7	4.3	1.9	7.1
Panama	Men	25.0	15.3	34.8	14.1	10.8	17.4	6.4	2.9	10.7
Panama	Women	5.2	3.2	7.0	3.2	2.5	4.1	1.7	0.8	2.8
Papua New Guinea	Men	78.1	58.0	100.0	64.1	45.1	81.7	48.8	20.9	82.5
Papua New Guinea	Women	38.1	23.6	51.5	32.4	22.7	41.5	27.0	11.0	45.3
Paraguay	Men	45.2	33.0	57.8	32.2	22.5	41.8	20.0	10.2	32.1
Paraguay	Women	14.7	10.9	18.8	9.9	7.1	13.4	5.7	2.5	9.3
Peru	Women	9.5	6.4	12.9	6.8	5.4	8.5	4.2	2.5	6.1
Philippines	Men	58.9	45.9	73.0	47.9	39.1	55.9	35.5	22.3	51.3
Philippines	Women	12.8	10.0	16.0	9.8	8.1	11.7	6.6	4.3	9.6
Poland	Men	46.1	32.6	58.1	36.3	30.5	43.6	26.3	15.4	36.8
Poland	Women	37.6	28.2	47.7	27.5	22.8	33.1	17.6	10.7	25.6
Portugal	Men	36.6	27.4	45.7	32.5	25.5	40.0	28.1	16.7	41.4
Portugal	Women	15.4	10.8	20.5	14.1	9.9	18.3	12.8	5.9	21.1
Qatar	Men	18.6	10.6	27.2	27.9	18.6	37.6	53.8	27.8	91.1
Qatar	Women	1.6	0.7	2.7	1.8	0.9	2.9	2.1	0.7	4.0
Republic of Korea	Men	76.0	56.4	93.9	66.0	46.3	86.7	54.3	27.2	88.6
Republic of Korea	Women	6.6	4.0	9.6	5.5	3.1	8.3	4.2	1.6	7.9
Republic of Moldova	Men	40.7	32.2	50.9	43.6	35.4	53.3	49.1	31.3	66.3
Republic of Moldova	Women	5.4	4.1	7.0	5.4	4.2	6.5	5.4	3.3	7.7

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Romania	Men	53.3	41.2	66.9	41.7	34.4	50.6	29.6	17.2	44.3
Romania	Women	27.5	20.9	34.8	24.1	19.5	28.7	20.3	11.9	30.1
Russian Federation	Men	68.9	54.1	87.8	61.0	50.0	74.2	52.1	33.4	76.2
Russian Federation	Women	21.8	16.4	28.1	22.3	17.8	26.6	23.6	14.2	33.0
Rwanda	Men	28.8	16.6	41.4	23.8	17.5	30.5	18.9	10.3	28.1
Rwanda	Women	6.8	3.7	10.2	5.9	3.6	8.4	5.1	2.1	8.0
Saint Kitts and Nevis	Men	15.6	8.9	22.9	14.8	9.9	21.0	15.0	5.1	27.3
Saint Kitts and Nevis	Women	1.5	0.6	2.5	1.0	0.4	1.6	0.6	0.1	1.2
Saint Vincent and the Grenadines	Men	28.7	5.3	64.4	28.7	5.9	69.7	29.9	2.3	87.0
Saint Vincent and the Grenadines	Women	5.0	0.8	11.2	3.4	0.5	8.0	2.2	0.2	6.0
Samoa	Men	62.1	41.3	86.8	47.7	36.4	60.2	33.5	17.9	54.2
Samoa	Women	26.6	16.8	37.1	21.2	15.4	27.3	15.9	7.0	24.9
Sao Tome and Principe	Men	4.9	2.8	7.1	11.6	7.9	15.9	43.7	21.5	73.6
Sao Tome and Principe	Women	1.8	0.9	3.0	1.9	1.1	3.1	2.2	0.9	3.9
Saudi Arabia	Men	20.2	15.5	25.4	24.6	18.9	31.6	34.1	18.8	53.2
Saudi Arabia	Women	3.5	2.3	4.9	3.0	1.8	4.5	2.6	0.8	5.2
Senegal	Men	17.4	12.6	21.9	21.2	16.8	25.8	29.0	17.5	43.2
Senegal	Women	1.5	0.8	2.1	0.9	0.5	1.3	0.4	0.2	0.8
Serbia	Men	54.8	41.6	68.3	46.8	37.0	56.6	37.7	22.3	54.9
Serbia	Women	40.4	30.8	51.6	40.5	30.6	49.2	40.8	24.6	59.7
Seychelles	Men	48.2	34.0	64.6	44.7	31.7	59.9	41.4	21.1	66.3
Seychelles	Women	11.1	7.2	15.3	9.3	6.4	13.2	7.2	3.5	11.7
Sierra Leone	Men	39.9	26.0	55.3	52.1	38.8	66.4	77.0	48.6	100.0
Sierra Leone	Women	20.6	11.9	31.6	14.4	9.0	20.8	8.8	3.7	14.6
Singapore	Men	27.5	21.7	33.5	27.8	21.5	33.4	29.0	16.4	43.8
Singapore	Women	5.9	4.5	7.5	5.2	3.9	6.5	4.4	2.2	7.2

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Slovakia	Men	46.2	31.1	61.1	40.8	27.7	56.1	35.8	13.4	61.9
Slovakia	Women	21.1	12.8	30.5	18.8	10.4	28.1	16.6	5.0	30.1
Slovenia	Men	30.2	23.2	36.7	24.3	19.2	29.5	18.0	10.6	26.7
Slovenia	Women	22.6	18.2	28.1	19.2	15.4	24.0	15.4	8.7	22.2
Solomon Islands	Men	65.0	44.5	86.2	53.4	37.8	70.9	42.6	16.4	73.5
Solomon Islands	Women	26.9	17.3	37.0	23.0	16.6	31.1	19.5	7.1	34.8
South Africa	Men	34.5	26.9	42.6	34.2	27.5	41.1	34.3	20.8	47.4
South Africa	Women	11.2	8.8	14.0	9.3	7.5	11.3	7.1	4.3	10.1
Spain	Men	45.2	35.3	56.2	35.2	29.3	43.0	24.6	16.8	33.2
Spain	Women	32.3	24.0	40.3	28.7	23.5	35.2	24.8	16.5	34.5
Sri Lanka	Men	31.4	24.9	38.6	29.9	21.1	39.5	29.6	9.4	54.2
Sri Lanka	Women	1.9	1.3	2.6	0.6	0.4	0.9	0.1	0.0	0.2
Suriname	Men	75.5	42.7	100.0	59.5	35.2	100.0	39.3	15.6	72.1
Suriname	Women	17.6	7.3	32.3	12.3	5.7	22.4	7.4	2.5	13.9
Swaziland	Men	15.9	12.1	20.9	17.9	13.2	23.3	22.2	10.3	39.3
Swaziland	Women	3.3	2.0	4.5	2.5	1.5	3.5	1.8	0.7	3.1
Sweden	Men	33.0	25.2	40.6	23.9	19.9	28.2	14.9	10.2	19.5
Sweden	Women	34.7	26.8	42.1	24.5	20.1	28.5	14.6	9.7	18.7
Switzerland, Liechtenstein	Men	34.7	28.6	40.8	29.3	24.5	34.6	23.0	16.3	29.8
Switzerland, Liechtenstein	Women	25.8	20.9	30.0	21.9	17.9	25.5	17.0	12.1	21.8
Syria	Men	50.7	28.4	79.7	70.1	43.3	100.0	88.9	50.3	100.0
Syria	Women	14.0	4.9	25.6	16.5	5.4	32.9	22.9	4.1	55.7
Tajikistan	Women	0.3	0.1	0.7	0.3	0.1	0.5	0.2	0.1	0.5
Thailand	Men	46.3	38.4	54.6	42.9	36.6	49.8	38.2	28.3	47.8
Thailand	Women	3.1	2.6	3.6	2.5	2.1	2.9	1.8	1.3	2.4

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
Timor-Leste	Men	90.4	65.1	100.0	90.7	74.0	100.0	82.5	51.5	100.0
Timor-Leste	Women	6.5	3.2	11.1	4.3	2.6	6.4	2.5	0.9	4.5
Togo	Men	10.8	5.3	17.3	14.0	8.5	20.5	21.6	10.3	35.5
Togo	Women	3.5	1.3	6.3	2.4	1.1	4.0	1.4	0.5	2.5
Tonga	Men	55.0	40.9	69.5	48.9	38.3	60.9	42.4	23.9	64.0
Tonga	Women	15.4	11.2	20.3	13.5	10.6	17.4	11.5	5.8	18.1
Trinidad and Tobago	Men	44.4	23.4	67.7	40.8	30.2	54.1	38.9	19.3	61.9
Trinidad and Tobago	Women	15.7	8.7	25.2	10.2	7.3	13.1	5.7	2.5	9.1
Tunisia	Men	56.2	41.0	71.4	62.0	42.0	86.4	69.0	30.1	100.0
Tunisia	Women	6.1	3.5	9.0	2.6	1.4	3.9	0.8	0.2	1.6
Turkey	Men	58.6	44.4	71.8	44.9	37.3	53.6	30.8	20.5	42.5
Turkey	Women	19.6	15.4	24.7	14.4	11.6	17.0	9.2	6.1	12.7
Turkmenistan	Men	21.0	10.9	34.7	17.5	11.9	24.5	13.9	8.0	20.8
Turkmenistan	Women	0.9	0.4	1.5	0.8	0.5	1.2	0.6	0.3	1.0
Tuvalu	Men	73.8	52.5	100.0	62.3	35.8	94.5	49.4	22.6	100.0
Tuvalu	Women	29.8	17.3	45.9	25.5	12.4	40.7	21.5	6.0	44.0
Uganda	Men	27.4	18.4	35.9	19.2	13.8	24.9	11.7	6.2	19.2
Uganda	Women	4.8	3.1	6.3	3.3	2.4	4.5	2.0	1.0	3.3
Ukraine	Men	60.3	48.7	72.4	52.3	43.5	62.5	43.1	31.5	57.1
Ukraine	Women	16.1	12.3	19.4	14.6	12.3	17.5	12.6	8.7	17.6
United Arab Emirates	Men	20.2	14.1	27.2	28.6	17.8	40.1	50.2	18.9	95.6
United Arab Emirates	Women	2.3	1.2	3.4	2.7	1.3	4.4	3.8	0.8	8.0
United Kingdom	Men	49.4	37.0	64.5	36.5	26.9	47.1	24.0	14.7	37.0
United Kingdom	Women	46.2	35.6	58.4	33.8	25.1	43.1	21.5	12.8	32.1
United Republic of Tanzania	Men	38.5	23.7	54.8	31.0	22.8	40.7	23.6	12.6	36.5
United Republic of Tanzania	Women	4.9	2.3	7.7	4.1	2.3	6.2	3.3	1.6	5.6

Country	Sex	Prevalence 2000, %			Prevalence 2010, %			Prevalence 2025, %		
		Mean	95% CrI		Mean	95% CrI		Mean	95% CrI	
United States of America	Men	36.3	28.3	45.7	28.6	22.0	35.3	20.2	13.8	28.0
United States of America	Women	29.2	23.0	37.7	22.0	17.7	27.4	14.4	10.0	19.0
Uruguay	Men	48.3	36.0	59.3	32.4	26.4	39.1	18.1	12.1	25.4
Uruguay	Women	37.2	29.1	45.8	23.8	19.1	28.8	12.4	7.9	17.2
Uzbekistan	Men	30.8	21.3	43.4	26.6	17.7	36.8	22.1	8.6	38.7
Uzbekistan	Women	1.6	0.9	2.4	1.4	0.8	2.1	1.2	0.5	2.2
Vanuatu	Men	72.2	39.9	100.0	60.8	34.0	100.0	46.9	15.2	88.7
Vanuatu	Women	24.1	5.3	50.9	20.3	5.6	44.0	16.6	4.0	38.6
Venezuela	Men	51.2	22.7	100.0	39.1	10.9	79.2	26.4	6.2	55.2
Venezuela	Women	33.4	7.9	72.8	23.6	7.6	48.9	14.3	3.2	32.3
Viet Nam	Men	51.2	39.8	65.3	48.5	39.9	57.9	45.9	30.8	65.6
Viet Nam	Women	1.8	1.3	2.4	1.4	1.1	1.7	1.0	0.6	1.5
Yemen	Men	35.6	20.3	52.3	51.6	28.9	81.4	78.4	37.1	100.0
Yemen	Women	14.3	7.4	21.8	16.7	7.7	26.9	22.4	5.5	45.3
Zambia	Men	31.1	23.1	39.6	27.6	19.6	35.7	24.2	10.4	41.0
Zambia	Women	6.1	3.6	8.3	5.1	3.0	7.0	4.0	1.4	7.2
Zimbabwe	Men	33.2	25.3	43.2	32.1	24.5	40.0	31.6	17.2	50.6
Zimbabwe	Women	3.2	1.9	4.4	2.4	1.4	3.5	1.7	0.6	3.0

Appendix D: Relative reductions and posterior probabilities

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
Albania	Men	-9.1	0.72	0.28	0.11
Albania	Women	-35.0	0.98	0.02	0.68
Algeria	Men	27.0	0.30	0.70	0.06
Algeria	Women	-75.0	1.00	0.00	1.00
Andorra	Men	-9.9	0.71	0.29	0.15
Andorra	Women	-10.2	0.72	0.28	0.16
Argentina	Men	-29.8	0.97	0.03	0.54
Argentina	Women	-45.6	1.00	0.00	0.92
Armenia	Men	-20.8	0.94	0.06	0.25
Armenia	Women	-41.0	1.00	0.00	0.85
Australia	Men	-37.5	1.00	0.00	0.81
Australia	Women	-42.6	1.00	0.00	0.92
Austria	Men	-21.5	0.92	0.08	0.29
Austria	Women	-15.7	0.83	0.17	0.20
Azerbaijan	Men	-19.6	0.83	0.18	0.35
Azerbaijan	Women	-33.8	0.96	0.04	0.63
Bahamas	Men	0.6	0.56	0.44	0.18
Bahamas	Women	-41.9	0.97	0.03	0.79
Bahrain	Men	146.1	0.00	1.00	0.00
Bahrain	Women	72.2	0.07	0.93	0.00
Bangladesh	Men	-36.5	1.00	0.00	0.72
Bangladesh	Women	-87.9	1.00	0.00	1.00

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
Belgium	Men	-25.7	0.96	0.04	0.40
Belgium	Women	-16.3	0.83	0.17	0.22
Belize	Men	-40.5	0.96	0.04	0.72
Belize	Women	-45.5	0.99	0.02	0.81
Benin	Men	50.5	0.07	0.93	0.00
Benin	Women	-36.0	0.96	0.05	0.69
Bolivia	Men	-40.1	0.98	0.03	0.78
Bolivia	Women	-35.3	0.97	0.03	0.67
Bosnia Herzegovina	Men	-18.1	0.86	0.14	0.24
Bosnia Herzegovina	Women	-17.0	0.83	0.17	0.27
Botswana	Men	25.3	0.24	0.77	0.02
Botswana	Women	-25.6	0.90	0.10	0.47
Brazil	Men	-34.6	0.98	0.02	0.68
Brazil	Women	-37.3	0.99	0.02	0.74
Brunei Darussalam	Men	-0.3	0.58	0.42	0.19
Brunei Darussalam	Women	-39.6	0.95	0.05	0.73
Bulgaria	Men	-26.7	0.93	0.07	0.46
Bulgaria	Women	-32.4	0.96	0.04	0.60
Burkina Faso	Men	56.3	0.05	0.95	0.00
Burkina Faso	Women	-47.3	1.00	0.00	0.88
Burundi	Men	-22.1	0.86	0.14	0.41
Burundi	Women	-24.3	0.89	0.11	0.42
Cambodia	Men	-12.2	0.73	0.27	0.23
Cambodia	Women	-64.4	1.00	0.00	1.00
Cameroon	Men	215.8	0.00	1.00	0.00
Cameroon	Women	3.4	0.49	0.51	0.08

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
Canada	Men	-39.5	1.00	0.00	0.90
Canada	Women	-53.6	1.00	0.00	1.00
Cape Verde	Men	62.0	0.05	0.95	0.00
Cape Verde	Women	-38.6	0.97	0.03	0.75
Chad	Men	163.5	0.00	1.00	0.00
Chad	Women	17.4	0.31	0.69	0.04
Chile	Men	-18.3	0.87	0.13	0.26
Chile	Women	-18.8	0.86	0.14	0.26
China	Men	-15.2	0.82	0.18	0.18
China	Women	-48.4	1.00	0.00	0.93
Colombia	Men	-32.1	0.95	0.05	0.58
Colombia	Women	-37.2	0.96	0.04	0.71
Comoros	Men	-20.1	0.86	0.14	0.34
Comoros	Women	-56.5	1.00	0.00	0.97
Congo	Men	257.5	0.00	1.00	0.00
Congo	Women	13.0	0.35	0.65	0.05
Cook Islands	Men	-23.5	0.85	0.15	0.44
Cook Islands	Women	-16.1	0.78	0.22	0.32
Costa Rica	Men	-32.8	0.91	0.09	0.62
Costa Rica	Women	-37.0	0.95	0.05	0.69
Cote d'Ivoire	Men	57.3	0.05	0.95	0.00
Cote d'Ivoire	Women	-38.7	0.98	0.02	0.73
Croatia	Men	-1.0	0.56	0.44	0.04
Croatia	Women	22.2	0.16	0.84	0.01
Cuba	Men	-5.6	0.61	0.39	0.19
Cuba	Women	-39.7	0.97	0.03	0.73

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
Cyprus	Men	-14.7	0.78	0.22	0.25
Cyprus	Women	-15.7	0.79	0.21	0.27
Czech Republic	Men	-8.1	0.73	0.27	0.06
Czech Republic	Women	-1.1	0.55	0.45	0.03
Democratic Republic of the Congo	Women	20.8	0.27	0.73	0.03
Denmark	Men	-55.2	1.00	0.00	0.99
Denmark	Women	-52.4	1.00	0.00	0.99
Djibouti	Men	-21.0	0.85	0.15	0.36
Djibouti	Women	-22.6	0.86	0.15	0.40
Dominica	Men	-1.9	0.60	0.40	0.17
Dominica	Women	-41.6	0.96	0.04	0.76
Dominican Republic	Men	-7.3	0.65	0.35	0.17
Dominican Republic	Women	-37.4	0.97	0.03	0.69
Ecuador	Men	-32.2	0.95	0.05	0.59
Ecuador	Women	-39.6	0.98	0.02	0.76
Egypt	Men	45.7	0.11	0.90	0.01
Egypt	Women	-71.6	1.00	0.00	1.00
El Salvador	Men	-38.7	0.96	0.04	0.70
El Salvador	Women	-43.5	0.97	0.03	0.77
Eritrea	Men	-19.6	0.84	0.16	0.34
Eritrea	Women	-23.9	0.87	0.13	0.44
Estonia	Men	-24.0	0.96	0.04	0.35
Estonia	Women	-6.2	0.69	0.31	0.04
Ethiopia	Men	-1.7	0.60	0.40	0.10
Ethiopia	Women	-17.5	0.82	0.18	0.28

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
Fiji	Men	-25.2	0.87	0.13	0.47
Fiji	Women	-18.0	0.78	0.22	0.37
Finland	Men	-30.1	0.99	0.01	0.55
Finland	Women	-26.3	0.98	0.02	0.41
France	Men	-20.3	0.92	0.08	0.27
France	Women	-8.2	0.71	0.29	0.08
Gabon	Men	190.9	0.00	1.00	0.00
Gabon	Women	18.0	0.30	0.70	0.03
Gambia	Men	55.4	0.06	0.94	0.00
Gambia	Women	-37.3	0.98	0.03	0.71
Georgia	Men	-8.9	0.73	0.27	0.11
Georgia	Women	-9.0	0.70	0.30	0.12
Germany	Men	-15.4	0.89	0.11	0.10
Germany	Women	-4.1	0.64	0.36	0.02
Ghana	Men	42.8	0.10	0.90	0.00
Ghana	Women	-39.6	0.98	0.02	0.73
Greece	Men	-12.9	0.77	0.23	0.20
Greece	Women	-17.9	0.82	0.18	0.32
Grenada	Men	-0.6	0.56	0.45	0.18
Grenada	Women	-40.5	0.97	0.03	0.76
Guatemala	Men	-39.8	0.95	0.05	0.71
Guatemala	Women	-46.3	0.98	0.02	0.82
Guinea	Women	-36.2	0.96	0.04	0.69
Guyana	Men	-31.7	0.94	0.06	0.58
Guyana	Women	-39.7	0.98	0.02	0.75

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
Haiti	Men	23.0	0.25	0.75	0.02
Haiti	Women	-34.6	0.95	0.05	0.64
Honduras	Men	-40.8	0.96	0.04	0.76
Honduras	Women	-45.5	0.98	0.02	0.84
Hungary	Men	-30.3	0.98	0.03	0.55
Hungary	Women	-27.6	0.96	0.04	0.48
Iceland	Men	-46.5	1.00	0.01	0.88
Iceland	Women	-41.0	0.99	0.01	0.80
India	Men	-41.2	0.97	0.03	0.78
India	Women	-71.3	1.00	0.00	1.00
Indonesia	Men	27.8	0.07	0.93	0.00
Indonesia	Women	-40.9	1.00	0.00	0.84
Iran	Men	-22.8	0.86	0.14	0.41
Iran	Women	-85.3	1.00	0.00	1.00
Iraq	Men	61.0	0.07	0.93	0.00
Iraq	Women	31.7	0.24	0.76	0.03
Ireland	Men	-32.6	0.96	0.04	0.62
Ireland	Women	-28.9	0.93	0.07	0.54
Israel	Men	-1.3	0.57	0.43	0.08
Israel	Women	-12.0	0.74	0.26	0.20
Italy	Men	-12.5	0.85	0.15	0.06
Italy	Women	-1.5	0.57	0.43	0.01
Jamaica	Men	0.0	0.55	0.45	0.11
Jamaica	Women	-33.7	0.94	0.06	0.62
Japan	Men	-32.6	0.99	0.01	0.63
Japan	Women	-27.4	0.97	0.03	0.46

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
Jordan	Men	46.4	0.05	0.95	0.00
Jordan	Women	39.9	0.15	0.86	0.01
Kazakhstan	Men	-24.9	0.94	0.07	0.40
Kazakhstan	Women	-14.1	0.78	0.22	0.22
Kenya	Men	-21.5	0.89	0.11	0.35
Kenya	Women	-29.2	0.92	0.08	0.52
Kiribati	Men	-24.6	0.85	0.15	0.43
Kiribati	Women	-14.2	0.74	0.26	0.28
Kuwait	Men	57.3	0.06	0.94	0.00
Kuwait	Women	32.8	0.24	0.76	0.04
Kyrgyzstan	Men	-1.7	0.57	0.43	0.04
Kyrgyzstan	Women	-26.4	0.94	0.06	0.46
Lao People's Dem. Rep.	Men	-22.8	0.93	0.07	0.35
Lao People's Dem. Rep.	Women	-55.3	1.00	0.00	0.99
Latvia	Men	-13.0	0.83	0.17	0.10
Latvia	Women	-2.2	0.58	0.42	0.04
Lebanon	Men	33.4	0.15	0.85	0.01
Lebanon	Women	32.4	0.20	0.80	0.02
Lesotho	Men	56.3	0.04	0.96	0.00
Lesotho	Women	-21.7	0.86	0.14	0.39
Liberia	Men	47.9	0.09	0.91	0.00
Liberia	Women	-38.5	0.98	0.02	0.73
Libya	Men	17.2	0.31	0.69	0.08
Libya	Women	-75.2	1.00	0.00	1.00
Lithuania	Men	-28.1	0.96	0.04	0.49
Lithuania	Women	4.0	0.45	0.55	0.03

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
Luxembourg	Men	-22.0	0.91	0.09	0.34
Luxembourg	Women	-15.1	0.82	0.18	0.19
Madagascar	Men	-12.5	0.74	0.26	0.23
Madagascar	Women	-43.0	0.99	0.01	0.83
Malawi	Men	-21.6	0.93	0.08	0.29
Malawi	Women	-37.0	0.98	0.02	0.71
Malaysia	Men	-19.0	0.84	0.16	0.34
Malaysia	Women	-53.5	1.00	0.01	0.92
Maldives	Men	-18.4	0.77	0.23	0.38
Maldives	Women	-73.1	1.00	0.00	1.00
Mali	Men	75.7	0.01	0.99	0.00
Mali	Women	-16.1	0.78	0.22	0.28
Malta	Men	-22.5	0.90	0.10	0.36
Malta	Women	-19.0	0.85	0.16	0.30
Marshall Islands	Men	-21.4	0.82	0.18	0.41
Marshall Islands	Women	-14.4	0.73	0.27	0.32
Mauritania	Men	76.4	0.02	0.98	0.00
Mauritania	Women	-33.0	0.95	0.05	0.62
Mauritius	Men	-11.2	0.75	0.25	0.17
Mauritius	Women	-30.5	0.96	0.05	0.53
Mexico	Men	-44.4	1.00	0.00	0.94
Mexico	Women	-48.4	1.00	0.00	0.97
Mongolia	Men	-13.3	0.78	0.22	0.19
Mongolia	Women	-41.2	0.99	0.01	0.81
Morocco	Men	32.5	0.17	0.83	0.00
Morocco	Women	-64.2	1.00	0.00	0.98

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
Mozambique	Men	-21.1	0.85	0.15	0.38
Mozambique	Women	-22.5	0.87	0.13	0.39
Myanmar	Men	-41.0	0.97	0.03	0.77
Myanmar	Women	-57.9	1.00	0.00	0.95
Namibia	Men	32.7	0.14	0.86	0.00
Namibia	Women	-21.4	0.88	0.12	0.34
Nauru	Men	-23.7	0.86	0.14	0.45
Nauru	Women	-18.8	0.80	0.20	0.38
Nepal	Men	-18.1	0.90	0.10	0.20
Nepal	Women	-68.1	1.00	0.00	1.00
Netherlands	Men	-29.0	0.99	0.01	0.51
Netherlands	Women	-23.0	0.97	0.03	0.27
New Zealand	Men	-42.2	1.00	0.00	0.92
New Zealand	Women	-46.9	1.00	0.00	0.98
Nicaragua	Women	-45.3	0.98	0.02	0.82
Niger	Men	119.8	0.00	1.00	0.00
Niger	Women	-39.6	0.99	0.01	0.78
Nigeria	Men	59.7	0.04	0.96	0.00
Nigeria	Women	-47.6	0.99	0.01	0.89
Niue	Men	-29.6	0.92	0.08	0.54
Niue	Women	-22.4	0.84	0.16	0.43
Norway	Men	-47.9	1.00	0.00	0.98
Norway	Women	-46.8	1.00	0.00	0.98
Oman	Men	72.9	0.03	0.97	0.00
Oman	Women	27.1	0.28	0.72	0.04

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
Pakistan	Men	18.2	0.28	0.72	0.02
Pakistan	Women	-62.4	1.00	0.00	0.99
Palau	Men	-21.8	0.83	0.17	0.40
Palau	Women	-11.8	0.72	0.28	0.29
Palestine	Men	72.8	0.05	0.95	0.00
Palestine	Women	32.5	0.23	0.77	0.03
Panama	Men	-54.8	1.00	0.00	0.95
Panama	Women	-47.2	0.99	0.01	0.86
Papua New Guinea	Men	-24.5	0.87	0.13	0.45
Papua New Guinea	Women	-17.0	0.79	0.21	0.34
Paraguay	Men	-38.5	0.99	0.01	0.76
Paraguay	Women	-43.2	1.00	0.00	0.84
Peru	Women	-37.4	0.99	0.02	0.71
Philippines	Men	-25.9	0.95	0.05	0.41
Philippines	Women	-32.2	0.98	0.02	0.61
Poland	Men	-27.4	0.95	0.05	0.47
Poland	Women	-35.8	0.99	0.02	0.70
Portugal	Men	-13.7	0.80	0.20	0.17
Portugal	Women	-9.8	0.71	0.29	0.20
Qatar	Men	94.0	0.02	0.98	0.00
Qatar	Women	19.7	0.33	0.67	0.05
Republic of Korea	Men	-18.5	0.83	0.17	0.28
Republic of Korea	Women	-24.7	0.90	0.10	0.44
Republic of Moldova	Men	13.0	0.26	0.74	0.00
Republic of Moldova	Women	1.2	0.51	0.49	0.04

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
Romania	Men	-29.1	0.96	0.04	0.52
Romania	Women	-15.6	0.81	0.19	0.20
Russian Federation	Men	-14.4	0.83	0.17	0.17
Russian Federation	Women	5.9	0.42	0.58	0.03
Rwanda	Men	-19.7	0.83	0.17	0.35
Rwanda	Women	-14.0	0.78	0.23	0.22
Saint Kitts and Nevis	Men	-0.2	0.57	0.43	0.16
Saint Kitts and Nevis	Women	-42.8	0.98	0.02	0.79
Saint Vincent and the Grenadines	Men	-1.1	0.58	0.42	0.17
Saint Vincent and the Grenadines	Women	-40.7	0.96	0.04	0.75
Samoa	Men	-29.5	0.93	0.07	0.54
Samoa	Women	-25.1	0.88	0.12	0.45
Sao Tome and Principe	Men	277.5	0.00	1.00	0.00
Sao Tome and Principe	Women	14.5	0.35	0.65	0.04
Saudi Arabia	Men	37.9	0.08	0.92	0.00
Saudi Arabia	Women	-17.2	0.76	0.24	0.34
Senegal	Men	36.8	0.08	0.92	0.00
Senegal	Women	-50.5	1.00	0.00	0.93
Serbia	Men	-19.5	0.90	0.10	0.25
Serbia	Women	0.8	0.52	0.48	0.04
Seychelles	Men	-8.0	0.70	0.30	0.11
Seychelles	Women	-23.0	0.91	0.09	0.35
Sierra Leone	Men	48.8	0.05	0.95	0.00
Sierra Leone	Women	-39.2	0.98	0.02	0.73
Singapore	Men	3.8	0.46	0.55	0.03
Singapore	Women	-16.3	0.81	0.19	0.25

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
Slovakia	Men	-13.6	0.74	0.26	0.25
Slovakia	Women	-13.8	0.77	0.24	0.25
Slovenia	Men	-26.1	0.95	0.05	0.43
Slovenia	Women	-20.2	0.91	0.10	0.27
Solomon Islands	Men	-21.4	0.84	0.17	0.41
Solomon Islands	Women	-16.3	0.77	0.23	0.32
South Africa	Men	0.5	0.51	0.49	0.03
South Africa	Women	-23.5	0.93	0.07	0.35
Spain	Men	-29.8	0.99	0.01	0.53
Spain	Women	-13.6	0.82	0.18	0.13
Sri Lanka	Men	-3.9	0.61	0.39	0.17
Sri Lanka	Women	-81.8	1.00	0.00	1.00
Suriname	Men	-33.3	0.94	0.05	0.62
Suriname	Women	-38.5	0.99	0.02	0.75
Swaziland	Men	22.8	0.26	0.74	0.02
Swaziland	Women	-29.9	0.93	0.08	0.54
Sweden	Men	-37.3	1.00	0.00	0.77
Sweden	Women	-40.1	1.00	0.00	0.85
Switzerland	Men	-21.3	0.97	0.04	0.23
Switzerland	Women	-21.9	0.97	0.03	0.23
Syria	Men	29.9	0.05	0.93	0.00
Syria	Women	32.2	0.24	0.76	0.03
Tajikistan	Women	-17.1	0.79	0.21	0.31
Thailand	Men	-10.7	0.82	0.18	0.04
Thailand	Women	-25.7	0.98	0.02	0.36

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
Timor-Leste	Men	-8.7	0.59	0.38	0.15
Timor-Leste	Women	-41.2	0.96	0.04	0.75
Togo	Men	56.2	0.05	0.95	0.00
Togo	Women	-39.5	0.97	0.03	0.77
Tonga	Men	-13.6	0.79	0.21	0.20
Tonga	Women	-15.2	0.79	0.21	0.25
Trinidad and Tobago	Men	-3.4	0.59	0.41	0.19
Trinidad and Tobago	Women	-43.3	0.97	0.03	0.81
Tunisia	Men	9.3	0.36	0.64	0.09
Tunisia	Women	-70.8	1.00	0.00	1.00
Turkey	Men	-31.2	0.98	0.02	0.57
Turkey	Women	-36.0	1.00	0.01	0.72
Turkmenistan	Men	-18.5	0.82	0.18	0.34
Turkmenistan	Women	-16.4	0.79	0.21	0.29
Tuvalu	Men	-22.8	0.84	0.16	0.41
Tuvalu	Women	-18.6	0.80	0.20	0.38
Uganda	Men	-39.1	0.99	0.02	0.76
Uganda	Women	-40.0	0.99	0.01	0.79
Ukraine	Men	-17.3	0.90	0.10	0.15
Ukraine	Women	-13.6	0.83	0.17	0.11
United Arab Emirates	Men	71.5	0.05	0.95	0.00
United Arab Emirates	Women	34.6	0.21	0.79	0.02
United Kingdom	Men	-34.6	0.99	0.01	0.70
United Kingdom	Women	-36.6	1.00	0.01	0.74
United Republic of Tanzania	Men	-23.3	0.88	0.12	0.42
United Republic of Tanzania	Women	-18.5	0.82	0.18	0.32

Country	Sex	Relative reduction in prevalence, %, 2010-2025	Posterior probability		
			Decrease	Increase	Target achievement
United States of America	Men	-29.1	0.99	0.01	0.50
United States of America	Women	-34.4	1.00	0.00	0.70
Uruguay	Men	-44.1	1.00	0.00	0.92
Uruguay	Women	-47.7	1.00	0.00	0.96
Uzbekistan	Men	-18.0	0.82	0.18	0.30
Uzbekistan	Women	-15.8	0.77	0.23	0.29
Vanuatu	Men	-23.2	0.84	0.15	0.42
Vanuatu	Women	-18.9	0.81	0.19	0.35
Venezuela	Men	-32.6	0.95	0.05	0.61
Venezuela	Women	-39.2	0.97	0.03	0.76
Viet Nam	Men	-5.2	0.66	0.34	0.06
Viet Nam	Women	-29.5	0.95	0.05	0.54
Yemen	Men	53.5	0.06	0.94	0.00
Yemen	Women	30.2	0.24	0.77	0.04
Zambia	Men	-13.8	0.75	0.25	0.26
Zambia	Women	-21.8	0.87	0.14	0.38
Zimbabwe	Men	-1.8	0.58	0.43	0.08
Zimbabwe	Women	-30.9	0.95	0.05	0.57

Appendix E: Country groupings sensitivity analyses

Measure	Grouping basis	Within-group variability	Summary statistics			
			Mean	SD	Min	Max
Men						
Coverage	Tobacco control only	Low	0.992	0.015	0.938	1.000
		Moderate	0.993	0.016	0.929	1.000
	Geography and tobacco epidemiology	Low	0.993	0.015	0.938	1.000
		Moderate	0.993	0.016	0.929	1.000
RMSE	Tobacco control only	Low	0.073	0.032	0.022	0.199
		Moderate	0.070	0.031	0.020	0.194
	Geography and tobacco epidemiology	Low	0.071	0.033	0.022	0.205
		Moderate	0.069	0.031	0.021	0.195
Women						
Coverage	Tobacco control only	Low	0.982	0.027	0.865	1.000
		Moderate	0.984	0.024	0.900	1.000
	Geography and tobacco epidemiology	Low	0.982	0.027	0.885	1.000
		Moderate	0.984	0.025	0.900	1.000
RMSE	Tobacco control only	Low	0.035	0.027	0.001	0.133
		Moderate	0.034	0.027	0.001	0.132
	Geography and tobacco epidemiology	Low	0.035	0.027	0.001	0.131
		Moderate	0.034	0.026	0.001	0.130