Sex and age specific projections of smoking prevalence in Spain: a Bayesian approach

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ABSTRACT

Objectives: To project future smoking prevalence rates in Spain by sex and age groups using Bayesian methods and to estimate the probability of a 30% relative reduction between 2010 and 2025.

Methods: We used the data from the Spanish National Health Surveys (2003, 2006 and 2011) to obtain information about current and former smoking. We reconstructed annual smoking rates from 1989 through 2011 by sex and 5-year age groups. The prevalence were projected for the period 2012-2025 using a Bayesian logistic binomial model and estimated the probability to achieve the 30% relative reduction endorsed by the WHO. We calculated the 95% credible interval (CrI) of the posterior distribution which includes a 95% of the distribution of potential smoking prevalences.

Results: In men, the projections show a decline for crude (-2.64% annually, 95% CrI: -3.32; -1.97) and adjusted (-2.50%, 95% CrI:-3.14; -1.87) prevalence. In women, the projections show a decline for crude prevalence (-0.36%, 95% CrI: -1.02; -0.30)) and the age-adjusted prevalence (-1.02%, 95% CrI: -1.61, -0.47). By age groups, the decline is greater among women aged 15-39 years (-3.92%, 95% CrI: -4.92; -2.96)) while for women aged 40-64 years an increase (1.84%, 95% CrI: 1.06; 2.58) is expected. In men the probability to achieve the WHO target is 0.728 and in women is less than 0.001. The age-group 15-39 shows the highest probability to achieve the target.

Conclusions: The results suggest smoking prevalence will decrease during 2012-2025 in all age groups for both sexes except for women aged 40-64. We found that the WHO target of a 30% reduction in prevalence is likely to be achieved overall and in the 15-39 years age groups for both sexes, but not achieved for older women and it is uncertain whether it will be achieved for older men. These results highlight the need to strengthen public health interventions that focus on reducing tobacco use in adult women aged 40-64 years old.

IMPLICATIONS

We project a decrease in smoking prevalence in during 2012-2025 except for women aged 40-64.
The WHO Target of a 30% relative reduction could be achieved in the population aged 15-39; but not in women and the results are inconclusive in men.
These results highlight the need to strengthen public health interventions that focus on reducing tobacco use in adult women aged 40-64 years old.

INTRODUCTION

Smoking is one of the biggest threats to the public health the world has faced. Accordingly to data from the Institute for Health Metrics from 2015, 11.47% of the total deaths and 6.04% of the disability-adjusted life-years (DALYs) were attributable to the tobacco use, being the 2nd risk factor of death globally [1]. Specifically, tobacco is responsible of 16.07% of male deaths and 5.8% of female deaths [1], Death rates are higher in middle (107.99 deaths per 100,000) and high-income countries (130.85 deaths per 100,000) than in lower-income countries (33.64 deaths per 100,000), reflecting the higher historical smoking rates in high-income countries [1]. In 2012, 21% of the population aged 15 and above worldwide smoked tobacco. Men smoked at five times the rate of women; the average prevalence was 36% and 7%, respectively [2]. In Spain, male smoking prevalence peaked at 58.5% in 1980 and declined to 41.8% in 2000 and 31.7% in 2007. In Spanish women, the smoking prevalence leveled off at 26% from 1985 until the 2000s when it started to decrease [3].

Two smoke-free laws have been passed in Spain. In 2005, a smoke-free legislation came into effect (Law 28/2005). This regulation outlawed smoking in all public indoor areas but excluded certain hospitality venues depending on size [4]. This led to a modification of the legislation in 2010 (Law 42/2010), that extended the smoke-free regulation to all hospitality venues [5] without exception and to some outdoors areas, including hospital premises, educational campuses, and playgrounds.

The WHO Framework Convention on Tobacco Control launched in 2005 is a treaty developed in response to the globalization of the tobacco epidemic that provides requirements directed to the production, sale, distribution, advertisement, and taxation of tobacco. In this sense, the WHO has established a voluntary target of 30% relative reduction in the prevalence of tobacco use in persons aged 15 and more years by 2025 [6]. Monitoring the progress of the tobacco use is beneficial because it will assist us in taking the necessary corrections or new actions to reduce consumption of tobacco products. Trends from the past years with projections can serve as a useful guide for future strategies, assisting the development of tobacco control [7,8].

The objectives of this study are to project the sex and age-specific smoking prevalence in Spain from 2012 to 2025 by means of Bayesian methods and to estimate the probability of achieving the WHO target of a 30% relative reduction of the smoking prevalence between 2010 and 2025, assuming unchanged trends.

MATERIAL AND METHODS

Data

Smoking data were obtained from the three (2003, 2006 and 2011) most recent editions of the Spanish National Health Interview Survey [9]. All surveys included information on smoking status, age at smoking initiation (for current and former smokers) and age at smoking cessation (for former smokers). Data on current (from 2011 to 2014) and estimated population numbers in the future (from 2015 to 2025) are needed for the projection of future smoking

prevalence. These data were obtained from the National Statistics Institute of Spain, stratified by age and sex [10].

Reconstruction method

We reconstructed the smoking prevalences for each calendar year for the period 1989-2011 with a validated method [3] that uses information on age at smoking initiation and cessation [11–14]. To obtain the number of smokers, we assigned each survey participant a smoking status (smoker/nonsmoker) for each calendar year in which the participant was aged 15 years and older. Never smokers were considered nonsmokers for the whole period. Current smokers were considered smokers from the year of initiation up to the current year. Former smokers were considered smokers from the year of smoking initiation to the year of cessation and were considered nonsmokers before initiation and from the year of cessation onward. We pooled data from the 3 surveys (2003, 2006 and 2011) taking into account the complex survey design. Data were grouped by calendar year (from 1989, first year with data for all the age-groups) and age (from 15-19 years to 85+ years). For each calendar year and age-group we calculated the smoking prevalence as the number of smokers in the sample in that calendar year and age-group over the corresponding total. We calculated the crude smoking prevalence (the number of smokers for all the ages over the corresponding total), the age-adjusted smoking prevalence (standardized using the direct method with the world standard population in 2001[15]) and the age-specific smoking prevalences for the following groups: 15 to 39 years, 40 to 64 years, and for 65 and more years.

We used JoinPoint regression to describe the changes in the trend of the reconstructed smoking prevalence. JoinPoint regression models identify those years where trends have a significant change. Annual Percent Changes (APC) and their 95% confidence intervals (95%CI) in prevalence was then computed for all segments. The model was limited to a maximum of two Joinpoints (three different trends), implying three different trends (with three statistically significant different APCs). The JoinPoint analysis was conducted with the JoinPoint Regression Program, version 4.2 [16].

Projection methods

In order to project future smoking prevalence we used a log-linear model. Assuming $x_{i,j,t}$ the number of smokers observed for the i^{th} age group, the j^{th} sex group (men or women) and the t^{th} year follows a Binomial distribution, the following Bayesian model was suggested:

$$x_{i,j,t} \sim Bin(Y_{i,j,t}, \pi_{i,j,t})$$
$$\frac{\pi_{i,j,t}}{1-\pi_{i,j,t}} = e^{\left(\alpha_i+\beta_i(t-t_o)\right)},$$

Where $Y_{i,j,t}$ is the individuals observed, $\pi_{i,j,t}$ is the prevalence (proportion) of smokers and t_0 is the reference year (the first year used for the estimation of the model). By applying a Bayesian model we avoid fitting problems in age groups with low prevalences and small counts of smokers, as it could happen in a classical frequentist approach making use of a similar log-

linear model, when it could derive in unstable, overdispersed or biased estimates of the parameters. Even in that situation the Bayesian model could produce projections and credible intervals [17]. Also, in this case it would be helpful to calculate the probability of a hypothesis, a characteristic of the Bayesian inference.

Before applying the model two decisions must be made: the number of years used to estimate the model (the prevalence of these years is previously known for the observed sample) and the number of years projected (where the model will project the prevalence). Using all available years is not necessarily the best option to obtain the best model since the assumption of log-linearity in the prevalence of smoking may not be met [18]. In contrast, models created from a short projection base may meet the assumption of log-linearity more robustly, but will produce estimates with poorer precision [18]. Previous research has found that 5-10 years balances meeting the assumption of log-linearity and precision [18]. Regarding the number of years projected, a larger number of years make the log-linear assumption questionable and the precision decreases. As our model extrapolates the estimated time trend into the future years, a future change in public health policies could change the time trend and will not be included in the model, so it is not recommendable making long-term projections [19].

We therefore have limited our projections until 2025. Based on these factors, we decided to estimate our model based on the information for the period 2005-2011 and used it to project prevalence rates during the period 2012-2025, and we estimated the probability (pr) to achieve the WHO target of 30% reduction by 2025 from baseline prevalence in 2010. As baseline prevalence in 2010, we used the estimated crude prevalence for that year. Due to the different trends observed in the Join Point regression in the re-built series, we also estimated the model using information of 2009-2011 to estimate the probability to achieve the WHO target of 30% reduction by 2025.

A Gaussian distribution as prior was applied for all α_i and β_i so that α_i ~ Normal (0, τ_α) and β_i ~ Normal (0, τ_β). Precision parameters τ_α and τ_β having flat hyper-priors τ_α ~ Gamma (ψ, ϕ) and τ_β ~ Gamma (ψ, ϕ), where $\psi=\phi=0.001$. The models were implemented using WINBUGS and run in R [20, 21]. Each model was generated by a Markov Chain Monte Carlo run of three chains of 25,000 values, discarding the first 5,000 as a burn-in process and keeping every second. The chains differentiated for the initial values of τ_α and τ_β (1 in the first chain, 0.1 in the second chain, and 10 in the third chain) and an initial value of 0 for all α_i and β_i. Therefore, we obtained 30,000 samples of the model parameters, which allowed us to project the future number of smokers in each sex and age group. Once the projected number of smokers was obtained, the distribution of the smoking prevalence was calculated as detailed in the reconstruction method. For projections, we used the population as a denominator in the prevalence calculation. We also calculated the APC for the projected period. The Bayesian analysis considers the projection parameters (in our case, the projected prevalence of smoking) as variables and allows for the estimation of the distribution of these parameters. This distribution (usually called the posterior distribution in Bayesian analyses) allows for the estimation of the parameter in question (smoking prevalence) as the median of the distribution, and the uncertainties in these parameters (the credible intervals, which enclose 95% of the distribution of potential smoking prevalences). It also allows for the estimation of

the probabilities of the distribution under a constant, like the WHO target from the distribution. The estimation of these uncertainties is not possible under other approaches (like a frequentist approach).

All of the data used in this study are freely accessible and individual data are not available (the information is presented as aggregated data and does not contain data on individuals), thus, approval from an Ethic Board was not required.

RESULTS

Smoking prevalence in men

Figure 1 and Table 1 shows the reconstructed (1989 to 2011) and the projected smoking (2012-2025) prevalence rates in men. The reconstructed smoking prevalence (1989-2011) in men shows a decrease. The crude prevalence declined in the nineties (49.1% in 1989, 41.2% in 1998, APC = -1.96% (95%CI: -2.32; -1.60)) and it decreased more quickly from then (1998-2009 APC =–3.27% (95%CI: -3.40; -2.80), 2009-2011 APC = –6.11% (95%CI: -9.80; -2.26)). The age-adjusted prevalence exhibited similar trends (46.0% in 1989; 40.6% in 1999, APC = –1.28%, 95%CI: -1.60; -0.96) with a greater declines in prevalence since 2000 (1999-2009 APC = –2.65%, 95%CI: -3.02; -2.28 and 2009-2011 APC = –6.42%, 95%CI: -10.24; -2.43). By age-groups, we observed that the prevalence for the 15-39 age-group (from 54.9% in 1989 to 30.1% in 2011), for the 40-64 age-group (from 43.8% in 1989 to 30.0% in 2011) and the 65 and more years age-group (from 19.9% in 1989 to 10.2% in 2011) have kept the decrease. The projection for the 2012-2025 period follows the same pattern in the overall crude prevalence (APC = –2.64%, 95%CrI: -3.32; -1.97), the age-adjusted prevalence (APC = –2.50%, 95%CrI: -3.14; -1.87), and by age groups: in the 15-39 years prevalence (APC = –3.28%, 95%CrI: -4.29; -2.31), the 40-64 years prevalence (APC = -1.69%, 95%CrI: -2.61; -0.84) and the 65 and more years prevalence (APC = –3.11%, 95%CrI: -5.53; 0.10).

Smoking prevalence in women

Figure 1 and Table 1 shows the reconstructed (1989 to 2011) and the projected smoking (2012-2020) prevalence rates in women. For the period 1989-2011, the crude prevalence increased until the beginning of the 21st century (23.4% in 1989, 23.6% in 1999, APC = 0.09% (95%CI: -0.17; 0.34), then slightly declined (23.6% in 1999, 19.6% in 2009, APC = –1.99%, 95%CI: -2.28; -1.70). The age-adjusted prevalence changed the trend, increasing in the nineties (24.1% in 1989, 28.0% in 2000, APC = 1.46%, 95%CI: 1.25; 1.67) and decreasing later (2000-2009 APC = -1.50%, 95%CI: -1.83; -1.17 and 2009-2011 APC = -5.83%, 95%CI: -8.69; -2.88). When we considered age groups, we observed that for the younger women population (15-39 years) the prevalence leveled off in the nineties (40.0% in 1989, 39.8% in 1999, APC = 0.01%, 95%CI: -0.34; 0.35) and started to decline since 2000 (1999-2009 APC = –3.15%, 95%CI: -3.54; -2.76 and 2009-2011 APC = -6.44%, 95%CI: -10.49; -2.21). For women between 40 and 64 years prevalence increased throughout the study period, faster in the nineties (8.1% in 1989, 19.7% in 2000, APC = 8.58%, 95%CI: 8.36; 8.80) and more slowly in the later years (22.9% in 2005, 23.9% in 2011, APC = 0.52%, 95%CI: 0.01; 1.02). Women over 65 years had a low smoking

prevalence. The projection for the last period (2012-2025) indicates an increasing prevalence for 40-64 age group (APC = 1.84%, 95%CrI: 1.06; 2.58), and a strong decline in young women (APC = –3.92%, 95%CrI: -4.92; -2.96). These opposite trends means a slow decline for the overall crude (APC = –0.36%, 95%CrI: -1.02; -0.30) and the age-adjusted (APC = –1.02%, 95%CrI: -1.61; -0.47) prevalences.

WHO target for 2025

Table 1 shows the smoking prevalence projected for 2025, reported as median and their 95% CI. The table also shows the estimated prevalences for 2010, the target established by the WHO (a 30% relative reduction from the 2010 prevalences) and the estimated probability to achieve the target. In men the probability to achieve the WHO target is 0.728 and in women is less than 0.001. The age-group from 15 to 39 shows the highest probability to achieve the WHO target (pr= 0.986 in men and pr = 0.996 in women). Using data from the period 2009-2011, the probability to achieve the WHO target, as compared to the main analysis performed using data from the period 2005-2011, was higher for women (0.320) and similar for men (0.723) (data not shown). Again, the age-group from 15 to 39 shows the highest probability to achieve the WHO target (pr=0.901 in men and pr=0.769 in women).

DISCUSSION

Our study shows the decrease in the smoking prevalence in men and women. However, according to our projection, the WHO goal of 30% relative reduction of smoking prevalence could be only achieved among young population in 2025 with a high probability (over 0.95). In men, the decline in the smoking prevalence has been continued over the last two decades, with no apparent change (acceleration or deceleration) of the trend. In women, the smoking prevalence was increasing until the beginning of the 21st century and has started to decline since then. As in the case of men, the smoking prevalence in women has not seemingly reached a minimum. The prevalence in men and women is converging, but our projections do not show a decrease in the smoking prevalence of men below that of women.

In women, three different patterns are observed: in the older cohorts, the smoking prevalence has been always minimal. In younger cohorts we observed an increase of smoking prevalence following a decrease in gender inequality in Spain [22]. The youngest cohorts, born and raised under stricter public policies of smoking regulation, have shown a decrease of the smoking prevalence compared to previous cohorts.

Following the stages of the cigarette epidemic by Thun et al [23], the situation in Spain could be located in the fourth stage, when smoking prevalence in men and women are decreasing and almost converging. The decline in the smoking prevalence may be related to the public policies of tobacco control led by the World Health Organization. The WHO has established a voluntary target of 30% relative reduction in the prevalence of tobacco use in persons aged 15+ years by 2025 [6]. According to our results by that year, will all the reservations about the adequacy of the projections, it seems possible to achieve the target of the WHO for men, but the results are not conclusive. The WHO target seems unattainable for the women, whose prevalence has

only recently started to decline and, in the case of some age groups (women aged 40-64) may be still increasing. This group of women were adolescents between 1962 and 1985, corresponding in part with an increase in women's liberation in Spain, a phenomenon capitalized by the tobacco industry to increase the amount of smoking in women [22,24]. Using the last three years of observed data (2009-2011) to estimate the model, the results are similar for men but are more promising for women, with low but now insignificant probability to achieve the target.

This research has some limitations. First, smoking prevalence data was not available for all years previous to 2011, so we needed to reconstruct these prevalences based on three cross-sectional surveys. In this sense, an important limitation of the reconstruction method is that we did not have complete information on prior smoking behaviors for individuals included in the cross-sectional surveys. For example, we could not allow for individuals who had periods of relapse after previously quitting smoking. Nonetheless, the reconstruction method has been validated before [3]. Moreover, the uncertainties associated with the reconstructions were taken into account with the use of a Bayesian model. Second, all information used for the reconstruction was self-reported, which may induce a degree of measurement error.

Nonetheless, previous research has shown self-reported smoking to be valid, especially when only considering information on current status (instead of number of cigarettes smoked)[27]. Moreover, the age groups used in this research did not permit to study the adolescence that remains integrated in a major age group from 15 to 39 years. This could generate a source of bias in the projections because the adolescents are in a first stage in the development of the nicotine dependence. Future studies could study separately this group of population. The projected period (from 2012 to 2025) is a very long period to assume an unchanged trend. The plausibility of the projection in the last years may be compromised, but on the other hand it allows for the opportunity to put uncertainty boundaries around the 2025 WHO Targets, which may be important policy implications. In this sense, it could be updated more accurately with the next Spanish National Health Surveys. On the other hand, our study also has some strengths. First, the sample size used to reconstruct the smoking prevalence and subsequently project future prevalences was very high, with more than 60,000 individuals measured across the three surveys. Second, the use of a Bayesian model allows for the incorporation of several sources of uncertainty, including in the data that is used for the projection model. Moreover, the Bayesian model allows calculating probabilities on the veracity of hypothesis, as the achievement of the WHO target for 2025. We calculated it under two possible scenarios: using the period 2005-2011 to estimate the model and, based on the reconstruction of the smoking prevalence, using the period 2009-2011. However, the projection for 2025 could be considered with caution because it is not recommendable making long-term projections with this Bayesian model [18,19].

In conclusion, the smoking prevalence is declining in Spain for both men and women, with a convergence by 2025. Nonetheless, women from 40 to 64 years of age are projected to have an increased smoking prevalence in the future. Thus, these middle-aged women require special attention in terms of public health policies in order to achieve the WHO target of reduction of smokers by 2025.

BIBLIOGRAPHY

1. Institute of Health Metrics, University of Washington (2016). http://vizhub.healthdata.org/gbd-compare/. Accessed March 8, 2017.
2. World Health Organization. Global Health Observatory (GHO) data. Prevalence of tobacco use. http://www.who.int/gho/tobacco/use/en/. Accessed March 8, 2017.
3. Bilal U, Fernández E, Beltran P, Navas-Acien A, Bolumar F, Franco M. Validation of a method for reconstructing historical rates of smoking prevalence. *Am J Epidemiol*. 2014;179(1):15-19.
4. Fernandez E. Spain: going smoke free. Tob Control 2006 Apr;15(2):79-80.
5. Fernández E, Nebot M. Spain: Beyond the 'Spanish model' to a total ban. Tob Control 2011; 20:6-7.
6. World Health Organization. *Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013-2020.*; 2013.
7. Bilano V, Gilmour S, Moffiet T, et al. Global trends and projections for tobacco use, 1990–2025: an analysis of smoking indicators from the WHO Comprehensive Information Systems for Tobacco Control. *Lancet*. 2015;385(9972):966-976.
8. World Health Organization. *MPOWER in Action*.; 2013. http://www.who.int/tobacco/mpower/publications/mpower_2013.pdf. Accessed March 8, 2017.
9. Instituto Nacional de Estadística. Encuesta Nacional de Salud. http://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176783&menu=resultados&idp=1254735573175. Accessed March 8, 2017.
10. Instituto Nacional de Estadística. Cifras de Población y Censos Demográficos. Proyecciones de población a largo plazo. http://www.ine.es/jaxi/menu.do?type=pcaxis&path=/t20/p251/&file=inebase . Accessed March 8, 2017.
11. Borras JM, Fernandez E, Schiaffino A, Borrell C, La Vecchia C. Pattern of smoking initiation in Catalonia, Spain, from 1948 to 1992. *Am J Public Health*. 2000;90(9):1459-1462.
12. La Vecchia C, Decarli A, Pagano R. Prevalence of cigarette smoking among subsequent cohorts of Italian males and females. *Prev Med (Baltim)*. 1986;15(6):606-613.
13. Fernández E, Schiaffino A, García M, Saltó E. Prevalencia del consumo de tabaco en España entre 1945 y 1995 . Reconstrucción a partir de las Encuestas Nacionales de Salud. *Med Clin (Barc)*. 2003;120(1):14-16.
14. Harris JE. Cigarette smoking among successive birth cohorts of men and women in the United States during 1900-80. *J Natl Cancer Inst*. 1983;71(3):473-479.
15. Ahmad OB, Boschi-pinto C, Lopez AD, Murray CJ, Lozano R, Mie I. *Age Standardization of Rates: A New Who Standard*; 2001.
16. National Cancer Institute. Joinpoint Trend Analysis Software. https://surveillance.cancer.gov/joinpoint/. Accessed March 8, 2017.
17. R. Clèries, J. Ribes, M. Buxo, A. Ameijide, R. Marcos-Gragera, J. Galceran, et al., Bayesian approach to predicting cancer incidence for an area without cancer registration by using cancer incidence data from nearby areas., Stat. Med. 31 (2012) 978–87.
18. Valls J, Castellà G, Dyba T, Clèries R. Selecting the minimum prediction base of historical

data to perform 5-year predictions of the cancer burden: The GoF-optimal method. *Cancer Epidemiol*. 2015 Jun;39(3):473-9.

19. Dyba T, Hakulinen T. Do cancer predictions work? *Eur J Cancer*. 2008;44(3):448-453.
20. R Development Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing. 2003.
21. Sturtz S, Ligges U, Gelman A. R2WinBUGS: a package for running WinBUGS from R. *J Stat Softw*. 2005;12(Gelman):1-16.
22. Bilal U, Beltrán P, Fernández E, Navas-Acien A, Bolumar F, Franco M. Gender equality and smoking: a theory-driven approach to smoking gender differences in Spain. *Tob Control*. 2016;25(3):295-300.
23. Thun M, Peto R, Boreham J, Lopez AD. Stages of the cigarette epidemic on entering its second century. *Tob Control*. 2012;21(2):96-101.
24. Shafey O, Fernández E, Thun M, Schiaffino A, Dolwick S, Cokkinides V. Cigarette Advertising and Female Smoking Prevalence in Spain, 1982-1997: Case Studies in International Tobacco Surveillance. *Cancer*. 2004;100(8):1744-1749.
25. Cordoba R, Villalbi JR, Salvador-Llivina T, Lopez-Garcia Aranda V. El proceso en España de la adopción de una legislación eficaz para la prevención del tabaquismo. *Rev Esp Salud Publica*. 2006;80(6):631-645.
26. Salvador-Llivina T. Condicionantes del consumo de tabaco en España. *Adicciones*. 2004;16(Supl. 2):25-58.
27. Hatziandreu EJ, Pierce JP, Fiore MC, Grise V, Novotny TE, Davis RM. The reliability of self-reported cigarette consumption in the United States. *Am J Public Health*. 1989;79(8):1020-1023.

Figure 1. Estimate of the reconstructed smoking prevalence (1989-2011) and median for the projected prevalence distribution (2012-2025) for men and women in Spain.

Table 1. Estimated smoking prevalence (1989 and 2011) and Annual Percent Changes (APC) (1989-2011) with 95% confidence interval (1989-2011); median for the projected smoking prevalence distribution in 2015, 2020 and 2025 and Annual Percent Change (APC) (2012-2025) with 95% credible interval; WHO target for 2025 and probability (Pr) to achieve the target for men and women in Spain.

		Reconstructed					Projected					WHO Target for 2025	
	Prevalences	1989	2011	APC (95%CI)			2015	2020	2025	APC (2012-2025) (95%CI)		Target	Pr
Men	**Crude**	49.1%	25.7%	1989-1998	-1.96	(-2.32; -1.60)	24.2%	20.9%	18.7%	-2.64	(-3.32; -1.97)	19.0%	0.598
				1998-2009	-3.27	(-3.40; -2.80)	(23.1%; 25.3%)	(19.3%; 22.5%)	(16.7%; 20.9%)				
				2009-2011	-6.11	(-9.80; -2.26)							
	Adjusted	46.0%	27.0%	1989-1999	-1.28	(-1.60; -0.96)	25.1%	21.7%	19.4%	-2.50	(-3.14; -1.87)	20.1%	0.728
				1999-2009	-2.65	(-3.02; -2.28)	(23.9%; 26.3%)	(20.1%; 23.5%)	(17.4%; 21.7%)				
				2009-2011	-6.42	(-10.24; -2.43)							
	15-39	54.9%	30.1%	1989-1999	-1.53	(-1.87; -1.19)	26.4%	22.0%	18.7%	-3.28	(-4.29; -2.31)	22.6%	0.986
				1999-2009	-2.92	(-3.31; -2.53)	(24.6%; 28.2%)	(19.5%; 24.6%)	(15.7%; 22.2%)				
				2009-2011	-6.99	(-11.04; -2.76)							
	40-64	43.8%	30.0%	1989-1999	-0.70	(-1.00; -0.40)	28.5%	25.6%	24.3%	-1.69	(-2.61; -0.84)	21.8%	0.075
				1999-2009	-2.06	(-2.41; -1.71)	(26.8%; 30.2%)	(23.1%; 28.3%)	(20.9%; 28.1%)				
				2009-2011	-4.97	(-8.62; -1.18)							
	65- +	19.9%	10.2%	1989-1998	-1.17	(-2.30; -0.03)	10.3%	8.7%	7.8%	-3.11	(-5.53; 0.10)	6.9%	0.278
				1998-2011	-4.67	(-5.29; -4.04)	(8.8%; 12.1%)	(6.5%; 11.7%)	(5.1%; 12.5%)				
Women	**Crude**	23.4%	17.7%	1989-1999	0.09	(-0.17; 0.34)	19.4%	19.0%	19.2%	-0.36	(-1.02; -0.30)	12.9%	<0.001
				1999-2009	-1.99	(-2.28; -1.70)	(18.5%; 20.3%)	(17.5%; 20.4%)	(17.2%; 21.3%)				
				2009-2011	-4.91	(-7.97; -1.75)							
	Adjusted	24.1%	22.0%	1989-2000	1.46	(1.25; 1.67)	21.6%	20.4%	19.8%	-1.02	(-1.61; -0.47)	16.2%	<0.001
				2000-2009	-1.50	(-1.83; -1.17)	(20.5%; 22.7%)	(18.9%; 22.0%)	(17.9%; 21.9%)				
				2009-2011	-5.83	(-8.69; -2.88)							
	15-39	40.0%	25.7%	1989-1999	0.01	(-0.34; 0.35)	22.8%	18.7%	15.3%	-3.92	(-4.92; -2.96)	19.3%	0.996
				1999-2009	-3.15	(-3.54; -2.76)	(21.1%; 24.5%)	(16.5%; 21.0%)	(12.8%; 18.1%)				
				2009-2011	-6.44	(-10.49; -2.21)							
	40-64	8.1%	23.9%	1989-2000	8.58	(8.36; 8.80)	26.5%	28.8%	32.2%	1.84	(1.06; 2.58)	16.6%	<0.001
				2000-2005	3.30	(2.33; 4.28)	(24.9%; 28.2%)	(26.1%; 31.8%)	(28.2%; 36.6%)				
				2005-2011	0.52	(0.01; 1.02)							

65- +	1.3%	2.3%	1989-2006	3.48	(2.78; 4.19)	2.4%	2.7%	3.2%	2.93	(-0.87; 7.16)	1.5%	0.009
			2006-2011	-1.06	(-5.28; 3.35)	(1.8%; 3.1%)	(1.7%; 4.2%)	(1.7%; 6.1%)				

95% CI: 95% confidence interval for 1989-2011; 95% credible interval for 2012-2025