Tobacco control campaign in Uruguay: a population-based trend analysis

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Summary

Background **In 2005, Uruguay initiated a series of comprehensive anti-smoking measures. We aimed to assess the effect of Uruguay's anti-tobacco campaign.**

Methods **We did a population-based trend analysis, using neighbouring Argentina, which has not instituted such extensive anti-tobacco measures, as a control. We assessed three key endpoints in both countries: per-person consumption of cigarettes, as measured by tax records; the prevalence of tobacco use in adolescents, as measured by school-based surveys; and the prevalence of tobacco use in adults, as measured by nationwide household-based surveys.**

Findings **During 2005–11, per-person consumption of cigarettes in Uruguay decreased by 4·3% per year (95% CI 2·4 to 6·2), whereas per-person consumption in Argentina increased by 0·6% per year (–1·2 to 2·5; p=0·002 for difference in trends). During 2003–09, the 30-day prevalence of tobacco use in Uruguayan students aged 13 years, 15 years, and 17 years decreased by an estimated 8·0% per year (4·5 to 11·6), compared with a decrease of 2·5% annually (0·5 to 4·5) in Argentinian students during 2001–09 (p=0·02 for difference in trends). From 2005 to 2011, the prevalence of current tobacco use in Uruguay decreased annually by an estimated 3·3% (2·4 to 4·1), compared with an annual decrease in Argentina of 1·7% (0·8 to 2·6; p=0·02 for difference in trends).**

Interpretation **Uruguay's comprehensive tobacco-control campaign has been associated with a substantial, unprecedented decrease in tobacco use. Decreases in tobacco use in other low-income and middle-income countries of the magnitude seen in Uruguay would have a substantial effect on the future global burden of tobacco-related diseases.**

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Introduction

80% of tobacco smokers worldwide live in low-income and middle-income countries.[1] As smoking rates in many high-income countries continue to decrease, low-income and middle-income countries have borne an increasingly large share of the worldwide morbidity and mortality burden from tobacco-related disease.[2] In 2001, 70% of the 4·8 million annual smoking deaths and 74% of the 73 million lost disability-adjusted life-years attributable to smoking were in low-income and middle-income countries.[3] If these trends continue, by 2030 such countries will account for a projected 80% of the 8 million annual tobacco-related deaths.[2,4]

Findings from one study[1] suggest that low-income and middle-income countries could avert 115 million smoking-related deaths by 2050 through a combination of tax increases, advertising bans, informational media campaigns, restrictions on smoking in public places, and enhanced tobacco dependence treatments. By 2010, some low-income and middle-income countries had legislated for strong warning labels on tobacco products, restricted smoking in public spaces, and imposed complete bans on tobacco advertising. However, high-income countries as a whole still levied substantially larger tobacco taxes and made substantially greater investments in tobacco dependence treatment, mass media campaigns, and overall spending on tobacco control.[1]

In Uruguay, a middle-income country in South America with 3·5 million inhabitants, smoking has become the main cause of avoidable mortality. In 2004, an estimated 14% of the country's 32 000 deaths were attributable to tobacco use, including passive smoking.[5]

Since 2005, Uruguay has instituted a series of comprehensive anti-smoking measures that have placed the country in the forefront of tobacco control policy worldwide. In response, the tobacco manufacturer Philip Morris International took legal action against Uruguay in 2010, maintaining that the government's 'single presentation' rule—ie, barring the marketing of multiple versions of the same brand, such as Silver, Blue, or Lights—along with its requirement that pictograms with health warnings occupy 80% of both the front and back of every cigarette pack, violated the country's bilateral investment treaty with Switzerland.[6] Similar legal actions have been taken by international tobacco manufacturers against Australia, which has also adopted stringent anti-tobacco measures.[7] As previously noted,[8] such a legal strategy has the potential to reverse many of the tobacco control accomplishments codified in the Framework Convention on Tobacco Control (FCTC), which was originally adopted at WHO's 56th World Health Assembly in May, 2003, and has now been accepted by 174 countries.[9] It also has important implications for global health governance—especially the conflict between health and trade—that go beyond the narrower issue of tobacco control.

Assessment of the effect of Uruguay's tobacco control measures is therefore of crucial importance. Although some reports of individual surveys are available (appendix), no systematic analysis of overall trends in tobacco consumption has been done.

See Online for appendix

Through the sustained efforts of the National Alliance for Tobacco Control to unite the country's public and private institutions, Uruguay ratified the FCTC in September, 2004. Beginning in 2005, the newly elected administration created a National Programme for Tobacco Control within its Ministry of Public Health to serve as the focal point for the implementation of a series of measures codified under the FCTC (appendix). By June, 2009, the government had banned all tobacco advertising and promotion, except at the point of sale, they also banned all tobacco sponsorships, prohibited smoking in all enclosed public spaces and all public and private workplaces, necessitated primary health-care providers to offer free diagnosis and treatment of tobacco dependence according to nationally established clinical norms, mandated that pictograms with health warnings cover 80% of the front and back of all cigarette packs, outlawed such terms as light, mild, and low in tar, and restricted all brands to a single presentation. After a series of tax increases, the real consumer price of a pack of cigarettes increased by 88% from January, 2003, to December, 2010 (appendix).

In this paper, we report on a series of population trend analyses in Uruguay, and compare them with trends in neighbouring Argentina.

Methods

Main endpoints

We focused on three main endpoints: tobacco consumption per person, the prevalence of adolescent smoking, and the prevalence of tobacco use in adults. We chose the middle-income country Argentina for comparison not only because of its geographical proximity and common language and culture, but also because Argentina did not enact comprehensive nationwide anti-tobacco legislation until June, 2011,[10] and has still not ratified the FCTC.[9] In 2003, an estimated 15% of the country's 274 000 deaths in people aged 35 years or older were attributable to tobacco use.[11] In both Uruguay and Argentina, the economic effect of smoking-related diseases, including lost productivity and health-care costs, has been about 1% of gross domestic product.[11,12]

Data sources

For both Uruguay and Argentina, we calculated per-person consumption as the number of cigarettes taxed (whether manufactured domestically or imported) divided by the number of people aged 15 years or older during each year from 2000 to 2011 (appendix).

For surveys of adolescent tobacco use in Uruguay, we used a series of four nationally representative surveys of drug use in the middle-school and upper-school grades, corresponding to ages 13 years, 15 years, and 17 years (see appendix for all survey data sources and sample sizes). Done at 2-year intervals from 2003 through 2009, the surveys were based on self-reported use as elicited in questionnaires administered in the classroom. Each survey asked the same questions about current tobacco use, including any use within the previous 30 days. Each survey also used the same two-stage sampling design, based on classes sampled within schools. In Argentina, we used a series of four equivalent nationally representative surveys of drug use in the same grades and age groups, using a similar two-stage sampling design, and asking the same questions about 30-day tobacco use, with questionnaires administered in the classrooms in 2001, 2005, 2007, and 2009 (appendix).

For surveys of adult tobacco use in Uruguay, we obtained the underlying data from six nationwide household-based population surveys of adult smoking practices covering the period 1998–2011. These surveys differed with respect to the age range of respondents, coverage of rural areas, and the wording of questions about current tobacco use. All surveys used a similar multi-stage design, based on census units within larger census sections within each of the country's 19 departments (called departamentos). To make consistent comparisons of prevalence across surveys in Uruguay, we restricted the sample within each survey to respondents aged 15–64 years who lived in localities with at least 5000 inhabitants, with the exception of a 2006 survey designed by the Junta Nacional de Drogas (JND), which covered localities with at least 10 000 inhabitants. On the basis of data from the 2011 survey by the Instituto Nacional de Estadística (INE), we estimated that current tobacco users within our restricted sample of individuals aged 15–64 years living in localities with 5000 or more inhabitants constituted 85% of all tobacco users aged 15 years or older nationwide.

When determining the level of current tobacco use in Uruguay, we included smokers of hand-rolled cigarettes (cigarrillos armados a mano), non-cigarette tobacco, and manufactured cigarettes. Within our restricted sample, roughly 87% of current tobacco users smoked manufactured cigarettes, 99% of current tobacco users smoked manufactured cigarettes, hand-rolled cigarettes, or both. We defined current smokers as individuals who reported that they had smoked during the past 30 days or smoked every day or some days (appendix). We defined daily smokers as individuals who responded that they smoked daily or who reported smoking on average at least once a day. In view of these definitions, we had five datapoints for the prevalence of current tobacco use (1998, 2001, 2006, 2009, 2011), and four datapoints for the prevalence of daily tobacco use in Uruguay (2001, 2006, 2009, 2011).

For Argentina, we obtained the underlying data from three nationwide household-based population surveys of risk factors for non-transmissible chronic diseases, covering individuals who lived in localities of 5000 or more inhabitants, done in 2001, 2005, and 2009. These surveys also used a multi-stage sampling design based on the country's political and administrative hierarchy of census units within its 24 provinces. To approximate the same age range as our survey data from Uruguay, we restricted our analyses of each of these three Argentinian risk-factor surveys to respondents aged 18–64 years. In alternative sensitivity analyses, however, we also considered an unrestricted sample of respondents aged 18 years or older. We supplemented these three micro-databases with a summary report of four nationwide surveys of drug use in individuals aged 16–65 years living in urban areas with 80 000 or more inhabitants, done in 2004, 2006, 2008, and 2010 (appendix).

In our analyses of the micro-data from the 2001 Argentinian risk-factor survey, we defined a current smoker as an individual who responded as saying that he or she smokes occasionally or who reported a specific number of cigarettes when asked how many cigarettes he or she regularly smokes every day. For the 2005 and 2009 Argentinian risk-factor surveys, we defined a current smoker as an individual who said that he or she smokes some days or every day when asked whether they currently smoke. In the four nationwide drug-use surveys, current tobacco use was based on consumption reported in the previous 30 days. Therefore, for Argentina, we had seven datapoints for the prevalence of current tobacco use (2001, 2004–2006, 2008–2010) and three datapoints for the prevalence of daily tobacco use (2001, 2005, 2009).

Statistical analysis

For both adolescents and adults, we explicitly accounted for design effects arising from multi-stage surveys in our computation of 95% CIs around our point estimates of the prevalence of tobacco use. To assess relative changes in tobacco use in Uruguay and Argentina, we did log-linear regression analyses on each of our three outcome measures—per person consumption, adolescent prevalence, and adult prevalence—testing whether the post-2005 trend in Uruguay differed from the corresponding trend in Argentina. Accordingly, we used logarithmic scales in our graphical plots of changes in these endpoints over time. In separate analyses of current and daily tobacco use in adults, we also compared the absolute change from 2001 to 2009 in Uruguay with the corresponding absolute change from 2001 to 2009 in Argentina. Although the latter approach did not take advantage of all of the survey information available, it avoided the assumption that any specific year was the starting point for the hypothesised divergence in prevalence trends between the two countries.

Role of the funding source

The sponsor of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

During 2005–2011, per person (aged ≥15 years) consumption in Uruguay decreased at an estimated annual rate of 4·3% (95% CI 2·4 to 6·2), whereas per-person consumption in Argentina increased by 0·6% annually (–1·2 to 2·5; p=0·002 for difference in trends between countries; figure 1). A sensitivity analysis showed that with the inclusion of auto-correlated residuals our log-linear regression model increased the estimated downward trend for Uruguay to 5·2% (2·4 to 7·9), with an estimated autocorrelation coefficient of 0·17.

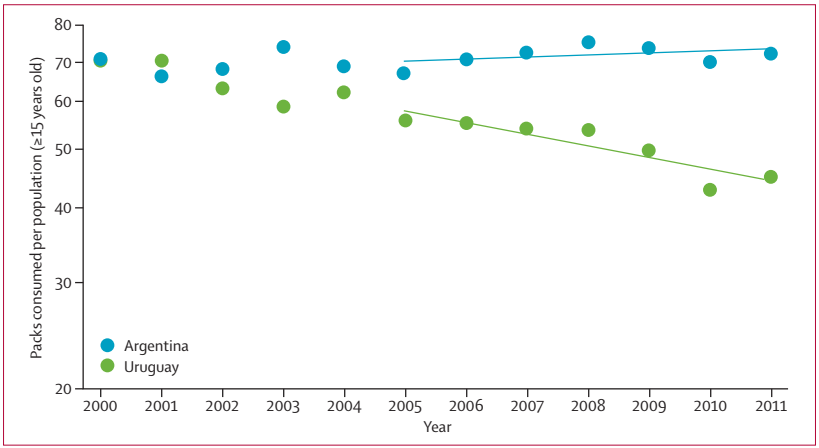

Figure 1: **Annual consumption of cigarettes per person aged 15 years or older in Uruguay and Argentina, 2000–11**
The fitted lines show the trends in per person consumption from 2005 onward, based on our log-linear regression analysis.

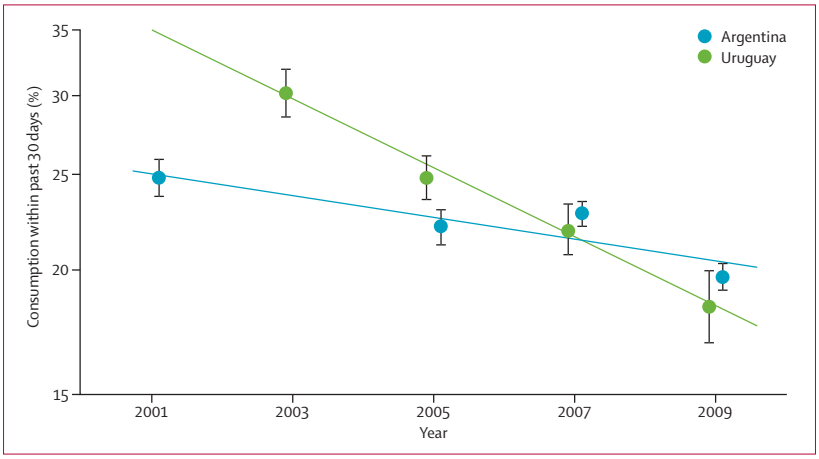

Figure 2: **30-day prevalence of tobacco use in school students in Uruguay and Argentina**
Error bars are 95% CIs around each survey estimate (dots). The lines show the estimated trends in prevalence in each country.

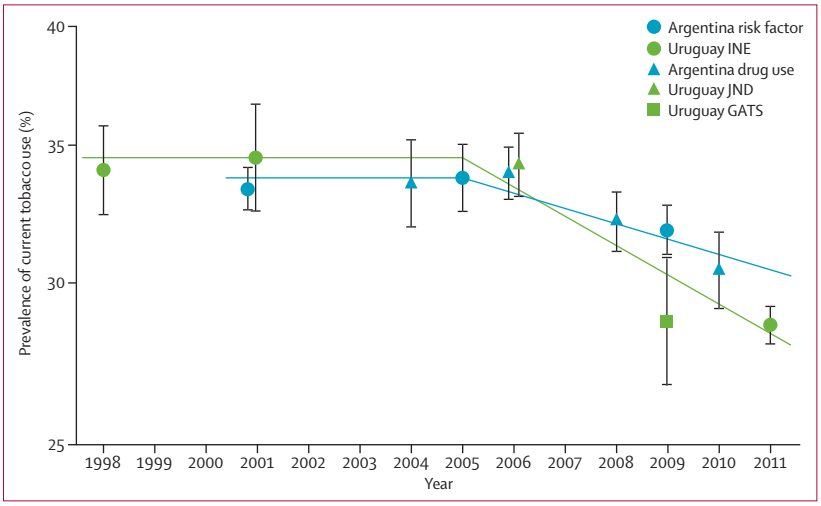

Figure 3: **Prevalence of current tobacco use in Uruguay and Argentina**
Error bars are 95% CIs around each survey estimate (dots). The lines show the estimated trends in prevalence in each country. GATS=Global Adult Tobacco Survey. INE=Instituto Nacional de Estadística. JND=Junta Nacional de Drogas.

The 30-day tobacco-use prevalence in surveyed students decreased in Uruguay from 24·8% (23·5–26·1) in 2005 to 18·4% (16·8–19·9) in 2009, whereas the corresponding prevalence in Argentina decreased from 22·1% (21·2–23·0) in 2005 to 19·7% (19·1–20·3) in 2009 (figure 2). On the basis of log-linear regression analysis, we estimated that adolescent tobacco use in Uruguay decreased by 8·0% annually (4·5 to 11·6); the corresponding annual rate of decrease in Argentina was 2·5% (0·5 to 4·5; p=0·02 for difference in trends between countries).

Sensitivity analysis showed that female Uruguayan students had a persistently higher prevalence of tobacco use than their male classmates (female-to-male prevalence ratio=1·32 [95% CI 1·24 to 1·39]; p=0·002). However, the annual proportional decrease in tobacco-use prevalence in female Uruguayan students was indistinguishable from that in male students (p=0·704). In Argentina, female and male students had statistically indistinguishable tobacco-use prevalence (p=0·72) and indistinguishable rates of decrease in prevalence (p=0·51).

	Uruguay	Argentina
Current tobacco use (95% CI)		
2001	34·5% (32·4–36·6)	33·3% (32·5–34·1)
2009	28·7% (26·6–30·8)	31·8% (30·9–32·7)
Total decrease	5·8% (2·9–8·7)	1·5% (0·3–2·7)
Daily tobacco use (95% CI)		
2001	31·2% (29·2–33·3)	26·8% (26·0–27·5)
2009	23·4% (21·7–25·1)	23·6% (22·8–24·4)
Total decrease	7·9% (5·3–10·5)	3·2% (2·1–4·2)

In both countries, the survey population was restricted to individuals living in localities with populations larger than 5000.

Table: **Current and daily prevalence of tobacco use in individuals aged 15–64 years in Uruguay and 18–64 years in Argentina, 2001–09**

We detected no trends in the prevalence of tobacco use in adults before 2005. After 2005, log-linear regression analysis gave an annual rate of decrease of 3·3% (2·4–4·1) in Uruguay, which was a bigger decrease than the annual rate in Argentina (1·7% [0·8–2·6]; p=0·02 for difference in trends between countries; figure 3).

Figure 3 shows only a single trend-line for all datapoints from Argentina, without distinguishing the Argentinian drug-use surveys from the Argentinian risk-factor surveys. Our sensitivity analyses showed that the fixed effect of Argentinian drug-use surveys versus the Argentinian risk-factor surveys was not statistically different from zero (p=0·8), whereas the difference between Uruguay and Argentina in post-2005 trends remained statistically significant (p=0·03). We also recorded similar differences in the post-2005 rate of decrease in prevalence when we substituted data for individuals aged 18 years or older in the Argentinian risk-factor surveys.

Between 2001 and 2009, the prevalence of current smoking in Uruguay decreased by a greater extent than it did in Argentina (p=0·007; table). During the same period, the prevalence of daily smoking also reduced to a greater extent in Uruguay than it did in Argentina (p=0·001; table). In sensitivity analyses, however, the prevalence of current smoking in Uruguayan men decreased by 6·7 percentage points (2·5 to 10·9) from 2001 to 2009, and corresponding prevalence in Argentinian men decreased by 3·2 percentage points (1·5 to 5·0), but the difference was not statistically significant (p=0·13). Sensitivity analyses also showed that the prevalence of current smoking in Uruguayan women decreased by 3·5 percentage points (7·1 decrease to 0·2 increase) from 2001 to 2009, and the corresponding prevalence in Argentinian women increased by 0·1 percentage points (1·4 decrease to 1·6 increase), but the difference was not statistically significant (p=0·08).

Discussion

All three of our endpoints—per person consumption, adolescent prevalence, and adult prevalence—showed consistent decreases in smoking in Uruguay since the country initiated a comprehensive tobacco control programme in 2005. During 2005–11, per person consumption in Uruguay decreased in relative terms by an estimated 4·3% annually (equivalent, with annual compounding, to 23% over 6 years), whereas per person consumption in Argentina changed very little. During 2003–09, the 30-day prevalence of tobacco use in Uruguayan students aged 13 years, 15 years, and 17 years decreased by an estimated 8·0% annually, compared with a rate of decrease of 2·5% annually in Argentinian students during 2001–09. From 2005 to 2011, the prevalence of current tobacco use in Uruguay decreased

by an estimated 3·3% annually, compared with 1·7% annually in Argentina during the same period. Comparisons of both current and daily tobacco use restricted solely to surveys done between 2001 and 2009 confirmed substantially larger decreases in Uruguay than in Argentina.

Our study had several limitations. The neighbouring country of Argentina is clearly not the perfect comparison group. Although the nation as a whole did not adopt comprehensive tobacco control measures until 2011, in 2005, the city of Buenos Aires restricted tobacco advertising in government buildings,[13] and several provinces banned smoking in enclosed public spaces since then. These measures, in combination with cigarette tax increases and long-term decreases in the social acceptability of smoking, might have caused the downward trends in adult and adolescent smoking in Argentina seen in this study. If so, then our results measure the effect of Uruguay's more comprehensive programme of tobacco control against the background trends seen in Argentina, which had a more limited programme. We chose not to compare trends in Uruguay with those in Brazil (another neighbouring country) because, since 2003, Brazil has adopted several tobacco control measures, including tax increases, mandated pictograms with health warnings on all cigarette packs, and free access to tobacco dependence treatment.[14,15]

Our analysis of trends in per person consumption was restricted to cigarettes that were subject to taxation and thus did not take into account possible changes in the volume of contraband cigarettes. While contraband sales have been estimated as constituting about 7% of total sales in Uruguay[12] and about 11% of total sales in Argentina,[16] we have identified no reliable data for contraband sales trends. The apparent stagnation of per person consumption in Argentina (figure 1), by contrast with the estimated 10% relative decrease in adult smoking prevalence during 2005–2011 (figure 3), could be caused by the displacement of illegal contraband by increased sales of low-priced legal cigarettes. With respect to Uruguay, however, we note that the relative decrease in per person consumption was similar to the relative decrease in the prevalence of daily tobacco use. Particularly, during 2001–09, per person consumption in Uruguay decreased from 70·2 to 49·7 packs (of 20 cigarettes) per population aged 15 years or older (figure 1), a relative change of 29·2%. Concurrently, the prevalence of daily tobacco use decreased from 31·2% to 23·4% (table), a relative decrease of 25·3%.

Although the 30-day prevalence of tobacco use in middle-school and high-school students decreased more than twice as rapidly in Uruguay as in Argentina, school-based surveys have potential biases of under-reporting because of absenteeism. The available data, however, indicate that both countries had about the same attendance rates.[17] The possibility that Uruguay's school-based surveys were biased by increased underreporting of substance misuse during 2003–09 is belied by the finding that there were no concomitant decreases in students' reported consumption of alcohol, cocaine, or marijuana (appendix). Other school-based surveys, including the Global Youth Tobacco Surveys (GYTS), reported trends in tobacco-use prevalence during 2000–07, but GYTS excluded adolescents older than 15 years, and its coverage of Argentina was restricted solely to the city of Buenos Aires.[18]

To compare surveys with the same age ranges and levels of urbanisation, we restricted our study of tobacco-use prevalence in Uruguay to the population aged 15–64 years living in localities with at least 5000 inhabitants. This restricted population, we have estimated, constituted 85% of all tobacco users aged 15 years or more nationwide. Nonetheless, there was substantial heterogeneity in survey design. In particular, the JND 2006 survey, which covered only urban localities with 10 000 or more inhabitants, is likely to have a substantial upward bias, inasmuch as tobacco use prevalence in Uruguay has an increasing gradient in relation to urbanisation, as shown in our analyses of data from the INE 2011 survey.

Substantial heterogeneity in survey design was also evident in our study of tobacco-use prevalence in Argentina. We specifically excluded a 1999 nationwide survey of drug use in individuals aged 16–65 years because it covered only individuals living in urban areas with 100 000 or more inhabitants,[19] whereas all datapoints included in figure 3 were surveys of individuals living in areas with 80 000 or more inhabitants. In reports of the Argentinian risk-factor surveys of 2005 and 2009,[20] individuals who reported to have smoked fewer than 100 cigarettes in their lifetime were not counted as current smokers, even if they also reported currently smoking some days or every day. To ensure compatibility with prevalence estimates from the risk-factor survey of 2001,[21] we counted such individuals as current smokers. To address these issues of survey heterogeneity, and to increase the statistical power of analyses of prevalence trends in age-specific and sex-specific population subgroups, statistical methods for combining diverse survey data sources will be needed.[22]

We computed absolute changes in current and daily tobacco-use prevalence between 2001 and 2009 in both countries. The measurement of daily prevalence is prone to potential errors in misclassification between daily and occasional tobacco use. The 2009 surveys in both countries asked respondents whether they smoked every day ("todos los días"), some days ("algunos días"), or not at all ("no fuma"). By contrast with the 2009 surveys, the 2001 surveys in both countries asked each respondent the last time he or she smoked and, if within 30 days, how many cigarettes he or she smoked daily (in Uruguay, "¿Habitualmente, cuántos cigarrillos fuma diariamente?"; in Argentina, "Cantidad diaria de cigarrillos que fuma"). The fact that daily prevalence decreased more than

***Panel:* Research in context**

Systematic review

We systematically reviewed studies of the effect of national tobacco control policies, focusing on studies of middle-income and low-income countries published in peer-reviewed journals since 1990. We searched the tables of contents of major journals in the fields of public health, health policy, and tobacco control, as well as citations within all relevant articles. There were no restrictions on language. We assessed whether each study comprehensively assessed all three key dimensions of tobacco use: per head consumption, prevalence of adult tobacco use, and prevalence of adolescent tobacco use. We assessed the quality of studies on the basis of whether each study had precisely defined the intervention, including its intensity and duration, whether there was adequate pre-intervention and post-intervention observation, and whether a control or comparison group had been included. We assessed studies on the basis of whether a study had carefully considered potential confounders, and whether formal statistical tests were done. For tobacco-use prevalence, we assessed whether each study had adequately addressed potential incompatibilities between surveys and whether the computation of CIs took account of complex survey design. No previous studies of low-income or middle-income countries met all of the above assessment criteria.

Interpretation

Our study of Uruguay seems to be the first rigorous assessment of the effect of national tobacco control policies in a low-income or middle-income country that comprehensively assesses all three key dimensions of tobacco use, includes sufficient annual datapoints to draw reliable statistical inferences, adequately addresses incompatibilities between surveys, precisely specifies the interventions under study, includes data for before and after intervention, and incorporates a control group. To our knowledge, no other rigorous study of low-income or middle-income countries has reliably shown nationwide decreases in all three major dimensions of tobacco use of the magnitude reported here for Uruguay.

current prevalence might be an artifact of differences in the wording of survey questions, rather than a genuine shift of some daily smokers to occasional use.

Finally, 2001 was arguably not an appropriate baseline year for comparison, because Argentina had a severe financial crisis that spread in part to Uruguay. Although per head consumption did decrease in Argentina in 2001 (figure 1), our comparisons between 2001 and 2009 are consistent with our statistical analyses of trends after 2005.

Despite these limitations, the three key endpoints in our study show consistent decreases in tobacco use that occurred at the same time as Uruguay's comprehensive anti-tobacco programme. The population trends reported here are also consistent with the results of a 2008 nationwide study of the 7-day prevalence of tobacco use in Uruguayans aged 15 years or older,[23] as well as a preliminary report of a 16% quit rate during 2006–08 in a cohort of current smokers surveyed in Montevideo, Uruguay.[24] After Uruguay banned smoking in all enclosed public spaces and workplaces in March, 2006, air nicotine concentrations and hospital admissions for acute myocardial infarction decreased substantially.[25,26] Further studies will be needed to assess the effect of Uruguay's anti-tobacco campaign on other endpoints, such as measures of awareness of health risks.

Although we have recorded a substantial decrease in tobacco use in Uruguay—especially in adolescents—our analysis here does not inform us as to the quantitative contribution of each of the many tobacco control measures that the country has adopted. Tax increases enacted by the Uruguayan government undoubtedly played a part in this decrease. Although price has been an important factor in both high-income countries and low-income countries,[1,27] data for the quantitative effect of price increases in middle-income countries are not uniformly consistent.[28,29] On the basis of each government's official statistics on nominal cigarette prices and the general consumer price index from 2001–10 (appendix), real cigarette prices in both Uruguay and Argentina reached a low point in January, 2003. From that point until December, 2010, the real price increase was 88% in Uruguay, as compared with an increase of 119% in Argentina.This finding is consistent with evidence that price increases have a larger deterrent effect when combined with other tobacco-control measures.[30] Synergistic effects of multiple tobacco-control policies might be particularly important in the reduction of adolescent smoking.

Uruguay's tobacco control programme included unprecedented requirements that pictograms with health warnings cover 80% of the front and back of all cigarette packs, and that all brands be restricted to a single presentation. Findings from several studies point to the importance of such tobacco-control measures as the placement of prominent pictorial warnings on cigarette packs and the elimination not only of such descriptors as "light" and "mild," but also of any other design features that might falsely imply reduced risk.[31,32]

The potential for synergies between multiple tobacco-control measures goes directly to the issue of external generalisability. During 2005–09, Uruguay adopted a comprehensive programme of multiple tobacco control measures: a near-complete ban on advertising and promotion, the banning of smoking in enclosed public spaces and workplaces, the requirement that healthcare providers treat nicotine dependence, a rule that pictograms with warnings cover 80% of the front and back of every pack, the banning of misleading terms such as "light" and "mild", the restriction of all brands to a single presentation, as well as a substantial increase in tobacco taxes. The results reported here inform us as to the effect of Uruguay's tobacco control programme as a whole.

We are unaware of any rigorous study in any country—particularly in any low-income or middle-income country—that has reliably shown nationwide decreases in all three major dimensions of tobacco use of the magnitude reported here for Uruguay (panel). An analysis of the Massachusetts tobacco control programme, which combined a mass media campaign with tax increases and other measures, showed an annual rate of decrease in adult smoking prevalence during 1989–99 of about 1·8%.[30] In the American Stop Smoking Intervention

Study (ASSIST) in the USA during 1993–99, the proportional annual decrease in adult smoking prevalence in 17 intervention states was 2·1%, compared with 1·5% annually in 34 control states.[33] In Australia, another high-income country with a history of strict tobacco control measures, adult smoking prevalence decreased during 2001–07 at an annual rate of 1·3%,[34] whereas adolescent prevalence decreased during 1990–2005 at a rate of about 3·6% annually.[35]

For Brazil, a middle-income country, two-point comparisons of adult prevalence between 1989 and 2003[14] and between 1989 and 2008[15] yielded average annual rates of decrease of 3·1% and 3·3%, respectively, whereas in a two-point comparison of students aged 11–18 years in ten Brazilian provincial capitals between 1997 and 2004, lifetime cigarette use decreased at an average annual rate of 3·8%.[36] These studies, however, did not identify the effect of the tobacco control campaign initiated by Brazil in 2003. Nor did they compare Brazil with a suitable control country, such as Argentina, as we have done here.

Uruguay's campaign of increasingly comprehensive anti-smoking measures, which has placed the country in the forefront of tobacco control policy worldwide, has been associated with a substantial decline in tobacco use.

A sustained tobacco control programme similar to Uruguay's is likely to have a similarly large effect on smoking rates in other low-income and middle-income countries.[2] Decreases in tobacco use of the magnitude seen in Uruguay (about 23% over 6 years) would have a substantial effect on the future worldwide burden of tobacco-related diseases.[1]

Contributors

All authors contributed substantially to the design of this study, the analysis and interpretation of the data, and the drafting of the paper, and approved the final version of the paper. In particular, WA, EE, BG, AL, and AS contributed to the design of the study. WA, EE, FGM, and PT led the collection of micro-data from surveys in Uruguay; JEH obtained additional micro-data from surveys in Argentina. BG, FGM, and AS did preliminary statistical analyses on micro-data from Uruguay; JEH and PT did the final statistical analyses on data for both countries. JEH and PT wrote the initial drafts; WA, EE, BG, FGM, AL, and AS made substantive changes to drafts of the paper.

Conflicts of interest

JEH has served as a compensated expert witness on behalf of plaintiffs in tobacco-related litigation other than the cited lawsuit brought by Philip Morris International against Uruguay. All other authors declare that they have no conflicts of interest.

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Tobacco control: learning from Uruguay

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In *The Lancet*, Winston Abascal and colleagues present findings from their population-based trend analysis, which show a clear decrease in the prevalence of smoking in Uruguay between 2005 and 2011.[1] They associate this decrease with the far-reaching tobacco control campaign launched in the country in 2005. The campaign included actions such as the banning of tobacco advertising, the banning of smoking in all enclosed public spaces, tax increases, and legislation requiring that pictograms with health warnings cover 80% of both the front and back of every cigarette pack. They recorded annual decreases in all three selected indicators: a 4·3% (95% CI 2·4–6·2) decrease in per-person tobacco consumption, an 8·0% (4·5–11·6) decrease in adolescent smoking prevalence, and a 3·3% (2·4–4·1) decrease in adult tobacco-use prevalence. For all three indicators, recorded decreases were much larger in Uruguay than they were in Argentina, the country the investigators chose as a control. These findings confirm the outstanding and consistent progress made by Uruguay's anti-tobacco policy.

Abascal and colleagues' study reinforces two important factors for tobacco control. The first is the effect of the international initiative culminating in the Framework Convention on Tobacco Control (FCTC),[2] which has been ratified by 175 countries.[3] The second is the need to use evidence-based approaches, as done in their study, to assess tobacco-control actions.

The number of studies assessing anti-tobacco policies is increasing, and a review of 50 studies concluded that there is consistent evidence that smoking bans reduced exposure to second-hand smoke in public places.[4] Research is also playing an important part in the improvement of tobacco control policies.[5] In particular, epidemiological studies have been useful in measuring the results of legislative and regulatory policies to prevent the initiation of smoking, to support individuals who have stopped smoking, and to protect the general population against exposure to environmental tobacco smoke. A comprehensive analysis of time trends is essential to understand the consequences of preventing health problems in any population.

Argentina was chosen as a control by Abascal and colleagues because Uruguay and Argentina share many geographical and cultural characteristics, although the FCTC has not been ratified in Argentina. As the investigators discuss, Argentina is not a perfect comparator because, despite the FCTC not being ratified, restrictive actions such as the banning of tobacco advertising in government buildings have been implemented in Buenos Aires and in several provinces since 2005. However, global communication of the risks and harms of tobacco smoking make the selection of a perfect comparator—ie, a similar country with no anti-smoking activities—very difficult, if not impossible.

A pertinent question is whether Uruguay's tobacco control campaign would be as successful in countries in the region that have lower levels of education and literacy. Uruguay and Argentina, along with Chile, have the highest inequality-adjusted educational indices in Latin America (>0·681), but such educational indices are much lower in other countries such as Venezuela (0·567) and Brazil (0·492).[6] Abascal and colleagues point out that they are unaware of another rigorous study in any country that has shown nationwide decreases in all three indicators to the extent seen in Uruguay. In reference to Brazil, they state that existing studies have failed to show the effect of an aggressive anti-tobacco campaign started in Brazil in 2003. However, they do not mention that Brazil has had a long history of tobacco control measures dating back to the late 1990s.[7] Despite being one of the largest tobacco exporters in the world, data from two nationwide surveys show that the prevalence of adult smoking in Brazil decreased from 35% in 1989

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to 22% in 2003 (a 36% decrease in 14 years).[8] In 2008, the prevalence of smokers aged 18 years or older was 18% (a further decrease of 19% in 5 years).[9] Considering that Brazil has more than 190 million inhabitants and tremendous social inequality, the anti-tobacco measures achieved substantial success, and might have contributed to the recorded decrease of 20% in age-adjusted mortality of non-communicable diseases from 1996 to 2007.[10]

With the exception of African countries, the prevalence of smoking in Brazil is among the lowest in the world.[2] However, smoking is more common in individuals with lower levels of education (26% in individuals with less than 1 year of schooling *vs* 12% in individuals with more than 10 years of schooling).[9] Abascal and colleagues fault Brazilian studies for not comparing their findings with those from any other country. However, finding a country with cultural, social, and economic characteristics similar to Brazil's would be impossible. We therefore think that the appropriate way to assess the effect of tobacco control in Brazil should be based on internal comparisons, aimed at improving effective strategies to reduce the gap in smoking prevalence related to social inequalities.[11]

Uruguay and other countries in Latin America, such as Brazil, Mexico, Panama, Colombia, and Peru, are implementing the FCTC, but much remains to be done in these countries—eg, the raising of tobacco taxes and enhancing dependence treatment programmes. Because of the large social inequalities in some of these countries, any anti-tobacco strategies must effectively reach the lower socioeconomic strata of the population.

The challenges to reduce the number of smokers are enormous, but great obstacles have already been overcome. Anti-smoking measures are proving to be socially and culturally well received by the general population,[2,12] whose acceptance is crucial to ensure the sustainability of efforts to control tobacco use.

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We declare that we have no conflicts of interest.

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