Global trends and projections for tobacco use, 1990–2025: an analysis of smoking indicators from the WHO Comprehensive Information Systems for Tobacco Control

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Summary

Background **Countries have agreed on reduction targets for tobacco smoking stipulated in the WHO global monitoring framework, for achievement by 2025. In an analysis of data for tobacco smoking prevalence from nationally representative survey data, we aimed to provide comprehensive estimates of recent trends in tobacco smoking, projections for future tobacco smoking, and country-level estimates of probabilities of achieving tobacco smoking targets.**

Methods **We used a Bayesian hierarchical meta-regression modelling approach using data from the WHO Comprehensive Information Systems for Tobacco Control to assess trends from 1990 to 2010 and made projections up to 2025 for current tobacco smoking, daily tobacco smoking, current cigarette smoking, and daily cigarette smoking for 173 countries for men and 178 countries for women. Modelling was implemented in Python with DisMod-MR and PyMC. We estimated trends in country-specific prevalence of tobacco use, projections for future tobacco use, and probabilities for decreased tobacco use, increased tobacco use, and achievement of targets for tobacco control from posterior distributions.**

Findings **During the most recent decade (2000–10), the prevalence of tobacco smoking in men fell in 125 (72%) countries, and in women fell in 156 (88%) countries. If these trends continue, only 37 (21%) countries are on track to achieve their targets for men and 88 (49%) are on track for women, and there would be an estimated 1·1 billion current tobacco smokers (95% credible interval 700 million to 1·6 billion) in 2025. Rapid increases are predicted in Africa for men and in the eastern Mediterranean for both men and women, suggesting the need for enhanced measures for tobacco control in these regions.**

Interpretation **Our findings show that striking between-country disparities in tobacco use would persist in 2025, with many countries not on track to achieve tobacco control targets and several low-income and middle-income countries at risk of worsening tobacco epidemics if these trends remain unchanged. Immediate, effective, and sustained action is necessary to attain and maintain desirable trajectories for tobacco control and achieve global convergence towards elimination of tobacco use.**

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Introduction

Tobacco control is a global health priority. The WHO Framework Convention on Tobacco Control, which entered into force in 2005, formalised global commitment,[1] and so far has been ratified by 180 parties.[2] However, country-specific progress varies substantially, with very high prevalence of smoking among both men and women in many countries.[3] WHO estimates that about 6 million people worldwide die each year from causes attributed to smoking, with most of these deaths occurring in low-income and middle-income countries.[4] The 2011 UN political declaration on non-communicable diseases provided additional impetus both for urgent and sustained control of tobacco use and for preventive action against other risk factors for non-communicable diseases.[5] In 2013, the World Health Assembly endorsed the WHO global monitoring framework for non-communicable diseases and an associated voluntary global target of a 30% relative reduction in tobacco use worldwide among people aged 15 years or older by 2025 (with 2010 levels as baseline). This target was officially agreed on by WHO member states on the basis of experience from countries that had successfully implemented at the highest level of achievement at least three of the demand reduction measures outlined in the WHO Framework Convention, and will account for varying initial starting points for tobacco control in assessment of national progress.[6] This target was endorsed at the Sixth Meeting of the Convention of Parties in Moscow in October, 2014.[7] Monitoring of progress towards these targets will be of enormous benefit to individual

countries because it will assist them in taking necessary corrections or new actions to reduce consumption of tobacco products.

Although some country-specific estimates of prevalence and trends in tobacco smoking are available, a comprehensive and consistent set of estimates—combining historical trends and the most up-to-date data with projections of the future burden of tobacco use—is needed for as many countries as possible. The WHO Reports on the Global Tobacco Epidemic regularly provide specific-year estimates for smoking prevalence, but do not provide changes over time or levels of uncertainty around estimates.[3] The Institute for Health Metrics and Evaluation recently estimated prevalence trends from 1980 to 2012, but only for one measure, daily smoking.[8] Neither of these studies projected trends in smoking prevalence nor assessed target achievement.[3,8]

The tobacco epidemic proceeds through distinct stages,[9] which can be affected by policy interventions;[10] because many countries with mature tobacco epidemics have now implemented extensive control policies under the 2003 Framework Convention,[3] trends from the past 10 years can serve as a useful guide for future strategies. Synthesis of existing trend data by region and country, with projections, can provide a useful instrument to assist development for tobacco control. We aimed to provide a comprehensive and consistent set of trend estimates for four tobacco use indicators from 2000 to 2010, and projections to 2025, with target achievement probabilities under the WHO global monitoring framework, using the most comprehensive and up-to-date nationally representative data available.

Methods

Study design and data sources

We did a systematic assessment of trends for four tobacco smoking indicators—current tobacco smoking, daily tobacco smoking, current cigarette smoking, and daily cigarette smoking—for 178 countries from 1990 to 2014 with baseline projections to 2025. The four indicators we modelled represent important characteristics of frequency and product type, and are intended to capture the full diversity of tobacco smoking for which data are available. We report estimates for prevalence and trends in current tobacco smoking, incorporating daily smoking and occasional smoking[11] of any type of smoked tobacco.

We obtained data about tobacco use prevalence from the WHO Comprehensive Information Systems for Tobacco Control. This database encompasses major, internationally standardised data sources that report tobacco use of any kind; all data sources used are population-based surveys in the public domain. We investigated data availability and quality for all 194 WHO member states. The primary datasets included reports of survey estimates submitted to the WHO Framework Convention on Tobacco Control Secretariat, surveys such as the Global Adult Tobacco Survey[12] operated as part of the WHO Global Tobacco Surveillance System, and major nationally representative health surveys such as the World Health Survey,[13] Demographic and Health Surveys, the Behavioral Risk Factor Surveillance System,[14] and the WHO STEPwise surveys.[15] Data quality control at the time of collection was done by the WHO Comprehensive Information Systems for Tobacco Control unit, and discrepancies (eg, zero values of major prevalence estimates, higher reported prevalence for women than for men, prevalence more than 60%, or inconsistencies in different indicators) were investigated with country representatives before finalisation in the database. Details about the identification process for data sources and about data entry, reconciliation, and quality checking procedures are provided in the appendix.

For the **Demographic and Health Surveys** see http://www.measuredhs.com/

See **Online** for appendix

A data source was included if it provided prevalence estimates from country surveys for one or more of the four tobacco use indicators used in this study; involved randomly selected participants representative of the general population; and was officially recognised by the national health authority. A data source was excluded if it was earlier than 1990, was not nationally representative (eg, urban or rural only, geographic or political subdivision, subpopulations such as students only), or if the maximum age of target participants was younger than 15 years. The dataset for this analysis encompassed 896 surveys in 180 countries covering the period 1990 to 2014, amounting to 26 153 datapoints specific to country, year, sex, and age.

Outcome definitions

Tobacco refers to all forms of smoked tobacco encountered in the surveys including, but not limited to, cigarette, cigar, pipe, and water pipe. Cigarette included any kind of cigarette such as manufactured, roll-your-own, or local variants (eg, bidis in India or kreteks in Indonesia). Current refers to smoking at least once in the 30 days before the survey. Daily refers to smoking at least once per day during the same 30 day period.[16] Almost all surveys in the dataset excluded experimental smokers when reporting prevalence of current and daily smoking. Current tobacco smoking is an important indicator because it can more sensitively detect trends among groups with historically low prevalence of smoking (eg, women[17] and late teenagers[18]) than can the other component tobacco use indicators; we focused on this outcome in this study.

Statistical analysis

For analytic purposes, we categorised countries into 21 regions representing tobacco epidemiology and geography. These groups combined tobacco use patterns and control history with the UN geoscheme subregions.[3,19] Details of the country groupings are provided in the appendix.

The analytic approach for this study needed to address data scarcity for some countries, non-standard age categories, and information for four tobacco smoking

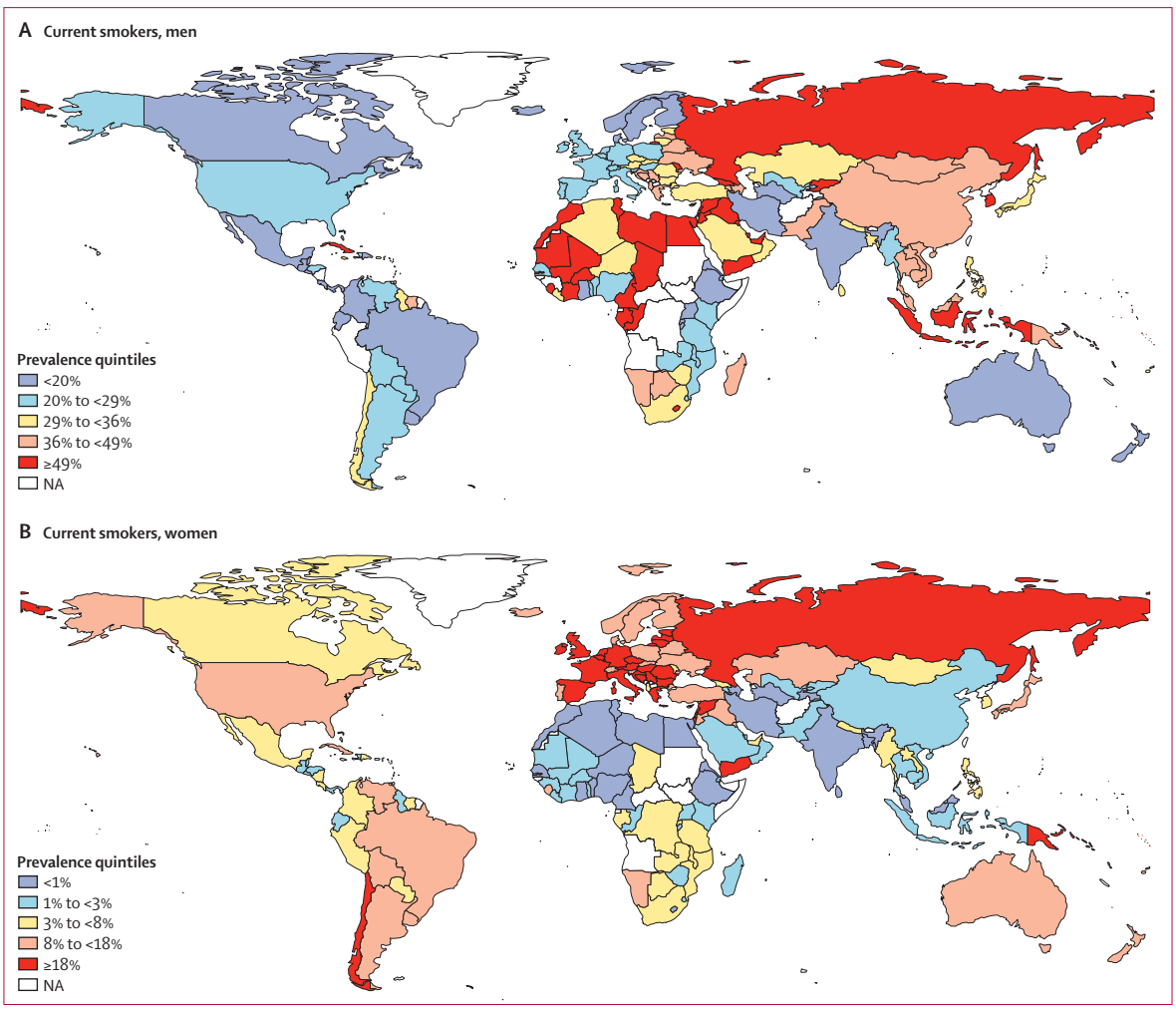

Figure 1: **Estimated prevalence of current tobacco smoking in 2025**
Figure shows age-standardised mean estimates for individuals aged 15 years or older. NA=not available.

indicators, with consistency constraints between indicators such that current tobacco smoking served as the prevalence envelope for daily tobacco smoking and current cigarette smoking, which in turn were both greater than or equal to daily cigarette smoking. To overcome these challenges, we developed a Bayesian hierarchical meta-regression model, combining observed data with additional prior assumptions to derive posterior distributions of the quantities of interest. This multistage modelling approach handles these problems by first identifying trends at the regional level, and then using these trends to build priors for the coefficients in subsequent country-level models, enabling supplementation of scarce country data with regional information. We used a piecewise linear spline to model age-specific prevalence in the population aged 15 years or older with breakpoints per 10-year age group chosen in consultation with WHO tobacco and statistical experts. This is a flexible approach that captures diversity and detail in age patterns in different countries.

We fitted the model over two periods, 1990–2000 and 2000–10, and used a time–period interaction term to allow for potential shifts due to country-level changes in time-varying factors (eg, implementation of tobacco control measures). Indicator coefficients with constraints in the form of priors enabled simultaneous and consistent estimation of the different indicators of tobacco use. Details about the model equations, a directed acyclic graph for the Bayesian hierarchical structure, and detailed information about prior assumptions are provided in the appendix. We did model fitting separately for men and women, applying Markov-chain Monte Carlo methods implemented in the Python programming language.[20] We used the DisMod-MR[21] package (a Bayesian modelling instrument) to handle non-standard age categories, model specification, and meta-regression, and the PyMC package[22] for Markov-chain Monte Carlo simulation. We obtained posterior distributions for all outcomes of interest, enabling the

calculation of probabilities of decrease or increase in prevalence of tobacco use, and probabilities of reaching tobacco control targets by 2025.

We fitted separate models by country and sex to allow for potentially diverging trends between sexes. We obtained trend estimates for the period 1990–2000 and 2000 onwards, carrying the post-2000 trend forward to provide projections for all four indicators to 2025. 1000 draws per year of age were generated from the resulting posterior distributions, and we used the WHO standard population[23] to obtain aggregated, age-standardised prevalence for ages 15 years or older. We estimated means and obtained 95% credible intervals from the 2·5% and 97·5% percentiles of the distributions of these replicates. We obtained numbers of smokers by multiplying prevalence and population estimates.[24] Quintiles of mean prevalence were calculated for 2010 and 2025. We calculated percentage changes from 2010 to 2025 and posterior probabilities of reduction, increase, and target achievement from these distributions. A posterior probability of reduction of 95% or greater means that at least 95% of the simulated percentage changes are below zero.

We used autocorrelation plots to assess model convergence, tested for predictive accuracy using root-mean-squared errors and coverage of 95% posterior predictive intervals, and checked for robustness in out-of-sample prediction by holdout cross-validation. We used the Bayesian information criterion to assess interaction terms.[25]

Role of the funding source

The funders had no role in the design, implementation, analysis, or writing of the study, or choice of journal. The corresponding author had full access to all the data and had final responsibility for the decision to submit for publication.

Results

We generated estimates about current tobacco smoking for 173 countries for men and 178 countries for women. The appendix contains country-specific estimates of prevalence in 2010 and 2025; relative percentage changes and posterior probabilities of reduction, increase, and target achievement; and prevalence quintiles in 2010 and 2025 by WHO region and income categories. Figure 1 shows maps of predicted prevalence quintiles in 2025. The first quintile represents countries with the lowest prevalences, whereas the fifth quintile represents those 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, most countries in the first quintile (21 [57%] countries) were low-income or middle-income countries in Africa, with the fifth quintile concentrated in Europe and the western Pacific. For women, most countries in the first quintile were low-income and middle-income countries from diverse geographies (21 [84%] countries), 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

	Number of countries	Direction of trend, 2000–10		≥95% probability, 2010–25	
		Decrease	Increase	Decrease	Increase
Men					
Low-income or middle-income countries					
AFRO	40	15 (44%)	25 (56%)	1 (5%)	15 (37%)
AMRO	23	22 (57%)	1 (1%)	13 (54%)	0
EMRO	13	2 (14%)	11 (73%)	0	2 (2%)
EURO	17	16 (27%)	1 (<1%)	4 (12%)	0
SEARO	9	7 (86%)	2 (14%)	3 (80%)	0
WPRO	20	20 (89%)	0	1 (5%)	0
Subtotal	122	82 (80%)	40 (20%)	22 (40%)	17 (5%)
High-income countries					
AFRO	0	0	0	0	0
AMRO	8	7 (42%)	1 (<1%)	3 (39%)	0
EMRO	6	0	6 (13%)	0	4 (5%)
EURO	31	31 (73%)	0	15 (25%)	0
SEARO	0	0	0	0	0
WPRO	6	5 (11%)	1 (<1%)	3 (8%)	0
Subtotal	51	43 (94%)	8 (6%)	21 (56%)	4 (2%)
Total for men	173	125 (83%)	48 (17%)	43 (43%)	21 (5%)
Women					
Low-income or middle-income countries					
AFRO	42	36 (88%)	6 (12%)	21 (50%)	0
AMRO	25	25 (60%)	0	24 (60%)	0
EMRO	13	7 (74%)	6 (18%)	6 (74%)	0
EURO	18	16 (27%)	2 (1%)	6 (11%)	0
SEARO	9	9 (100%)	0	9 (100%)	0
WPRO	20	20 (88%)	0	7 (87%)	0
Subtotal	127	113 (96%)	14 (4%)	73 (88%)	0
High-income countries					
AFRO	0	0	0	0	0
AMRO	8	8 (40%)	0	7 (38%)	0
EMRO	6	1 (4%)	5 (3%)	0	0
EURO	31	27 (56%)	4 (16%)	9 (16%)	0
SEARO	0	0	0	0	0
WPRO	6	6 (12%)	0	4 (9%)	0
Subtotal	51	42 (88%)	9 (12%)	20 (51%)	0
Total for women	178	155 (95%)	23 (5%)	93 (81%)	0

Data are n, in which n refers to number of countries, or n (%), in which n refers to number of countries and % refers to the proportion of the regional population covered. Table shows data for individuals aged 15 years or older; income categories are from The World Bank. AFRO=WHO African Region. AMRO=WHO Region of the Americas. EMRO=WHO Eastern Mediterranean Region. EURO=WHO European Region. SEARO=WHO Southeast Asian Region. WPRO=WHO Western Pacific Region.

Table 1: **Relative change in age-standardised prevalence of current smoking by WHO region**

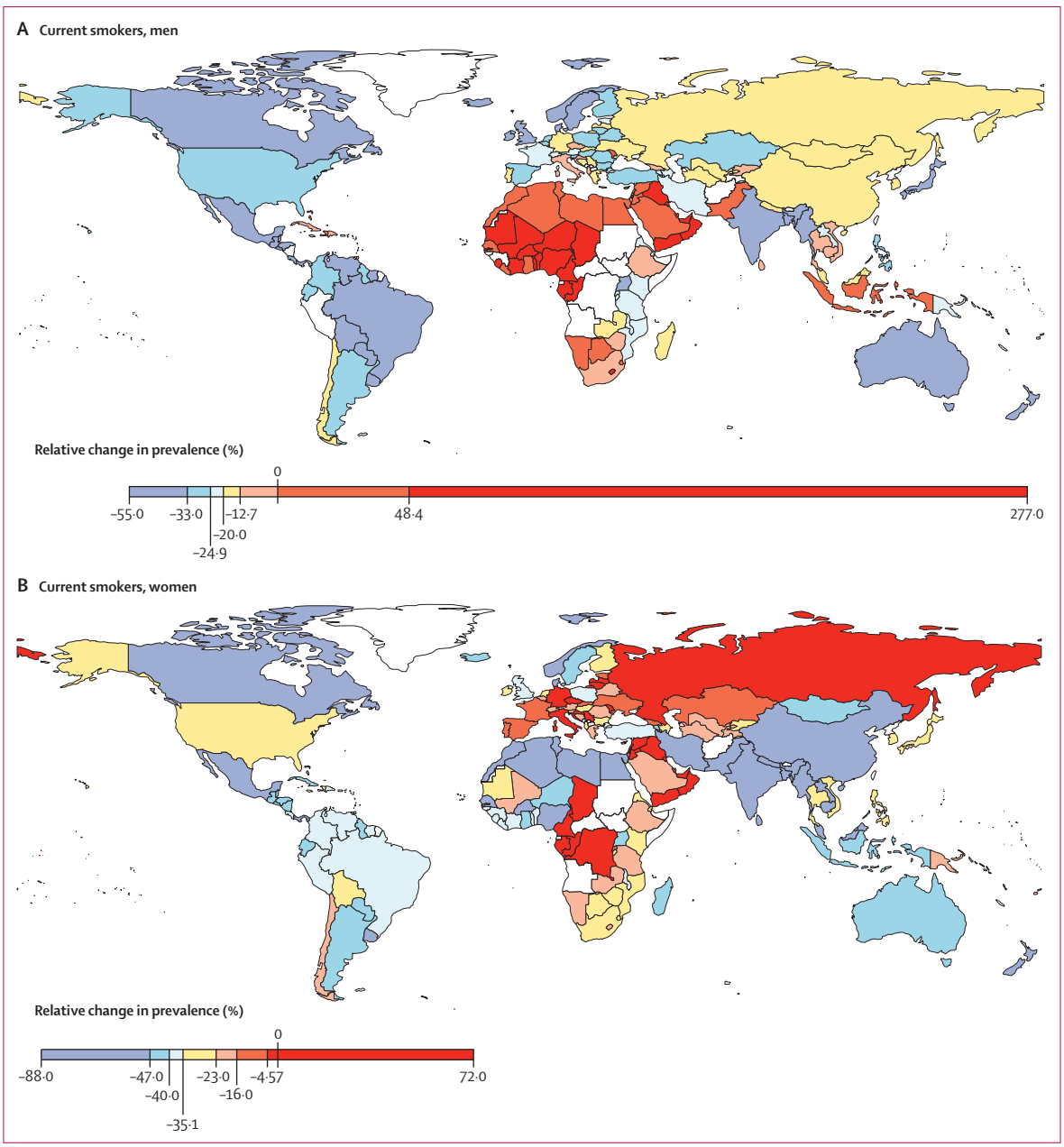

Figure 2: **Relative change in prevalence of current tobacco smoking between 2010 and 2025**
Figure shows age-standardised mean estimates for individuals aged 15 years or older. NA=not available.

women. For men, 24 (67%) countries in the first quintile were low-income or middle-income countries in Africa and the Americas, with several African nations increasing in prevalence. The composition of the fifth quintile remained similar to those in 2000. For women, patterns in the first and the fifth quintiles also remained similar to those in 2000. Our estimates of trends between 2000 and 2010 suggested that tobacco control efforts have been successful, with 125 (72%) countries for men and 155 (87%) countries for women showing any level of decrease to 2010.

If recent trends remain unchanged, there will be an estimated 1·1 billion current smokers (95% credible interval 700 million to 1·6 billion) in 2025. We project that the highest smoking quintile among men will shift from low-income and middle-income countries in Europe and the western Pacific to those in Africa and the eastern Mediterranean, suggesting 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 those at baseline, with

the first quintile mostly consisting of low-income and middle-income countries from diverse geographies including 15 (43%) African nations, with the fifth quintile concentrated in Europe and the western Pacific.

Table 1 summarises 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. Corresponding relative percentage changes from 2010 to 2025 are mapped in figure 2. From 2000 to 2010, 125 (72%) countries experienced decreases in prevalence for men, compared with 155 (87%) countries for women. If such trends continue, only 43 (25%) countries for men and 93 (52%) countries for women will have 95% or greater probability of decrease from 2010 to 2025, and 21 (12%) countries will have 95% or greater probability of increase among men over the same period. Decreases are projected for most countries in almost all regions except Africa for men and the eastern Mediterranean for both men and women. We noted high (≥95%) probabilities of decrease for most countries in the Americas for both men and women. By 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 (48%) high-income countries had a high probability of reduction, compared with only four (24%) low-income or middle-income countries, suggesting that within-region income inequalities remain an issue in tobacco control.

Scatterplots of relative percentage changes from 2010 to 2025 against baseline prevalence in 2010 are provided in figure 3, with countries categorised according to probabilities of achieving tobacco control targets. Only 37 (21%) countries are on track to achieve their targets for men and 88 (49%) countries are on track for women. Only three (2%) countries for men and 22 (12%) countries for women had high probabilities (≥95%) of target achievement. We estimated relative prevalence increases of greater than 100% for men in seven (4%) countries in Africa and the eastern Mediterranean. We noted low (<5%) target achievement probabilities for several countries for both sexes. Geographic representations of target achievement probabilities are shown in figure 4 and summaries by WHO region and World Bank income classification are shown in table 2. Low-income and middle-income settings had higher proportions (38 [31%] *vs* eight [16%]) of countries with low target achievement probabilities for men and high-income settings had higher proportions (12 [24%] *vs* 12 [9%]) of countries with low target achievement probabilities for women, suggesting continued growth of tobacco smoking among men in low-income countries and persistence among women in high-income countries.

The results for all indicators by country are available on the WHO website.

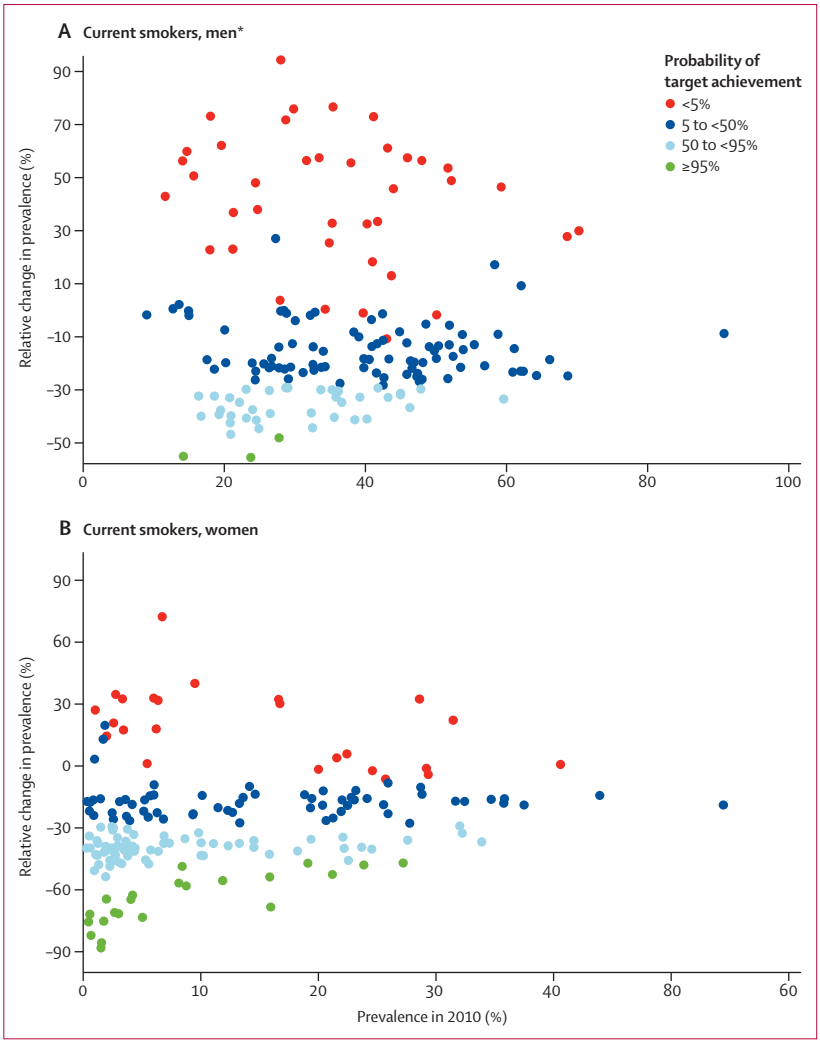

Figure 3: **Relative change in prevalence of current tobacco smoking between 2010 and 2025, versus baseline prevalence and probabilities of target achievement**
*Seven countries with more than 100% relative change not shown.

Discussion

This analysis of nationally representative survey data provides a comprehensive set of comparable and consistent estimates and projections for four tobacco use indicators and target achievement probabilities under the global monitoring framework for non-communicable diseases; the use of the most up-to-date data and a comprehensive modelling process enabled information from multiple indicators to be used directly in a single flexible model (panel). We estimated trends in prevalence of tobacco smoking from 1990 to 2010 using data available until June, 2014, and made projections to 2025 for 178 countries for women and 173 countries for men. We also estimated mean percentage changes in prevalence between 2010 and 2025 with posterior probabilities of reduction, increase, and target achievement. We engaged with national authorities to ensure a comprehensive database, used

For the **results of all indicators by country** see http://www.who.int/tobacco/publications/surveillance/en/

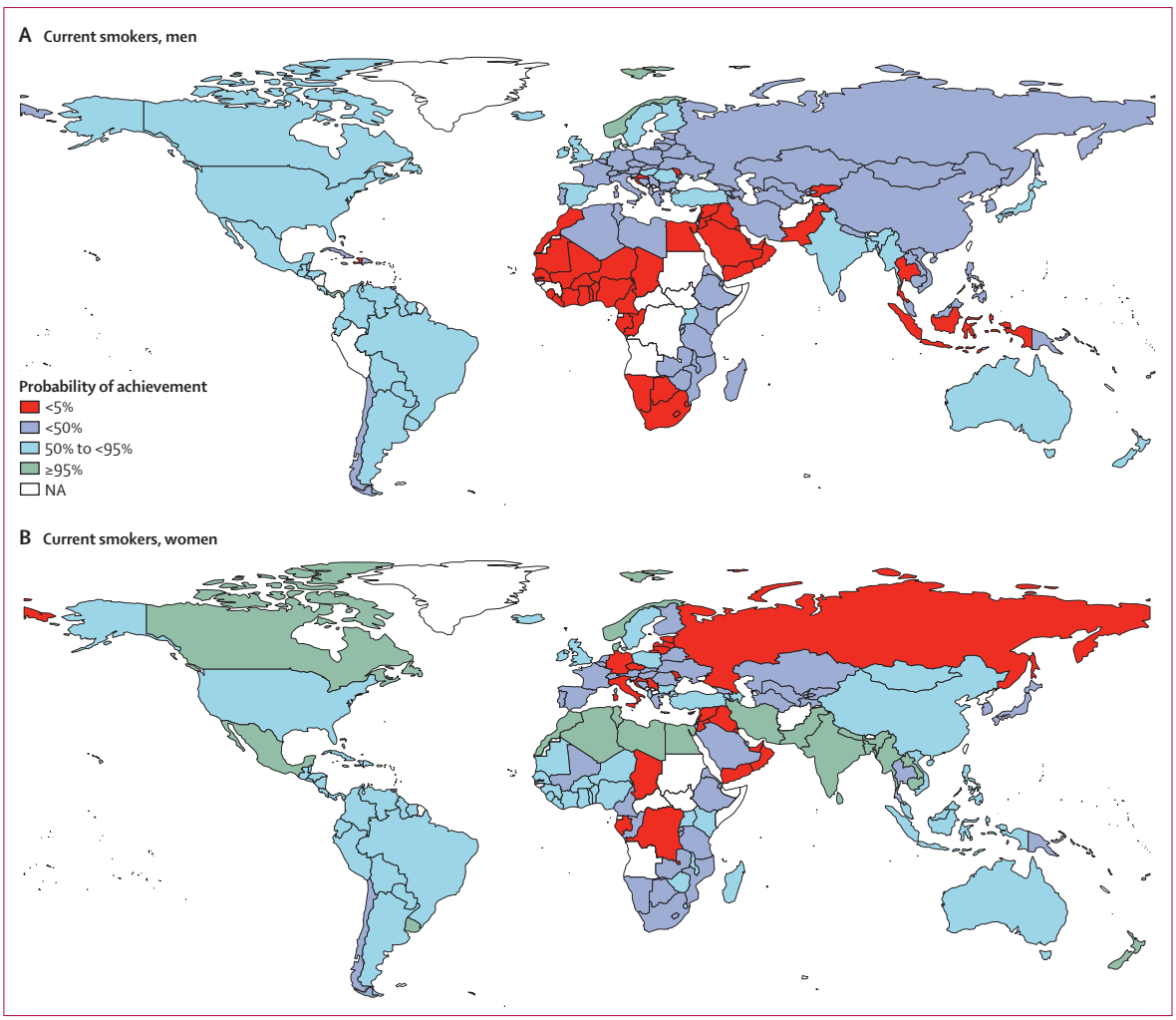

Figure 4: **Probability of 30% reduction in tobacco use by 2025**
Figure shows probability of countries achieving a 30% relative reduction compared with prevalence levels in 2010, assuming current trends continue.

the latest available survey data, and consulted with individual countries regarding discrepancies as part of the WHO global estimation process.

We noted wide variation in baseline prevalence, suggesting differences in tobacco epidemic stages and in control efforts between countries. Our prevalence projections showed that such disparities are likely to persist. Countries already at mature stages of the smoking epidemic at baseline, which are projected to retain high prevalence in 2025, need immediate and effective implementation or strengthening of measures for smoking cessation, avoidance of relapse, and deterrence of initiation. Countries where the smoking epidemic has not gained a foothold or is in its early stages are mostly in low-income or middle-income countries where tobacco control might not be a top priority because of scarce resources to address pressing health concerns. However, these situations present opportunities for these countries' governments, in cooperation with the international community, to invest in or strengthen cost-effective preventive strategies before tobacco companies establish and expand their markets.

Many countries will not achieve the 30% reduction target if current trends remain unchanged, and more effort is needed to attain or to maintain desirable trajectories. The demand reduction measures in the WHO Framework Convention on Tobacco Control (known as WHO MPOWER measures) serve as a good starting point. Aimed to assist countries with implementation of the framework, these measures consist of six broad implementation strategies: "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".[31] Although the WHO Framework Convention on Tobacco Control has been ratified by 180 parties to date,[2] completeness of implementation of the MPOWER

measures varies greatly across countries.[3] The importance of immediate and extensive MPOWER implementation is exemplified by Turkey, which we project will achieve a greater than 30% reduction in current smoking prevalence by 2025, representing an annual decrease of greater than 2·0% over 15 years. Turkey ratified the Framework Convention on Tobacco Control in 2004, and is the only country to have been assessed by WHO to have implemented MPOWER measures at the highest level. Turkey has experienced substantial reductions in tobacco use prevalence since then. If sustained, this trend would be sufficient to attain the 2% annual reduction over 15 years required by the target. However, even countries on track towards target achievement should be vigilant and exert efforts to maintain desirable trajectories. Norway provides an example of the importance of vigilance to maintain tobacco control efforts. We estimate that Norway will achieve a 45% reduction in current smoking prevalence, representing a 3·0% annual decrease over 15 years, with high probabilities (>95%) for both men and women. After waning prioritisation of tobacco control in the 1980s and stalled prevalence reductions, tobacco use reductions were again achieved after reinvigoration of the national programme for tobacco control in the 1990s, and have been maintained.[32] Norway was able to achieve a 30% reduction in tobacco use within a decade,[33] and its national tobacco control strategy continues to evolve.[34] These countries offer lessons in effective tobacco control, and show the potential value of the MPOWER package for countries that we have identified as at risk of increasing or static trends in current smoking prevalence.

Although tobacco control strategies are at the forefront of changes in tobacco use prevalence, smoking trends might also result from other factors. Similar to Norway, Sweden is projected to achieve 37% or greater relative reduction in current smoking prevalence, representing annual decreases over 15 years for both men and women of roughly 2·4%. In both countries, however, consumption of smokeless oral tobacco (snus) has been increasing in recent years.[35–37] Although snus has been suggested to help smoking cessation, its health effects remain controversial and debate about its role as a tobacco cessation strategy is ongoing.[35,38,39] Some portion of Norway and Sweden's success might therefore represent substitution to unmeasured forms of tobacco use rather than cessation, and for any country the particular cultural context of tobacco use remains an important consideration in interpretation of our model outputs.

Our study also had several limitations. First, our study relied on self-reported data with the potential for reporting bias that could vary across settings and over time. However, validation exercises with biomarkers in high-income settings have shown self-reported smoking behaviour to have high sensitivities (>90%),[40,41] and cross-country surveys in low-income and middle-income countries use scientific and evidence-based protocols to ensure comparability across settings and over time.[42] Although residual variability due to differences in data sources might persist despite quality control efforts, these factors were addressed to the extent feasible by prior specifications in the statistical model. Second, the need to calculate projections necessarily placed restrictions on the model choices. Although use of a functional form in the model enabled projection beyond

	Number of countries	Projected to achieve target	Probability of achieving target by 2025			
			<5%	5 to <50%	50 to <95%	≥95%
Men						
Low-income or middle-income countries						
AFRO	40	1 (5%)	24 (51%)	15 (44%)	1 (5%)	0
AMRO	23	16 (55%)	1 (1%)	6 (3%)	15 (54%)	1 (<1%)
EMRO	13	0	9 (70%)	4 (3%)	0	0
EURO	17	2 (9%)	2 (<1%)	12 (15%)	3 (12%)	0
SEARO	9	3 (80%)	2 (17%)	4 (17%)	3 (80%)	0
WPRO	20	2 (<1%)	0	18 (89%)	2 (<1%)	0
Subtotal	122	24 (38%)	38 (20%)	59 (42%)	24 (38%)	1 (<1%)
High-income countries						
AFRO	0	0	0	0	0	0
AMRO	8	2 (4%)	0	5 (2%)	3 (39%)	0
EMRO	6	0	6 (13%)	0	0	0
EURO	31	8 (16%)	1 (<1%)	21 (55%)	7 (17%)	2 (1%)
SEARO	0	0	0	0	0	0
WPRO	6	3 (8%)	1 (<1%)	2 (3%)	3 (8%)	0
Subtotal	51	13 (25%)	8 (6%)	28 (43%)	13 (50%)	2 (<1%)
Total for men	173	37 (35%)	46 (17%)	87 (42%)	37 (40%)	3 (<1%)
Women						
Low-income or middle-income countries						
AFRO	42	22 (50%)	4 (9%)	15 (36%)	21 (50%)	2 (5%)
AMRO	25	25 (60%)	0	0	24 (48%)	1 (13%)
EMRO	13	6 (74%)	6 (18%)	1 (<1%)	0	6 (74%)
EURO	18	5 (10%)	2 (1%)	11 (16%)	5 (10%)	0
SEARO	9	8 (96%)	0	1 (4%)	2 (14%)	6 (82%)
WPRO	20	6 (82%)	0	13 (<1%)	5 (86%)	2 (1%)
Subtotal	127	72 (85%)	12 (3%)	41 (10%)	57 (51%)	17 (36%)
High-income countries						
AFRO	0	0	0	0	0	0
AMRO	8	7 (38%)	0	1 (2%)	5 (34%)	2 (4%)
EMRO	6	0	4 (3%)	2 (5%)	0	0
EURO	31	6 (13%)	8 (32%)	16 (26%)	5 (12%)	2 (1%)
SEARO	0	0	0	0	0	0
WPRO	6	3 (2%)	0	3 (10%)	2 (1%)	1 (<1%)
Subtotal	51	16 (40%)	12 (24%)	22 (36%)	12 (36%)	5 (4%)
Total for women	178	88 (76%)	24 (7%)	63 (15%)	69 (48%)	22 (30%)

Data are n, in which n refers to number of countries, or n (%), in which n refers to number of countries and % refers to the proportion of the regional population covered. Table shows data for individuals aged 15 years or older; income categories are from The World Bank. AFRO=WHO African Region. AMRO=WHO Region of the Americas. EMRO=WHO Eastern Mediterranean Region. EURO=WHO European Region. SEARO=WHO Southeast Asian Region. WPRO=WHO Western Pacific Region.

Table 2: **Probability of achieving the target of a 30% relative reduction in tobacco use by WHO region**

Panel: **Research in context**

Systematic review

We searched PubMed with the terms "tobacco" OR "smoking" OR "cigarette" AND "trends" or "projections" for articles published in English before Dec 16, 2014. We identified no articles that provided a comprehensive and comparable systematic assessment of recent trends and projections ensuring consistency for four tobacco use indicators and including target achievement probabilities under the WHO global monitoring framework. We identified articles that estimated recent trends or made projections for a single country or small subsets of countries for one or two indicators.[26–30]

Interpretation

Our findings show that striking between-country disparities in tobacco use would persist in 2025, with many countries not on track towards target achievement and several low-income or middle-income countries at risk of worsening tobacco epidemics if recent trends remain unchanged. Immediate, effective, and sustained action is necessary to attain and maintain desirable trajectories for tobacco control and achieve global convergence towards elimination of tobacco use.

the timeframe of the data, all our projection estimates are subject to the standard limitations of projections based on a functional assumption, irrespective of the sophistication of the Bayesian hierarchical approach. Third, our study did not include estimates for smokeless tobacco, which is an important form of tobacco use. Unfortunately, severe limitations in availability and quality of data for smokeless tobacco compared with smoked forms[43] precluded the inclusion of smokeless tobacco in this study. Additionally, smokeless tobacco could have very different risk factors and use profiles compared with smoked tobacco, and might be better modelled 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, although a formal impact evaluation of the Framework Convention on Tobacco Control has not been done, there is some evidence that it accelerated adoption of some measures for tobacco control,[44] and future shifts occurring after country ratification might not be fully captured in our basis period for projection. However, varying lags in actual implementation of control measures after implementation of the framework, and existing policies for tobacco control in place before the framework, precluded use of the year of ratification as the base point for projections. Instead, we opted to use a common starting point that allowed for a straightforward comparison of projections, and provided a common reference point from which to examine country differences in actual implementation of tobacco control measures. Finally, some of the countries represented in our data had very few datapoints, and the trend estimates for these countries are likely highly affected by regional estimates. For these countries, the trend can be interpreted as their likely future trajectory of tobacco use prevalence if they adopt the tobacco control policies common in their region. Although trend estimates from our research can serve as an indicator of these countries' future tobacco trends, these countries need to improve surveillance and monitoring of tobacco use to properly understand their future risk profile of non-communicable diseases.

Patterns in target achievement probabilities, trajectories, and projected prevalence uncover areas for attention. We estimated low probabilities of target achievement and upward trends in prevalence for most countries in the WHO African region for men and in the WHO eastern Mediterranean region for both sexes. For men, both regions have several countries—six (32%) for the eastern Mediterranean region and 15 (38%) for the African region—with high (≥95%) estimated probabilities of increase, and 37% of the population covered by the African region are 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, with many more high-income than low-income countries achieving reductions in tobacco smoking by 2010, and the future landscape of tobacco control starkly defined by national income: less than 1% of the population of low-income and middle-income countries live in areas with a high probability of achieving tobacco control targets, compared with 36% of the population of high-income countries. International cooperation is thus needed, consistent with evidence that country capacity is a crucial mediator in implementation of tobacco control measures.[45] In view of increasing trends in other risk factors for non-communicable diseases (eg, blood pressure[46] and high body-mass index[47]), and low resources for several countries in these regions, immediate and effective action should be taken to prevent potential epidemics of non-communicable diseases that could burden already-fragile health systems. Tobacco is the most policy-responsive risk factor for non-communicable disesases,[48] 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[10] for these countries.

Synthesis of target achievement probabilities and projected prevalence also provides impetus for stronger control strategies for tobacco, even for high-income countries. Projected target achievement should not be taken as cause for complacency; some countries, such as Japan, with greater than 50% probability of achieving the target would still belong to the third-highest quintile of current prevalence of tobacco smoking (29% to <36%) among men in 2025. Our findings lend support to those from a modelling exercise that recommended a more ambitious reduction target for tobacco use to achieve corresponding goals to reduce premature mortality from non-communicable diseases.[48] Although a 30% relative reduction is feasible on the basis of previous experience and is useful for benchmarking progress,[6] it should not hold countries back from aspiring to more challenging yet efficient pathways towards elimination of tobacco use.

Although efforts for tobacco control in the past decade have been successful in reduction of tobacco use in many countries, some countries are at risk of substantial increases in tobacco use, and tobacco control targets remain out of reach for many. If recent trends remain unchanged, we project that many countries will not achieve tobacco control targets and more than 1 billion people will remain current smokers in 2025. Stagnating trends imply that future research is needed to devise ways to accelerate progress and for innovation in tobacco control strategies. Countries in Africa and the eastern Mediterranean, with few resources and fragile health systems, are susceptible to worsening tobacco epidemics, and there is also evidence that the epidemic will persist among women in some high-income countries. Immediate, effective, and sustained action is needed to attain and maintain desirable trajectories towards a tobacco-free world.

Contributors

All authors were involved in study design, data consolidation and processing, model development, analysis, and writing and editing of the report.

Declaration of interests

We declare no competing interests.

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