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Vulnerable populations and tobacco control in Latin America

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy in

in

Public Health (Epidemiology)

by

Pedro Kremer

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2021

The dissertation of Pedro Kremer is approved, and it is acceptable in quality and form for publication on microfilm and electronically.

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2021

DEDICATION

This dissertation is dedicated to those who guided me, loved me, and supported me all my life, Diana and Isaias Kremer, to those who taught me that the most beautiful friendship begins at home, Jonathan and Raul Kremer, to those who gave me purpose and pushed me to be a better human being every day of their lives, Lucy and Manu Kremer, and to the one that forever changed my understanding of the world, Rebeka.

TABLE OF CONTENTS

DISSERTATION APPROVAL PAGE	iii
DEDICATION	iv
TABLE OF CONTENTS	v
LIST OF FIGURES.....	ix
LIST OF TABLES.....	xi
ACKNOWLEDGEMENTS.....	xiv
VITA.....	xv
ABSTRACT OF THE DISSERTATION	xvii
Chapter 1 – Overall Introduction	1
Global and Latin American burden of tobacco.....	1
Contextualization of the tobacco epidemic.....	3
Tobacco and sex	5
Tobacco and age (Aim 1).....	7
Tobacco and SES with a focus on income	9
The case of Mexico (Aim 2)	11
The WHO Framework Convention on Tobacco Control and tobacco control policies	12

The case of Uruguay (Aim 3).....	15
Addressed gaps in the literature	16
References - Introduction.....	19
Chapter 1 Acknowledgements.....	21
Chapter 2 - Aim 1 - Trends and decomposition of sex gaps in tobacco smoking among the youth in Latin America.....	22
Abstract.....	22
Introduction.....	24
Methods	26
Results	29
Discussion	36
References – Aim 1.....	40
Chapter 2 Acknowledgements.....	43
Supplemental Material - Aim 1	44
Chapter 3 - Aim 2 – Sex-specific trends in smoking prevalence across income categories during periods of changing cigarette prices in Mexico between 2000 and 2018.....	54
Abstract.....	54

Introduction	56
Methods	59
Results	61
Discussion	65
References - Aim 2.....	68
Chapter 3 Acknowledgements.....	69
Chapter 4 - Aim 3 - Impact of Uruguay’s comprehensive tobacco control policy on smoking among the youth.....	70
Abstract	70
Introduction	72
Methods	74
Results	76
Discussion	78
References - Aim 3.....	81
Chapter 4 Acknowledgements.....	82
Chapter 5 - Overall Conclusions	83
Overview	83

Recommendations for future research.....	85
Recommendations for policy	89
Limitations.....	91
Conclusion	94
References – Conclusions	96
Chapter 5 Acknowledgements.....	98

LIST OF FIGURES

Figure 1-1 Smoking prevalence among women and men in Latin America. General population. 2015 or latest available data	2
Figure 1-2 Tobacco Epidemic Curve	5
Figure 1-3 Prevalence of Daily Tobacco Smoking by Income group and income quintile	10
Figure 1-4 Status of implementation of the MPOWER measures in Latin America - 2016	15
Figure 2-1 Adjusted risks for smoking susceptibility among male adolescents as compare to females in Latin America (1999-20016)	33
Figure 2-2 Adjusted risks for smoking prevalence among male adolescents as compare to females in Latin America (1999-20016)	33
Figure 2-3 Marginal risk ratios for boys' smoking susceptibility in selected Latin American Countries (1999-2016)	44
Figure 2-4 Marginal risk ratios for boys' smoking prevalence in selected Latin American Countries (1999-2016)	45
Figure 2-5 Trends in smoking susceptibility for boys and girls in eleven Latin American Countries (1999-2016)	52
Figure 2-6 Trends in smoking susceptibility for boys and girls in eleven Latin American Countries (1999-2016)	53

Figure 3-1 Nominal and inflation adjusted cigarettes price in Mexico between 2000 and 2018.....	62
Figure 3-2 Changes in smoking prevalence by sex across taxation phases in Mexico ..	63
Figure 3-3 Changes in income inequalities among smoking men and women adults in Mexico across two cigarette taxation phases, by Federative Entity	65
Figure 4-1 Unadjusted trends in smoking among youth between 1999 and 2016 in Uruguay and Argentina	77

LIST OF TABLES

Table 2-1 Descriptive statistics across sex and time period for selected countries in Latin America (1999-2016).....	30
Table 2-2 Crude and adjusted associations between male sex and (1) smoking susceptibility, and (2) smoking prevalence among adolescents in selected Latin American countries (1999-2016	31
Table 2-3 Crude and adjusted associations between male sex for smoking susceptibility and smoking prevalence among adolescents in selected Latin American countries (1999-2016)	32
Table 2-4 Means of smoking susceptibility and smoking prevalence among boys and girls, and percentage of the difference explained by age, economic resources, and behavioral/environmental variables in Latin America (1999-2016).....	34
Table 2-5 Means of smoking susceptibility and smoking prevalence among boys and girls, and percentage of the difference explained by age, resources and behavioral/environmental variables in groups of human development index countries in Latin America (1999-2016).....	36
Table 2-6 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Argentina	46
Table 2-7 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Belize.....	46
Table 2-8 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Chile	47

Table 2-9 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Costa Rica	47
Table 2-10 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Cuba	48
Table 2-11 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for El Salvador	48
Table 2-12 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Guyana	49
Table 2-13 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Panama	49
Table 2-14 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Paraguay	50
Table 2-15 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Suriname	50
Table 2-16 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Uruguay	51
Table 3-1 Smoking prevalence in Mexico between 2000 and 2018 by sex and across income quintiles	62
Table 3-2 Relative and absolute income inequality indices on smoking prevalence across taxation phases for men and women in Mexico*	64

Table 4-1 Description of the youth population in Uruguay and Argentina with regards to tobacco habits, information, and perceptions 77

Table 4-2 Results of the Difference-in-Differences models for the effect of the tobacco policy in Uruguay..... 78

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The dissertation author was the primary investigator and author of all chapters.

Chapters 1 and 5 were co-authored with Professors Tarik Benmarhnia and Gail Laughlin.

Chapter 2 and 4 were the result of intense collaboration between Professors Tarik Benmarhnia, Gail Laughlin, Caroline Thompson, and Eyal Oren, and are under review for publication, Chapter 2 is under review for publication in a peer-review journal, and Chapter 4 is being prepared for submission.

Chapter 3 has been submitted for publication and was co-authored with Professors Tarik Benmarhnia and Gail Laughlin.

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Kremer P, Pinedo, M., Ferraiolo, N. et al. *Tattoo Removal as a Resettlement Service to Reduce Incarceration Among Vulnerable Mexican Migrants*. *J Immigrant Minority Health*. 22;110–119 (2019).

Kremer P, Ulibarri M, Ojeda V, et al. *Adverse Childhood Experiences Are Associated with Depression in Adult Latinos Residing in Tijuana, Mexico*. *Kaiser Permanente Journal*, 23;18 (2019)

Kremer P, Pisani O, Nasini S, et al. *Factors Conditioning the Selection and Permanence in Family Medicine as a Medical Practice. A Multicentric Study in Four Argentinean Provinces*. *Argentinean Journal of Public Health*. 214;5(21):30-37 [in Spanish] (2014).

Maceira D, Kremer P, *Strengthening Delivery Networks at the Third Level of Healthcare. Lessons from the Argentinean Case*. *Medicine and Society*. Vol 32, p 10-30 [in Spanish] (2012).

ABSTRACT OF THE DISSERTATION

Vulnerable populations and tobacco control in Latin America

by

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Doctor of Philosophy in Public Health (Epidemiology)

University of California San Diego, 2021

San Diego State University, 2021

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Tobacco is responsible for over 7 million deaths every year. Various policies through the WHO Framework Convention on Tobacco Control contributed to reduce the burden of tobacco consumption with important heterogeneity across regions and population subgroups. Latin America is the most unequal region in the world, where health, social, and economic disparities likely result in a differential impact of tobacco

control policies between and within countries. This dissertation explores the trends in tobacco smoking in Latin America from a multi-country perspective as well as through country specific analyses. Specifically, we analyzed trends in income inequalities regarding smoking in Mexico and evaluated the effectiveness of a comprehensive tobacco control policy implemented in Uruguay targeting adolescents and young adults. Furthermore, this dissertation is characterized by a focus on disparities in relation to gender, age, and income. Nationally representative surveys were the main sources of data, and the methods employed quasi-experimental designs, decomposition analyses, and estimation of income inequalities, among others.

Results showed important heterogeneities in this region regarding inequalities in cigarette consumption by gender, age and income. Findings from eleven Latin American countries showed that over the past 20 years, teenagers did not follow the smoking trends observed among adults, with marked differences across gender groups. We also found that adult women in the lowest income categories in Mexico showed higher reductions in tobacco smoking during a period of sharp increase in cigarette prices, as compared to men, and to women in higher income categories. Finally, a comprehensive tobacco control policy was shown to be highly effective in reducing smoking prevalence among the youth in Uruguay.

The characteristics of the region and the findings of the study support the need to continue expanding tobacco control policies and research in Latin America with a focus on aligning policies to regional, gender and income differences to achieve maximal public health impact.

Chapter 1 – Overall Introduction

Global and Latin American burden of tobacco

Tobacco is the only legal consumer product that kills up to half of its users when used exactly as intended by the manufacturer. It is responsible for more than 7 million deaths every year (more than 7 million active smokers and around 890,000 non-smokers exposed to secondhand smoke). Killing one person every six seconds, tobacco costs the global economy US\$200 billion every year and is a significant risk factor for the main non-communicable diseases (NCDs) which are responsible for almost two-thirds of all deaths worldwide.¹

Tobacco use is also a marker of social inequity both between and within countries. While globally there is a declining overall rate of current smoking among adults, from 23.5% in 2007 to 20.7% in 2015, the largest relative reductions in tobacco use are taking place in high-income countries, which have declined from an overall average prevalence of 34% in 2007 to 29% in 2015. On the other hand, smoking prevalence in low-income countries has changed little on average (15.0% in 2007 and 13.2% in 2015).^{1,2}

In terms of sex differences, just as wide variations in smoking prevalence are observed from one region to another, the 2017 WHO World Report on Tobacco also highlighted concerns about the growing feminization of tobacco smoking, in particular in the youngest age groups.^{1,3} Furthermore, the sex differences are also greater for low and middle-income countries, compared to high income countries. An analysis of the first wave of Global Adults Tobacco Survey (GATS) implemented in 16 countries (n=3 million people, between 2006 and 2016) showed earlier initiation of smoking in women than in men. In several countries, tobacco use among adolescent girls is now more common

than among adult women, suggesting that the historically lower prevalence of tobacco use among women in many populations worldwide may not continue. ² Overall, the youth population is showing concerning trends with regards to smoking prevalence. After 17 years of active surveillance through the Global Youth Tobacco Survey (GYTS), the WHO reports that smoking prevalence did not show significant changes in 43 countries between 1999 and 2016, while 18 countries showed ascending trends. ¹

Latin America reports a diverse scenario across and within countries with regards to tobacco consumption. Despite some achievements on tobacco control, nearly 70 million smokers in Latin America are at risk of tobacco-related deaths and diseases. ⁴ The prevalence of daily tobacco smoking is 17.1% in adults, equivalent to 125 million smokers, and the age-standardized prevalence of smoked tobacco varies widely between countries, from the highest prevalence in Chile (38.9%) to the lowest in Panama and Barbados (7.4% and 7.0% respectively). ^{2,4,5}

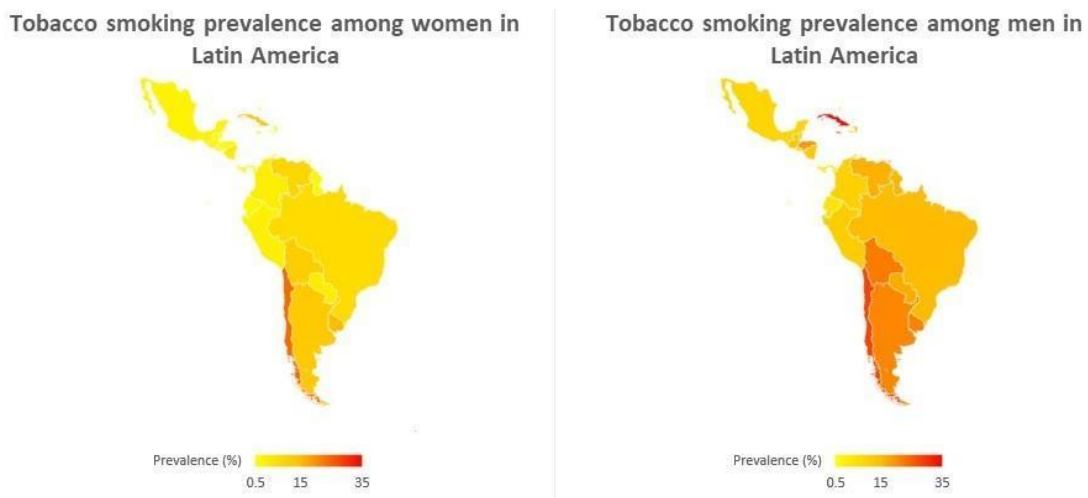


Figure 1-1 Smoking prevalence among women and men in Latin America. General population. 2015 or latest available data

Source: The Tobacco Atlas ²

Approximately 1 million tobacco-attributable deaths occurred in 2016 in the region, and tobacco is among the five leading risk factors for death and disability, contributing to poverty both through a decreased productivity and an impact on out-of-pocket expenses. The direct costs fall on the region's health systems as a result of diseases attributed to smoking amounting to approximately US\$33 billion, equivalent to 0.5% of the gross domestic product (GDP), and to 7% of Latin America's total annual spending on health.^{4,6}

While globally men continue reporting higher rates of cigarette smoking, Latin America and the Caribbean are ranked second (following the European region) by the WHO in terms of the increasing rates of female tobacco consumption. This fact is potentially attributed, at least partially, to the persistent efforts from the tobacco industry in targeting women in its marketing and advertising strategies.^{6,7} Another population group that is being targeted by the industry is the subpopulation of the youth. In Latin America, although most countries have bans on the sale of tobacco products to minors, evidence shows that initiation starts between 10-13 years old. Jamaica has the highest rate in youth consumption in the region (28.7%), followed by Colombia (22%) and Chile (19.7%).^{5,8} As both the inter-country sex- and age-related differences in tobacco use are wide in Latin America, the region becomes a suitable scenario to analyze conditioning factors and shape a better understanding of what policies may work and which ones would need further refinement or reformulation.

Contextualization of the tobacco epidemic

Beyond the analysis of the status of tobacco use across the world and the Latin American region, it is important to contextualize the prevalence data within the curves of the tobacco epidemic. In 1994, Lopez described the curve of the tobacco epidemic

(Figure 2), after observing the 100+ year history of smoking in developed countries. ⁹

The model allows for sex considerations and divides the epidemic in four stages. Stage I is one of low male and female prevalence of smoking and few smoking-related deaths. A few very low-income countries are in this stage. Stage II consists of a rapid rise in the number of male smokers to its peak, a start in the rise in female smokers, an upswing in the number of male deaths, but still few deaths in women. In stage III, the prevalence of male smoking begins to decline, female smoking is still increasing, and the rate of smoking-attributed male deaths is at its peak (around 30% of all deaths) with the rates for women sharply increasing. In stage IV, female and male smoking decline along with male deaths, although female deaths are still growing. A proposed stage V, not described by Lopez, involves declining rates of both smoking prevalence and deaths in both sexes. ¹⁰ While developed countries are typically considered to be in stage IV, most Latin American countries can be found in stages II and III, while some countries like Uruguay and Argentina are in stage IV. This highlights the variability in smoking patterns across Latin American countries and the need to consider the region's diversity.

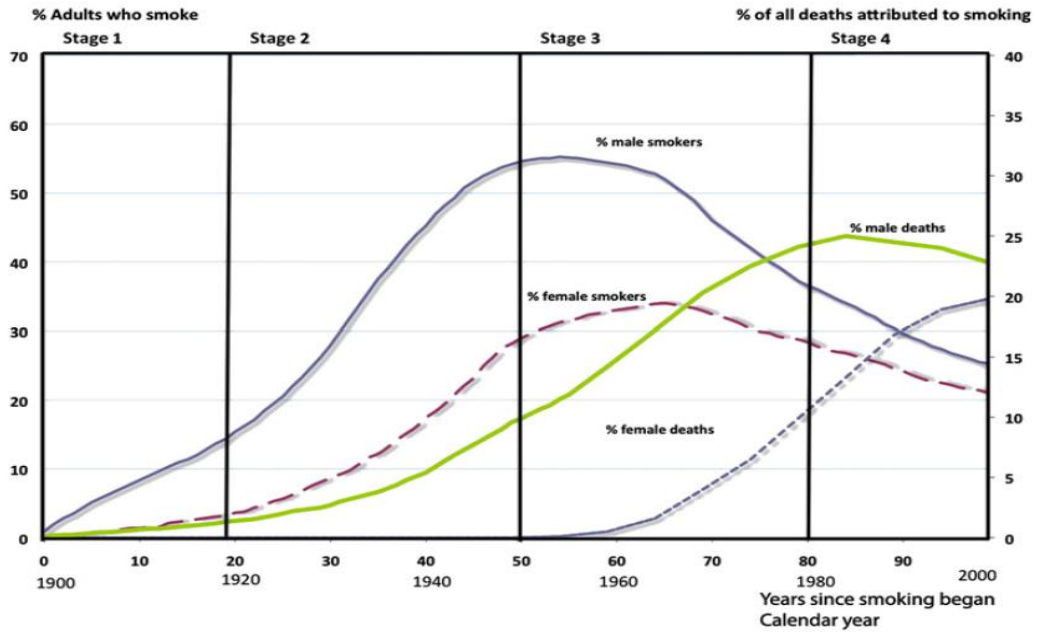


Figure 1-2 Tobacco Epidemic Curve

Source: Lopez et al. 1994⁶

Both the current situation and the trends described by Lopez show marked sex-related differences. Hence, a better understanding of the factors that are differentially associated to tobacco uptake and cessation across sex is key to understand and predict smoking prevalence in any geographical scenario. For this reason, sex differences are identified and analyzed in all three components of this investigation, including in Aim 1 where we explore sex differences in tobacco smoking susceptibility and prevalence among the youth in 11 Latin American countries, and in aims 2 and 3 where we explore the specific cases of Mexico (among the adults), and Uruguay (among the youth) respectively.

Tobacco and sex

A large body of evidence supports analyzing the trends and prevalence of tobacco use between men and women separately, based on different potential mechanisms. Factors like the overall evolution of gender equality, economic

development, countries' trade characteristics, tobacco production, and policy restrictions condition differences between men and women in tobacco use initiation and cessation trends.³

For these reasons, in this dissertation, we stratify the entire analysis by sex and incorporate gap-decomposition techniques (Aim 1) to gather a better understanding of sex related differences that drive sex-specific outcomes in tobacco smoking in Latin America. In the Region, the overall difference in the prevalence of daily smokers between men and women is one of the smallest, with a ratio of 1.6 male smokers to each female smoker.^{4,5} Nonetheless, there are large sex-related differences between countries. Only 4 percentage points separate men from women in Chile (41% men and 37% women), while the gap expands to 34 percentage points in Cuba (53% men to 19% women) and Honduras (36% men to 2% women). Moreover, sex differences tend to become smaller or disappear among the youth, where some countries are already showing equal prevalence of the use of tobacco products among girls and boys (Brazil, Colombia, and Uruguay) while in other countries the ratio is already inverted (Argentina and Chile). This speaks of the region's heterogeneity in this regard and reinforces the need to analyze it without losing track of country cases, where specific factors drive relevant differences.

The trends in the epidemic of tobacco consumption as described by Lopez are focused on the adult population. However, tobacco smoking initiation is widely conditioned by decisions that are made during previous stages in life. Although cessation is a key factor in reducing the burden of tobacco, reducing the uptake that takes place during the youth and early adulthood is critical.

Tobacco and age (Aim 1)

Even though there is an ongoing controversy in terms of the differential effectiveness of smoking prevention strategies vs. targeted cessation interventions¹¹, reducing smoking uptake in the youth is important given that around 90% of the adult smoking population initiates tobacco before the age of 18, and almost all of them by age 26.¹² Hence, adolescents are the focus of this investigation in two of its three components (multi-country in Aim 1 and country-specific in Aim 3). Teenagers behave in ways that are different from the adult population regarding smoking consumption and its conditioning factors. In this sense, specific youth related factors were investigated as potentially responsible for a higher propensity to initiate smoking and lower chances of quitting. A reduced ability to resist peer pressure, unawareness of tobacco harms, and psychosocial stress are some of the proposed factors that put disadvantaged boys and girls at higher risks for tobacco uptake.¹³ Another factor playing a role in youth smoking is the specific targeting through advertising by the tobacco companies. Adolescents seem to be easier to persuade through advertising and depicting messages, and the differential vulnerability is potentiated when considering youth plus economic disadvantage. In this sense, an analysis of tobacco industry documents reflected that young individuals from low socio-economic status are primary targets for tobacco marketing campaigns.¹²

The concept of susceptibility to cigarette smoking in adolescents was defined and validated as the absence of a firm decision not to smoke and is considered a stronger independent predictor of experimentation than the presence of smokers in the household.¹⁴ A worldwide study, including 356,414 never-smoking adolescents from 168 countries, representing a total of 70,025,268 never-smoking youth, showed that, overall, 12.5% were susceptible to smoking, of which 7.2% were boys and 5.3% were

girls. Susceptibility to smoking was increased by at least 2-fold for the Americas and Europe, in comparison with every other region in the world. Additionally, exposure to tobacco advertising and to parental or peer smoking were two strong conditioning factors for smoking susceptibility.

Of the 108 countries that have completed at least two Global Youth Tobacco Surveys (GYTS), the rate of tobacco use among adolescents only declined significantly in 20 countries, while 18 countries saw rising rates both among both boys and girls.¹ Latin American and Caribbean countries have the largest differences in tobacco use prevalence among youth, e.g. 28.7% in Jamaica compared to 7% in Paraguay.⁴ The WHO World Tobacco Report shows that most countries with reductions in tobacco use among boys and girls are high income countries with a very high Human Development Index. A large systematic review evaluated the equity effects of income on forty tobacco control measures in the youth. After reviewing 38 peer-reviewed journal articles, the authors reported that 16 measures or policies had a neutral effect and only 7 appeared to be pro-equity, meaning that they would shorten the gaps by generating additional benefits to the lowest income groups. Of those, four were related to tax/prices, two to minimum legal ages to buy cigarettes, and one to text messages used for cessation support. The study concluded that there is a need to increase the evidence base for equity impact of youth tobacco control interventions.¹⁵ None of the studies included in the systematic review was based in Latin America.

In addition to age and sex, socio-economic status has been shown to account for extensive variations in tobacco consumption. This factor was widely studied both in adolescents and adults. Furthermore, income has been associated with a differential prevalence of tobacco use both in developing and developed countries.

Tobacco and SES with a focus on income

According to the World Health Organization, populations that are more likely to smoke belong to the lower socio-economic groups, including single mothers, long-term unemployed, new immigrants, the homeless, the mentally ill, and members of ethnic minorities.¹³ While overall smoking prevalence has dropped in most high-income countries, there are substantial inequalities in tobacco use by income groups. In fact, not only smoking prevalence, but other tobacco consumption indicators, like age at first cigarette, exposure to secondhand tobacco, willingness to quit smoking, and success after quitting attempts show a disproportionate distribution in which the more disadvantaged groups report the lowest performances.^{16–19}

A systematic review including 29 studies on tobacco cessation reflected that adults at lower socioeconomic status (SES) groups are more likely to smoke and less likely to quit than adults from higher SES.²⁰ In the same line, a study using country and individual-level information from 109 countries showed that greater gross domestic product (GDP) per capita, higher level of individual education, and higher subjective socioeconomic status, significantly predicted the likelihood of quitting tobacco smoking.¹⁴ Another investigation reported that those who were socio-economically more advantaged were 2.5 times more likely to remain abstinent after quitting, compared to the most disadvantaged (OR 2.5, 95% CI 1.4– 4.7), concluding that rather than quit smoking, those that are more vulnerable often quit the smoking cessation treatments.²¹ Such evidence reinforces the need to consider the role of socio-economic status in the design of tobacco control strategies, which may result in effectiveness and equality gaps by favoring certain population groups.

In terms of income, Figure 3 below presents the world's smoking prevalence across income quintiles and grouped by three levels of country income, showing that the wealthier tend to smoke less than the poor at every level of country income. The figure also reflects that the gap between income quintiles becomes much narrower for the upper-middle income countries. Even though the prevalence of smoking decreases as the country income grows, the chart shows an exception among the wealthiest (Q5) population, where the prevalence of daily smoking tends to increase in line with the country's income.

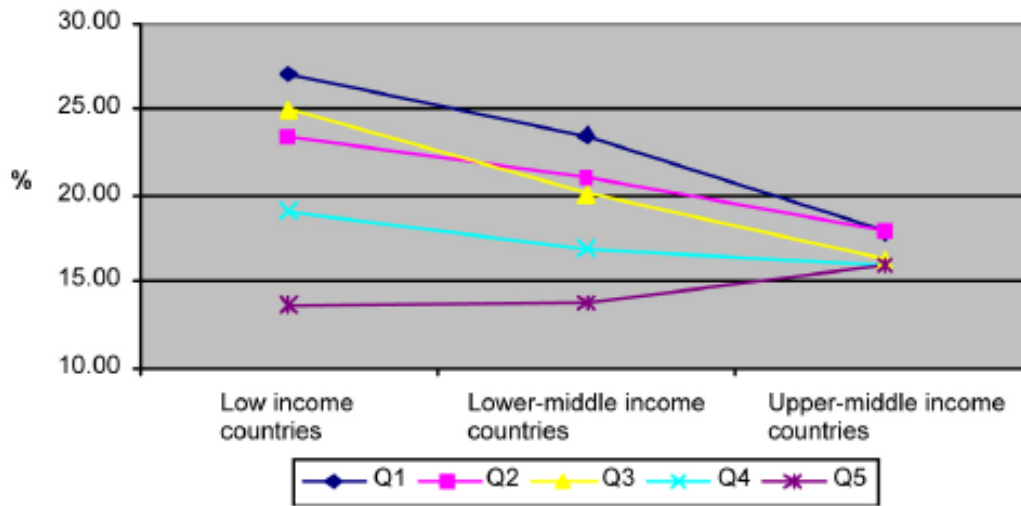


Figure 1-3 Prevalence of Daily Tobacco Smoking by Income group and income quintile

Source: WHO World Tobacco Report, 2017

Since Latin America is the region where income shows the highest gaps across population groups in the planet, analysis of the association between income and tobacco smoking in the region is key. A systematic review and meta-analysis showed a robust trend for higher prevalence of any tobacco consumption among the most economically deprived stratum. The researchers selected 25 out of 1,254 studies to conduct a meta-analysis, which showed that low income was associated with a 62% increase in the likelihood of smoking (OR 1.62; 95% CI 1.34–1.96) when compared to high income,

while in the case of middle income groups the odds were increased by 23% (OR 1.23; 95% CI 1.00-1.52). The study also showed a dose response effect along the income continuum. However, most of the analyzed publications were conducted in Brazil, and the evidence was inconclusive when countries were analyzed separately (i.e. the association between lower income and increased smoking prevalence could not be demonstrated in Mexico and Nicaragua).²²

The case of Mexico (Aim 2)

A large study addressing income and education inequalities in the smoking population used data from the Demographic and Health Survey (DHS) from 54 low and middle-income countries and quantified both the Relative Inequality Index and the Slope Index of Inequality, showing a wide variability both across income categories and across countries. Overall, the income inequalities were significantly higher among the low-income countries. Only four of the 54 countries were from Latin America (Peru, Guyana, Honduras and Bolivia) and the analysis of those countries did not reveal the same association as the general sample, even showing smaller income inequalities among smoking women in Bolivia, Honduras and Peru, a finding that was not reported among men in those same countries.²³

Being Mexico is one of the few countries in the planet where investigations show a positive association between income and tobacco use, meaning that those in higher socio-economic strata report higher smoking prevalence, the country offers an interesting setting to explore income inequalities in the smoking population.

During the last fifteen years, two different periods are identifiable in terms of cigarettes taxation in Mexico: one (before the year 2012) marked by an increasing pressure over the retail chain and the consumers, and another (after 2012) where the

excise tax rate on tobacco remained unchanged, making cigarettes increasingly affordable with regards to inflation and cost of living. In this regard, while a simulation study already reported that introducing a higher tax on cigarettes in Mexico would have a progressive effect on the income distribution²⁴, we take the opportunity to explore changes in income inequalities in the context of relatively increased and relatively reduced cigarettes prices, using actual data between 2002 and 2016. Furthermore, given that Mexico is a federal country where subnational states have agency over the taxation pressure on goods and services, we have the chance to explore these outcomes along a spectrum of tighter or more relaxed approaches to cigarettes pricing policies.

The WHO Framework Convention on Tobacco Control and tobacco control policies

The WHO Framework Convention on Tobacco Control (WHO FCTC) is the first global public health evidence-based treaty negotiated under the auspices of WHO. It was first proposed at the World Health Assembly in 1995 and discussions within an ad-hoc working group formally began in 1999. The treaty was adopted by the World Health Assembly in May 2003 and entered into force on 27 February 2005. It has since become one of the most rapidly and widely embraced treaties in United Nations history.^{25,26}

Among its general obligations, the treaty requires Parties to “...*establish essential infrastructure for tobacco control, including a national coordinating mechanism, and to develop and implement comprehensive, multisectoral tobacco-control strategies, plans and legislation to prevent and reduce tobacco use, nicotine addiction and exposure to tobacco smoke.*” In this context, the FCTC also endorses the countries in term of protecting their tobacco control initiatives from commercial and other vested

interests of the tobacco industry. Additionally, the agreement calls the Parties to support research, surveillance, and information exchange to enlarge the body of evidence to strengthen and ensure the full implementation of the treaty.

By December 2017 there were 181 State Parties to the Convention, including 30 of the 35 countries of the Region of the Americas.²⁷ Argentina, Dominican Republic, Cuba, Haiti, and the United States have not yet signed and/or ratified the treaty. The Americas have more countries refusing to sign or ratify the FCTC than any other region worldwide. In 2008 WHO introduced a set of affordable and achievable measures for tobacco control. These six measures, known as the MPOWER technical package, are intended to help countries in achieving compliance with their obligations under the FCTC. The acronym MPOWER is used to address them as follow: M - Monitor tobacco use and prevention policies, P - Protect people from tobacco smoke, O - Offer help to quit tobacco use, W - Warn about the dangers of tobacco, E - Enforce bans on tobacco advertising, promotion, and sponsorship, and R - Raise taxes on tobacco.

Estimates from WHO suggest that implementing measures P, W, E, and R of the MPOWER package may cost only US \$0.11 per capita annually in low- and middle-income countries, and its implementation may prevent 7.4 million premature deaths.¹ Those measures are known as the “best buys” and include increasing tobacco taxes, promoting smoke-free environments, warning about the risks of tobacco on tobacco packages and media campaigns, and enforcing total bans on tobacco advertisement, promotion and sponsorship.

In Latin America, eight countries meet an adequate level of monitoring of the implementation of the MPOWER package: Argentina, Chile, Colombia, Costa Rica, Panama, Peru, Suriname, and Uruguay. The availability of specific data on tobacco

consumption in the region is more extended for the youth, with every country in Latin America having carried out the Global Youth Tobacco Survey (GYTS) at least once, while several countries have already completed between two and four rounds. On the other hand, only six countries implemented the Global Adult Tobacco Survey at least once: Brazil (2008), Mexico (2009 and 2015), Uruguay (2009), Argentina (2012), Panama (2013), and Costa Rica (2015).⁴

Although the package of MPOWER was launched and recommended as a whole, most of the countries adapted and formulated tobacco control policies gradually, based on factors like opportunity, availability of resources, cultural acceptance, and others. In this sense, only a few analyzes explored the independent impact of each component within the overarching strategies. In Latin America, a simulation exercise based on population and smoking data for Brazil assessed the effect of a group of tobacco control policies on premature death. Almost half of the calculated reduction of premature mortality (46%) was explained by price increases, 14% by smoke-free air laws, 14% by marketing restrictions, 8% by health warnings, 6% by mass media campaigns, and 10% by cessation treatment programs.²⁸

Approximately half of the region of the Americas is protected by measures such as smoke-free environments and graphic health warnings. On the other hand, other measures are yet far from being largely implemented, as is the case for the ban on tobacco advertisement, promotion, and sponsorship. While 30 out of the 35 countries of the Region are Parties to the FCTC, only six have implemented at least four of its most effective measures: Argentina, Brazil, Canada, Chile, Panamá, and Uruguay.

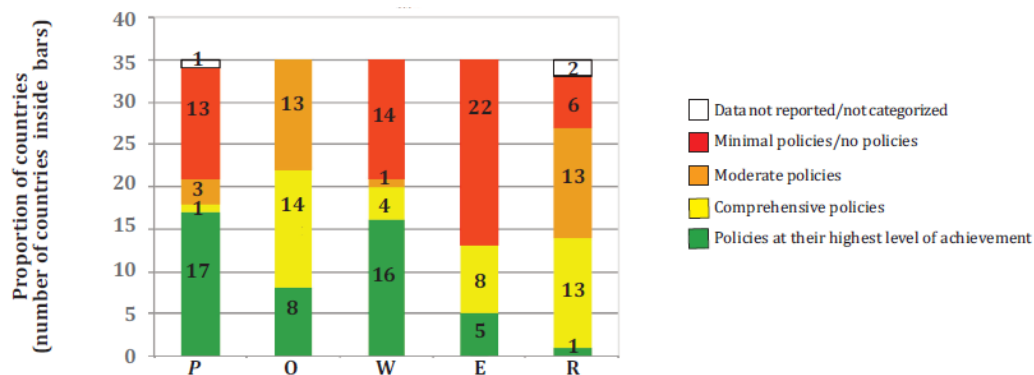


Figure 1-4 Status of implementation of the MPOWER measures in Latin America - 2016

Source: WHO World Tobacco Report 2017

The case of Uruguay (Aim 3)

Uruguay is among the few countries in the Latin American region that passed a comprehensive tobacco control law in 2008, covering most of the MPOWER components in a single regulatory bill. The law (N. 18.256/2008) tackled smoke free places, tobacco advertising, promotion and sponsorship, and packaging and labeling of tobacco products, among other measures. After this milestone, Uruguay became the Latin American country with the largest health warnings (with 80% coverage on the front and back of the package). Following the implementation of these measures, the Philip Morris tobacco company filed a complaint with the World Bank's International Centre for Settlement of Investment Disputes, alleging that the measures were in violation of a bilateral investment treaty. In 2016, an arbitration tribunal upheld Uruguay's right and obligation to protect the health of its population with measures in line with the WHO Framework Agreement for Tobacco Control (FCTC). This ruling was considered a milestone in the fight against tobacco worldwide. A study in 2017 comparing the 2007 and 2014 Global Youth Tobacco Surveys before and after the implementation of the national policy showed a marked reduction in cigarette smoking among adolescents 13

to 15 years old and did not find differences between boys and girls.^{29,30} However, no youth-specific investigations were found in which control groups were used. This opens an opportunity for our work to fill a gap in the already collected evidence about the effectiveness of a comprehensive regulatory package in a Latin American country. Aim 3 of this investigation uses a comparison group (Argentina) and a difference in differences design to explore the effect of a general tobacco control policy on the youth's smoking prevalence in Uruguay.

Addressed gaps in the literature

The MPOWER package proposed by WHO is well founded on existing evidence. There is a fair amount of literature already supporting the effectiveness of each of those measures and policies. Nonetheless, when the existing body of evidence is considered under specific perspectives, more research seems to be needed. The first gap relates to a relatively scarce evidence from the developing world when compared to the OECD countries. Research results from developed countries can be inadequate and even misleading if extrapolated to the developing world.³¹ Several factors were proposed as likely reasons for which funding, conducting, and disseminating tobacco research are major challenges in low- and middle-income countries, including a limited research infrastructure, language barriers as most international high-impact journals are published in English, and lack of institutional support for research dissemination. For example, developed countries report a growing feminization of tobacco consumption, mainly affecting young adults and teenagers. This trend was not yet confirmed in Latin America, where the income and development gaps across countries is considerably larger. Moreover, no large-scale, multi-country research was yet conducted in the region with the aim to explain sex-specific differences and drivers in relation to tobacco

consumption. The first manuscript of this investigation analyzes trends in tobacco susceptibility and cigarettes consumption among the boys and girls separately in several Latin American countries between the years 1999 and 2016 and uses a decomposition technique to address sex differences and its determinants across those two outcomes. A better understanding of the factors that condition smoking susceptibility and smoking prevalence across sex in the youth is still needed to target those factors in the policymaking process.

An additional reason why some of the evidence obtained from the developed world is not generalizable to Latin America relies on differential rates of enforcement across countries and regions. In this regard, the relative institutional weakness of many Latin American countries as compared to developed countries represents a vulnerable environment for the industry's strategies to influence policy, potentially reducing the expected impact of comprehensive tobacco control policies in the region. Uruguay is considered one of the world leading countries in the fight against tobacco, particularly after passing a large comprehensive tobacco control policy in the year 2008 and having challenged the tobacco industry in a trial against Phillip Morris. Hence, the third part of the investigation uses a difference-in-difference design and inverse probability of treatment weights to compare Uruguay with a suitable control country (Argentina), exploring sex-specific changes in smoking prevalence among the youth after the implementation of a comprehensive tobacco control policy.

Another relative gap in the literature refers to the scarcity of evidence on the differential impact of tobacco control policies on specific and more vulnerable populations in Latin America. As a highly diverse region, the implementation of policies needs to account for the impact on certain groups, which may lack access to a given benefit, or be disproportionately affected by certain regulations. Examples can be found

in the WHO/FCTC MPOWER measures: offer to help quit smoking might be available only to those groups that access the cessation services, becoming socially regressive by leaving the most vulnerable population, with barriers to access, unprotected. Another example relates to tobacco taxation. The measure requires previous knowledge of the price elasticity of the cigarettes' demand in the target population. With this knowledge, harming substitution effects by very inelastic groups in the lower income strata can be anticipated. Moreover, even though the effectiveness of taxation in reducing tobacco consumption is already supported by a large amount of evidence, the effect of changes in cigarettes prices on social indicators, like income inequalities, was not thoroughly evaluated in Latin America. The second part of the investigation explores changes in smoking and income inequalities among the adult smoking population in Mexico during two time periods where a tobacco taxation varied in intensity, estimating the relative and absolute income inequality indices among men and women, both at the national and subnational levels.

Although it is still important to keep on building over the existing evidence that examines the impact of a given tobacco control policy on smoking prevalence or cessation, the challenge is to break down the impact of those policies and explore in depth the situation of those that are most vulnerable. Finding reductions in smoking prevalence is probably not enough reason to conclude that a policy is effective, and therefore should be implemented or replicated. This investigation uses diverse techniques to explore the impact of those policies in specific population groups within the most inequal region in the world.

References - Introduction

1. WHO | WHO report on the global tobacco epidemic 2017. WHO. 2017. http://www.who.int/tobacco/global_report/2017/en/.
2. Zachary Cahn W, Drope J, Hamill S, et al. The Tobacco Atlas. Sixth Edition.; 2018. https://tobaccoatlas.org/wp-content/uploads/2018/03/TobaccoAtlas_6thEdition_LoRes_Rev0318.pdf.
3. Pampel FC. Global Patterns and Determinants of Sex Differences in Smoking. *Int J Comp Sociol.* 2006;47(6):466-487.
4. Pan American Health Organization. Report on Tobacco Control in the Region of the Americas 2018.; 2018.
5. Tobacco Atlas. Latin America and Caribbean Region – Tobacco Tactics.; 2020. <https://tobaccotactics.org/wiki/latin-america-and-caribbean-region/>.
6. Etienne CF. Curbing the tobacco epidemic in the Americas. *Rev Panam Salud Publica.* 40(4). 2016.
7. Schmidt L. Tobacco industry targeting of women and girls. 2012; Dec (1):1-5. <http://www.tobaccofreekids.org/research/factsheets/pdf/0138.pdf>.
8. Hanewinkel R, Isensee B, Sargent JD, Morgenstern M. Cigarette Advertising and Adolescent Smoking. *Am J Prev Med.* 2010.
9. Lopez AD, Collishaw NE, Piha T. A descriptive model of the cigarette epidemic in developed countries. *Tob Control.* 1994;3(3):242-247.
10. 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.
11. Shahab L. Effectiveness and Cost-Effectiveness of Programmes to Help Smokers to Stop and Prevent Smoking Uptake at Local Level.; 2015.
12. Services USD of H and H, Prevention C for DC and, Promotion NC for CDP and H, Health O on S and. Executive Summary (The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General). 2014:1-36.
13. World Health Organization. Commission on Social Determinants of Health. Closing the Gap in a Generation.; Geneva, 2008.
14. Gritz ER, Prokhorov A V., Hudmon KS, et al. Predictors of susceptibility to smoking and ever smoking: A longitudinal study in a triethnic sample of adolescents. *Nicotine Tob Res.* Aug;5(4):493-506. 2003.
15. Brown T, Platt S, Amos A. Equity impact of interventions and policies to reduce smoking in youth: systematic review. Nov;23(e2):e98-105. 2014.

16. Casetta B, Videla AJ, Bardach Phd A, et al. Review Association Between Cigarette Smoking Prevalence and Income Level: A Systematic Review and Meta-Analysis. *Nicotine Tob Res.* 2017;19(12):1401-1407.
17. Alves J, Kunst AE, Perelman J. Evolution of socioeconomic inequalities in smoking: results from the Portuguese national health interview surveys. *BMC Public Health.* 2015;15:311
18. Lund M. Social Inequality in Cigarette Consumption, Cigarette Dependence, and Intention to Quit among Norwegian Smokers. *Biomed Res Int.* Epub 835080. 2015.
19. Kotz D, West R. Explaining the social gradient in smoking cessation: it's not in the trying, but in the succeeding. *Tob Control.* 2009;18(1):43-46.
20. Pierce JP, Choi WS, Gilpin EA, Farkas AJ, Berry CC. Tobacco industry promotion of cigarettes and adolescent smoking. *J Am Med Assoc.* 279(7):511-515.1998
21. Veeranki SP, Mamudu HM, Anderson JL, Zheng S. Worldwide never-smoking youth susceptibility to smoking. *J Adolesc Heal.* Feb;54(2):144-50. 2014.
22. Bardach A, Andrés H, Perdomo G, Amanda R, Gándara R, Ciapponi A. Income levels and prevalence of smoking in Latin America: a systematic review and meta-analysis*. *Pan Am J Public Heal.* 2016;40(4).
23. Sreeramareddy CT, Harper S, Ernsten L. Educational and wealth inequalities in tobacco use among men and women in 54 low-income and middle-income countries. *Tob Control.* Jan;27(1):26-34. 2016.
24. Macias Sánchez A, Mx A. Increasing Tobacco Taxes Benefits the Poor. *Tobbaconomics. Policy Brief.* Apr 2020.
25. World Health Organization. WHO Framework Convention on Tobacco Control. Geneva, 2003.
26. World Health Organization. The WHO Framework Convention on Tobacco Control: An Overview. Geneva, 2015.
27. WHO | Parties to the WHO Framework Convention on Tobacco Control. WHO. http://www.who.int/fctc/signatories_parties/en/. Published 2017.
28. Levy D, de Almeida LM, Szklo A. The Brazil SimSmoke Policy Simulation Model: The Effect of Strong Tobacco Control Policies on Smoking Prevalence and Smoking-Attributable Deaths in a Middle Income Nation. Samet JM, ed. *PLoS Med*;9(11). 2012
29. Abascal W, Lorenzo A. Impacto de la política de control de tabaco en población adolescente en Uruguay. *Salud Publica Mex.* 59(Supl.1):40. 2017
30. De Maio FG, Konfino J, Ondarsuhu D, Goldberg L, Linetzky B, Ferrante D. Sex-stratified and age-adjusted social gradients in tobacco in Argentina and Uruguay: Evidence from the global adult tobacco survey (GATS). *Tob Control.* 24(6). 2015

31. Maziak W, Arora M, Reddy KS, Mao Z, Fogarty International Center's "International Tobacco Research and Capacity Building Program." On the gains of seeding tobacco research in developing countries. Tob Control.15 Suppl 1. 2006

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Chapter 2 - Aim 1 - Trends and decomposition of sex gaps in tobacco smoking among the youth in Latin America

Abstract

Introduction

The tobacco epidemic shows diverse trends globally, with marked differences across individual and country level variables. As most current smokers initiate tobacco consumption during youth, understanding the trends and conditioning factors of the differences in smoking susceptibility and smoking prevalence between boys and girls would allow for targeted policies that are not necessarily suitable for both sexes.

Methods

Global Youth Tobacco Surveys from eleven Latin American countries were analyzed, involving 105,079 respondents between the years 1999 and 2016. Risk ratios and risk differences for tobacco smoking susceptibility and prevalence were obtained comparing boys and girls across three time periods and Human Development Index (HDI) categories. Decomposition methods were used to explore sex-based differences.

Results

Means for susceptibility to tobacco smoking decreased from 34.3% and 34.6% among boys and girls respectively to 24.5% and 24.1% between 1999 and 2016. Smoking prevalence declined from 19% and 18.2% to 10.0% and 8.8% respectively. Country stratification by groups of HDI showed significant differences between categories, with increased risks for girls in relatively higher human development countries. Sex-gaps decomposition showed that the presence of close friends who

smoke, exposure to secondhand tobacco smoke, weight concerns, and availability of economic resources differentially conditioned boys and girls to smoke.

Conclusions

Stratification by HDI identified a highly heterogeneous scenario in the region. Countries within the highest development group showed increased susceptibility and prevalence among girls, while those in the medium development strata presented higher risks for boys. These findings are in accordance with models that predict that male/female smoking proportions are converging, potentially crossing-over in many high-income countries. Factors that condition sex-based differences should be taken into consideration for further research and policy design.

Introduction

Smoking is a leading risk factor for early death and disability worldwide, with projections reaching 10 million deaths by year by 2030. Although many countries are showing remarkable improvement in tobacco control, the burden of disease and disability associated with tobacco use is growing, especially in lower income countries^{1,2}.

Just as the tobacco epidemic differs by country and population characteristics, trends in adolescent smoking prevalence don't mimic the evolution of the epidemic in the adult population.³ Higher propensity of tobacco uptake among adolescents was associated with a reduced ability to resist peer pressure, unawareness of tobacco harms, and psychosocial stress, among others.⁴ Moreover, youth-targeted advertisement by the tobacco industry also played a significant role in tobacco uptake. Adolescents seem to be easier to persuade through advertising and depicting messages, and this vulnerability seems to be potentiated when young age and economic disadvantage overlap.⁵ Several studies report diverse risk factors for experimentation with tobacco among the youth, including exposure to secondhand tobacco smoke in the household, peer pressure, misinformation on the harms of tobacco, and the influence of advertising and youth-targeted campaigns.⁶⁻⁹

In terms of sex gaps, factors like the overall evolution of gender equality, economic development, and countries' cultural characteristics condition differences between men and women in tobacco use.^{10,11,12} Although wide variations are observed from one region to another, the 2016 World Health Organization Report on Tobacco highlighted concerns about the growing feminization of tobacco smoking in the -15 year age group.^{3,13,14}

As most current smokers initiate tobacco consumption during youth or early adulthood, understanding and transforming conditioning factors is critical. Keeping youth as non-smokers is a key challenge. The concept of susceptibility to cigarette smoking in adolescents was defined and validated as the absence of a firm decision not to smoke, and is considered a strong independent predictor of experimentation with tobacco products.¹⁵ A worldwide study, including 356,414 never-smoking adolescents from 168 countries showed that, overall, 12.5% of them were susceptible to smoking, of which 7.2% were males and 5.3% were females¹⁶.

Among the global challenges in tobacco control, inter and intra-regional heterogeneities demand individualized approaches to understand the evolution of the tobacco epidemic in each geographical setting. In this context, Latin America represents a singular challenge. Being an unequal sub-region in terms of social development, health indicators, and economic scenarios, tobacco related behaviors also show marked differences across countries that show a heterogeneous scenario in the smoking gap between boys and girls.

While most of the countries show higher prevalence among boys, others report similar prevalence (Brazil, Colombia, and Uruguay), and a third group presents an inverted ratio (Argentina and Chile).¹⁴ In this context, regional investigations on the factors that affect or condition these trends are lacking.

A better understanding of those factors that condition higher susceptibility or smoking prevalence between male and female adolescents would allow for targeted policies and strategies that are not necessarily suitable for both sexes. This is framed on the need to adapt and refine those policies that are already known to be effective in broader populations, to the need of specific vulnerable groups.

With the aim to enlarge the body of evidence and contribute to the design of targeted and effective policies to curbe the epidemic of tobacco among youth in Latin America, the present study analyzes the trends in tobacco susceptibility and smoking prevalence among youth in the sub-region between 1999 and 2016, with a focus on sex gaps and cross-country socioeconomic development strata. The analysis includes an ascertainment of eleven Latin American countries with comparisons across human development index (HDI) groups and considers the effect of known risk factors for tobacco experimentation and consumption for boys and girls. Decomposition techniques are implemented to explore sex related factors that differentially drive and influence smoking behaviors.

Methods

Study population

The Global Youth Tobacco Survey (GYTS) is a school-based survey developed by the World Health Organization (WHO) and the U.S. Centers for Disease Control and Prevention (CDC) in 1999 to track tobacco use and perceptions among young individuals across countries using a standardized methodology. The survey captures prevalence, access, media exposure and attitudes related to tobacco use among individuals in school grades corresponding to ages 13–15, although in practice the age range of the survey is wider and covers individuals between 11 and 19 with an average age of 14 years.¹⁷ Approximately 80 surveys have been conducted in Latin America since the beginning of the century across geographies and time.

Inclusion criteria for the selection of countries was defined by the availability of at least one round of nationally representative (or comparable major city) GYTS within each of the following time periods: 1999 to 2003, 2004 to 2009, and 2010 to 2016.

Countries in compliance with these criteria were: Argentina, Belize, Chile, Costa Rica, Cuba, El Salvador, Guyana, Panama, Paraguay, Suriname, and Uruguay. The final sample for analysis includes 105,079 respondents from 36 surveys in 11 Latin American Countries, between the years 1999 and 2016. Frequency weightings were not considered to avoid distortions created by the large variability in countries' populations. Although most of the selected surveys are nationally representative, a few surveys only generalizable to major cities were also included, given their high comparability with expected national averages.

Outcomes

Primary outcomes were defined as susceptibility to tobacco smoking and current tobacco smoking, both through dichotomous variables. The concept of smoking susceptibility among never smoking adolescents, defined as the absence of a firm decision not to smoke, was proposed by Pierce through the following variables, and incorporated into GYTS questionnaires.^{5,18,19} 1) "If one of your best friends offered you a cigarette, would you smoke it?" 2) "Do you think you will be smoking cigarettes 5 years from now?" 3) "At any time during the next 12 months do you think you will smoke a cigarette?" All questions used a four-point ordinal scale: (1) definitely not; (2) probably not; (3) probably yes; and (4) definitely yes. Susceptible adolescents were categorized as those who did not respond "Definitely not" to all three questions.^{8,15,16,19} However, since most of the GYTS conducted after the year 2009 did not include the third question about perceptions on the probability to smoke in five years, the definition of susceptibility was restricted to those who did not respond "definitely not" to the first and second questions. Respondents who smoked at least one cigarette during the last 30 days were considered smokers. The two outcomes were classified across the three defined time periods specified above.

Main Exposure and Covariates

Biological sex was considered as the main exposure. Three groups of covariates were selected a priori from the survey based on their relationship to diverse aspects of tobacco intake: age (continuous); resources, expressed as the amount of available money for personal use (ordinal, in a scale from 0 to 7); and behavioral/environmental factors including: smoking father (dichotomous, yes; no), smoking mother (dichotomous, yes; no), belief that smoking tobacco is harmful for health (dichotomous, yes; no), exposure to seconds hand tobacco smoke in the household (dichotomous, yes; no), belief that smoking tobacco helps in losing weight (dichotomous, yes; no), majority of closest friends smoke tobacco (dichotomous, yes; no), and recall of having seen many tobacco TV advertisements (dichotomous, yes; no). Additional variables were used only for descriptive purposes on the smoking population, including age of initiation (before 11 years and before 13 years old), cigarettes smoked per day, intention to quit smoking, previous attempts to quit smoking, reasons for willing to quit smoking (health concerns, peer pressure, relatives' pressure), and history of having received advice and/or help to quit smoking.

Analysis

Analyses involved descriptive statistics of the susceptible and the smoking population across sex and time period, both for the full sample and for each of the countries in the dataset with a stratification across human development index categories. Variables showing high correlation (i.e., over 0.75) were excluded to avoid multicollinearity, as was the case between smoking parents and household exposure to secondhand tobacco smoke (the former being excluded). Additionally, unadjusted and age, country and time period-adjusted logistic regression models were fit for each outcome, both for the entire sample as well as for each of the selected countries.

Marginal risk ratios and risk differences comparing boys and girls were obtained through the estimation of average marginal effects, which represents the change in the adjusted mean of each of the outcomes.²⁰

Finally, we used the Fairlie's approach (1999 and 2003)²¹ to the Oaxaca-Binder decomposition method (Oaxaca 1973)²²⁻²⁴ to explore the determinants of sex-based differences in tobacco susceptibility and smoking among the youth. This technique quantifies the contribution of each covariate to sex differences in the outcome variable. The results indicate how much the outcome would change under a hypothetical scenario under which the exposure to a given covariate was equalized between the male and female population. The decomposition analysis was conducted for both outcomes for the whole set of countries as well as for each human development index group in accordance to the latest United Nations Classification²⁵: Very High Human Development (Argentina, Chile and Uruguay), High Human Development (Belize, Costa Rica, Cuba, Panama, Paraguay, and Suriname), and Medium Human Development Index (El Salvador and Guyana). We conducted a separate decomposition analysis for each identified determinant, adjusting for age with fixed effects for country and time period.

Supplementary material includes trends graphs of the outcomes of interests by sex and results of decomposition analysis for each country. Analysis was conducted using Stata SE V.14.2. (StataCorp LLC, Texas)

Results

The analysis included 105,079 adolescents from eleven Latin American countries, including Argentina, Belize, Chile, Costa Rica, Cuba, El Salvador, Guyana, Panama, Paraguay, Suriname, and Uruguay. The mean age ranged between 13.7 and 14.2 years old across periods. Means for susceptibility to tobacco smoking decreased

from 34.3% and 34.6% among boys and girls respectively in the first time period, to 24.5% and 24.1% in the third one. Similarly, tobacco smoking prevalence also declined from 19% and 18.2% between 1999 and 2003, to 10.0% and 8.8% between 2010 and 2016. Supplemental material (see appendix) includes the temporal trends in the two outcomes by country over the study time period.

Table 2.1 shows descriptive statistics across sex over the three defined time periods. Both susceptibility and smoking prevalence decreased approximately 10 percentage points between 1999-2003 and 2010-2016, with little differences between sex. In all cases boys reported higher outcomes, except for susceptibility during T1.

Table 2-1 Descriptive statistics across sex and time period for selected countries in Latin America (1999-2016)

	1999-2003 n=25,196 (23.4%)		2004-2009 n=41,997 (39.0%)		2010-2016 n=40,592 (37.6%)	
	Boys	Girls	Boys	Girls	Boys	Girls
Susceptibles (%)	34.3	34.6	29.6	29.2	24.5	24.1
Tobacco smokers (%)	19.3	18.2	16.3	15.6	10.0	8.8
Mean age (sd)	13.8(1.5)	13.7(1.4)	14.2(1.4)	14.1(1.4)	14.1(1.4)	14.0(1.4)
No money (%)	37.4	38.0	45.2	42.5	20.9	20.5
Higher money (%)	21.9	24.9	25.3	25.0	17.9	16.1
Parent smokes (%)	46.9	47.0	38.1	38.6	35.4	35.7
Associates smoking with weight control (%)	50.2	53.3	47.4	53.3	65.2	65.3
Believes smoking boys are more attractive (%)	16.4	15.8	14.5	15.6	17.4	16.0
Believes smoking girls are more attractive (%)	12.9	11.8	10.9	8.9	14.3	13.7
Believes smoking is harmful (%)	93.5	94.5	94.2	95.3	79.9	84.4
Most/All close friends smoke (%)	15.5	15.7	14.7	14.0	10.0	7.3
SHTS at home (%)	47.3	44.4	39.3	40.0	27.9	28.6
Saw lots tobacco advertisements on TV (%)	37.8	38.2	26.5	25.7	33.2	31.7
Among smokers						
Initiation before 11 years old (%)	31.8	30.7	30.8	27.0	29.4	26.3
Initiation before 13 years old (%)	74.2	77.3	69.0	71.2	64.0	64.8
Over 5 cigs per day (%)	14.8	13.2	15.7	12.0	12.1	9.5
Wants to stop (%)	59.4	54.9	55.8	50.2	56.2	41.9
Tried to stop in past year (%)	63.8	60.7	62.8	61.6	64.1	57.8
Stopping bc health concerns (%)	31.2	26.7	29.5	25.1	34.3	25.9
Stopping bc parents pressure (%)	6.7	6.1	5.8	6.1	8.2	5.6
Stopping bc friends pressure (%)	2.3	2.7	2.4	2.4	3.6	4.2
Received advice or help to stop (%)	68.0	65.0	66.4	65.0	69.9	62.6

The proportion of teenagers with smoking parents and exposure to secondhand tobacco smoke decreased over time, while the percentage of boys and girls that considered smoking as a mean to lose weight increased from 50% to 65%.

Among the smokers, the proportion who smoked more than 5 cigarettes per day decreased mostly among girls (3.7 percentage points vs. 2.7 in boys), and higher reductions were found in this group regarding the willingness to quit smoking (13% reduction in girls vs 3.2% in boys). Peer pressure or influence gained relevance in both sexes among those who reported reasons for quitting tobacco use, and boys reported higher proportions of receiving help or advice to quit across the entire time span.

Table 2.2 presents crude and adjusted risk ratios and risk differences for the two outcomes, using girls as the reference category. There was no relevant difference in smoking susceptibility between the two groups, and boys showed an increased adjusted risk of 4% for smoking prevalence.

Table 2-2 Crude and adjusted associations between male sex and (1) smoking susceptibility, and (2) smoking prevalence among adolescents in selected Latin American countries (1999-2016)

Outcome	Crude				Adjusted*			
	RR	95% CI	RD	95% CI	RR	95% CI	RD	95% CI
Susceptibility	1.01	0.99,1.03	-0.003	-0.003,0.010	0.98	0.96,1.00	-0.005	-0.01,-0.001
Smoking	1.08	1.05,1.11	0.011	0.007,0.015	1.04	1.01, 1.07	0.006	0.002,0.010

Note: CI, confidence interval; RD, risk difference; RR, risk ratio. *Adjusted for age, country and time period.

When the analysis was stratified by groups of HDI (Table 2.3), considerable differences were apparent between the three groups, showing increased risks for girls in the very high development countries, and increased risks for boys in countries within the other categories, including an adjusted 31% increased risk of susceptibility and an 82% increased risk for smoking in the medium development countries. A risk difference of 0.07 for smoking in boys in this group can be interpreted as an additional 70 male smokers for each thousand smoking girls.

Table 2-3 Crude and adjusted associations between male sex for smoking susceptibility and smoking prevalence among adolescents in selected Latin American countries (1999-2016)

Outcome	Human Development Index	Crude				Adjusted*			
		RR	95% CI	RD	95% CI	RR	95% CI	RD	95% CI
Susceptibility	Very High	0.84	0.81,0.86	-0.07	-0.08,-0.06	0.83	0.80,0.85	-0.08	-0.09,-0.07
	High	1.08	1.04,1.11	0.018	0.01,0.02	1.08	1.04, 1.11	0.02	0.010,0.024
	Medium	1.31	1.23,1.40	0.06	0.04,0.07	1.3	1.22, 1.39	0.06	0.04,0.07
Smoking	Very High	0.79	0.76,0.83	-0.05	-0.06,-0.04	0.77	0.74,0.80	-0.05	-0.06,-0.04
	High	1.41	1.33,1.48	0.032	0.03,0.04	1.38	1.32, 1.46	0.03	0.026,0.036
	Medium	1.88	1.71,2.07	0.07	0.06,0.08	1.82	1.65, 2.01	0.07	0.06,0.08

Note: CI, confidence interval; RD, risk difference; RR, risk ratio. *Adjusted for age, country and time period.

Forest plots for both outcomes are presented in Figures 2.1 and 2.2 below using the youth female population as reference. The plots display age adjusted risk ratios and 95% confidence intervals by country for the entire timespan. For both outcomes, countries with the highest levels of development showed increased risks for girls, while the remaining strata reported the opposite effect: while Argentina, Chile and Uruguay showed risk reductions for boys in a range of 15% to 25%, for both outcomes, Guyana presented a 50% increased risk of smoking susceptibility in boys, and Suriname, Guyana, and Belize doubled the risk in smoking prevalence in the same group. Supplemental figures (see appendix) present the same analysis by country across the three time periods.

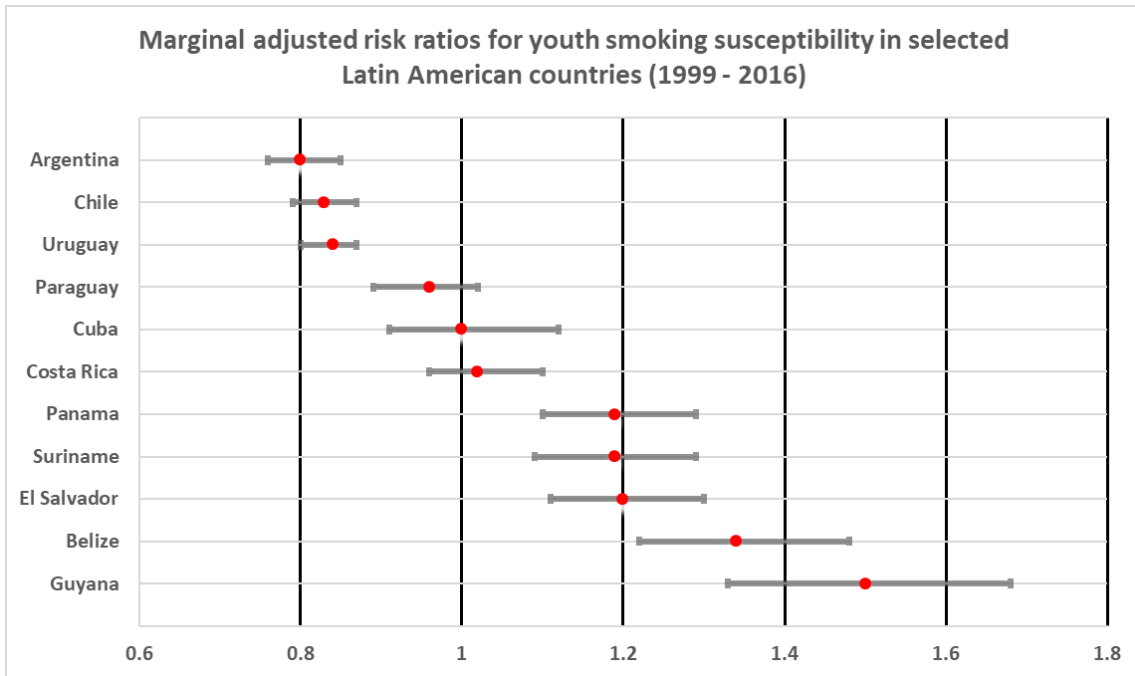


Figure 2-1 Adjusted risks for smoking susceptibility among male adolescents as compare to females in Latin America (1999-20016)

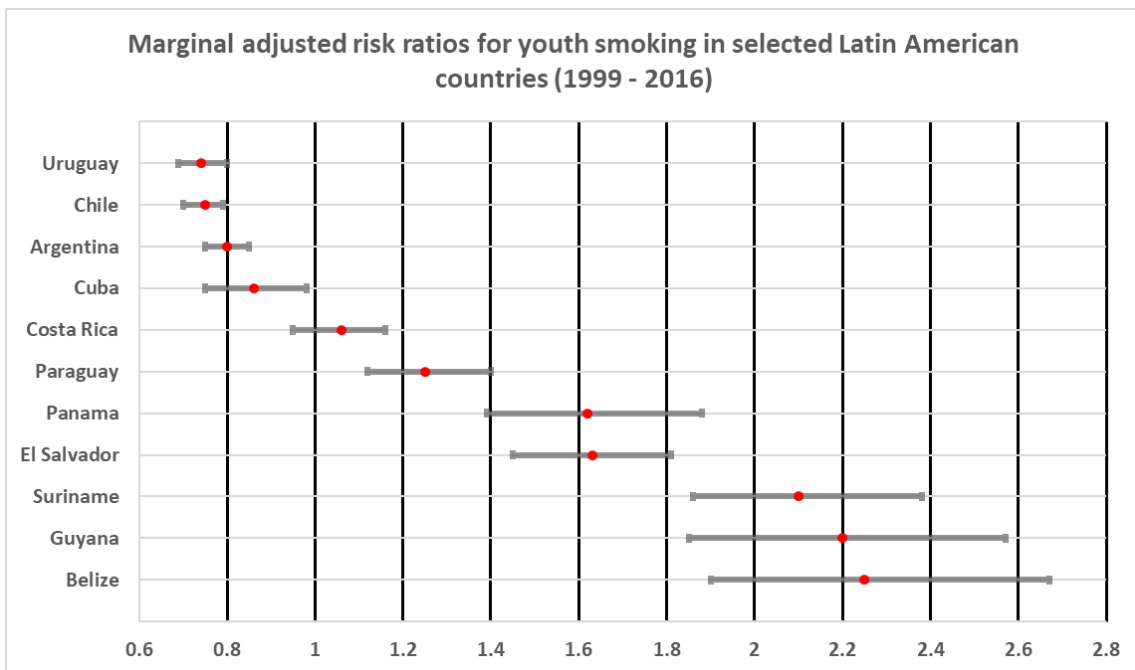


Figure 2-2 Adjusted risks for smoking prevalence among male adolescents as compare to females in Latin America (1999-20016)

The results from the decomposition analysis are presented in Table 2.4. In the whole sample, the boy-girl difference in the probability of smoking susceptibility was 0.4 (boys being more susceptible), and it was 1.1 for smoking prevalence (boys showing higher prevalence). The availability of resources explained almost 30% of the small gap for smoking prevalence. The group of behavioral and environmental factors explained variable proportions in both outcomes, although negative signs in these factors account for opposing forces over the gaps, shortening them against the girls. For example, even though boys showed higher prevalence in both outcomes, the gaps were already cushioned by opposing forces that actually impact girls disproportionately, as was the case for weight concerns and household exposure to secondhand tobacco smoke.

Table 2-4 Means of smoking susceptibility and smoking prevalence among boys and girls, and percentage of the difference explained by age, economic resources, and behavioral/environmental variables in Latin America (1999-2016)

Sex differences (%)	Susceptibility	Lower 95% CI	Upper 95% CI	Smoking	Lower 95% CI	Upper 95% CI
Girls	28.20	27.80	28.60	13.50	13.20	13.80
Boys	28.60	28.10	29.00	14.60	14.30	14.90
Gap (boys-girls)	0.40	0.30	0.40	1.10	1.10	1.10
Percent difference explained						
Age	0.34	0.35	0.35	2.10	2.08	2.08
Resources	2.80	2.82	2.82	29.00	28.97	29.05
Environmental/Behavioral factors						
Weight concerns	-7.12	-7.11	-7.12	-13.83	-13.80	-13.85
SHTS at home	-5.58	-5.58	-5.59	-16.46	-16.43	-16.48
Believe harms	0.00	0.00	0.00	0.06	0.06	0.06
Friends smoke	3.75	3.75	3.75	21.22	21.20	21.24
TV advertising	0.05	0.05	0.05	0.06	0.06	0.06

The negative signs on the gaps in both outcomes (Table 2.5) in the very high development countries reflect the observed increased risks for girls which was 7.4 percentage points for smoking susceptibility, and 5.2 points for smoking prevalence. In this group, the availability of resources did not show explanatory power over the

difference as compared to girls, but other factors gained relevance., as was the case of exposure to smoker friends, which explained 4.4 % of the gap in susceptibility and almost 30% of the gap in smoking prevalence. In this stratum, weight concerns explained almost 4% of the gap in smoking susceptibility. Both gaps were reduced in the high development group and elevated again to 6% and 7% respectively in the medium development countries, although in this case, the positive sign showed increased prevalence among boys. In the group of least developed countries, the availability of resources explained almost 9% of the gap against boys, while the exposure to friends who smoke explained over 20% of the difference. Additionally, the girls' increased belief that smoking can help in reducing weight counterbalanced the gap in smoking susceptibility, which would increase by another 8.3% if the boys held the same perspective as the girls in terms of the potential effect of tobacco smoking overweight control. On the other hand, reducing boys' exposure to secondhand tobacco smoke at home to the girls' levels would reduce the gap in smoking prevalence by 6.5% in this group of countries.

Table 2-5 Means of smoking susceptibility and smoking prevalence among boys and girls, and percentage of the difference explained by age, resources and behavioral/environmental variables in groups of human development index countries in Latin America (1999-2016)

Sex differences (%)	Very High Index			High Index			Medium Index		
	Susceptibility (%)	Lower 95% CI	Upper 95% CI	Susceptibility (%)	Lower 95% CI	Upper 95% CI	Susceptibility (%)	Lower 95% CI	Upper 95% CI
Girls	46.10	45.20	47.00	22.00	21.40	22.50	19.20	18.30	20.10
Boys	38.70	37.80	39.50	23.70	23.20	24.30	25.20	24.10	26.40
Gap (boys-girls)	-7.40	-7.40	-7.50	1.70	1.80	1.80	6.00	5.80	6.30
Percent difference explained									
Age	0.33	0.34	0.34	-0.50	-0.50	-0.50	-0.90	-0.96	-0.97
Resources	0.45	0.46	0.46	-10.40	-10.25	-10.63	7.20	7.26	7.31
Environmental/Behavioral factors									
Weight concerns	3.77	3.76	3.78	0.67	0.67	0.67	-8.29	-8.27	-8.32
SHTS at home	3.45	3.45	3.46	10.40	10.21	10.59	5.54	5.52	5.55
Believe harms	0.03	0.03	0.03	-1.88	-1.88	-1.89	2.32	2.32	2.32
Friends smoke	4.40	4.38	4.41	3.66	3.64	3.69	12.29	12.21	12.36
TV advertising	0.06	0.06	0.06	-0.43	-0.43	-0.43	3.92	3.91	3.93

Sex differences (%)	Very High Index			High Index			Medium Index		
	Smoking (%)	Lower 95% CI	Upper 95% CI	Smoking (%)	Lower 95% CI	Upper 95% CI	Smoking (%)	Lower 95% CI	Upper 95% CI
Girls	25.10	24.50	25.80	8.00	7.70	8.30	7.90	7.30	8.50
Boys	19.90	19.30	20.60	11.20	10.80	11.60	14.90	14.10	15.80
Gap (boys-girls)	-5.20	-5.20	-5.20	3.20	3.10	3.30	7.00	6.80	7.30
Percent difference explained									
Age	-0.95	-0.95	-1.00	1.50	1.54	1.55	2.00	2.02	2.02
Resources	9.90	9.94	9.95	23.10	23.02	23.08	8.90	8.91	8.95
Environmental/Behavioral factors									
Weight concerns	-0.40	-0.40	-0.40	-1.76	-1.76	-1.76	-3.74	-3.73	-3.74
SHTS at home	6.65	6.64	6.66	-32.60	-32.55	-32.65	6.46	6.45	6.47
Believe harms	-3.10	-3.10	-3.11	-0.23	-0.23	-0.23	1.20	1.20	1.20
Friends smoke	28.98	28.91	29.05	-11.86	-11.85	-11.87	22.84	22.74	22.93
TV advertising	0.50	0.50	0.50	1.57	1.57	1.57	5.53	5.52	5.54

Supplementary material includes charts on the evolution of the outcomes of interests by sex and results of decomposition analysis for each country.

Discussion

The present study analyzed the trends and prevalence of smoking susceptibility and smoking prevalence among adolescents between 1999 and 2016 in selected Latin American countries, with a focus on sex gaps and their potential components. Susceptibility to tobacco smoking and smoking prevalence tend to increase among girls in correlation with the countries' human development index, and the social, behavioral, and environmental factors that explain the gaps do not remain constant across development groups.

Stratification by human development index allowed for the observation of a highly heterogeneous scenario, illustrating a known characteristic of Latin American inequalities across diverse health and social development parameters. Countries with the highest human development indexes showed increased adjusted smoking susceptibility and prevalence among girls, while those in the medium development strata presented higher risks for boys. These results are in accordance with models that predict that male and female smoking proportions are converging and will probably cross over in many high-income countries.²⁶ Moreover, multi-country research on the relation between HDI and smoking prevalence already reported that HDI was correlated positively with cigarette smoking among women, but not in men.¹² Furthermore, our results align with a report from the World Health Organization, which mentions that over the past twenty years more girls than boys have begun to smoke in many high-income countries.²⁷ As an example, the Pan-European study on adolescents has shown a reversal of the smoking gender gap since the 1990s.²⁸

Our research showed that, in a highly heterogeneous scenario such as Latin America, social and environmental factors were able to explain relevant fractions of the sex gap in adolescent smoking prevalence, even though this gap changed sign across the highest and lowest levels of human development. In these groups, the presence of close friends who smoked and the exposure to secondhand tobacco smoke in the households were the most relevant explanatory factors.

No other investigations addressing gender gaps in adolescent smoking were identified in the literature, although two studies conducted in adults in Turkey and South Korea, applied a similar methodology^{29,30}. The Turkish investigation reported that employment condition and perceptions on tobacco taxation -two factors not assessed in our study- were the most relevant components of the explained part of the gap. On the

other hand, the study from South Korea found that marital status was the main factor explaining sex differences (11%). Interestingly, the role of educational level showed opposite signs in the two studies, in terms of increasing or reducing the gap. Our study was not capable of addressing educational status since the surveys were implemented in school settings by design.

In spite of the relative lack of evidence on the drivers that differentially impact boys and girls toward tobacco smoking, there is agreement on the need to identify and implement gender responsive policies in the general population. A report from the World Health Organization addresses this topic and provides examples on the differential impact of certain policies across sex and age.²⁷ For instance, young people seem to be more sensitive to price/taxation policies, while the style and appearance of cigarettes packages can be used to address or persuade boys and girls differentially. Moreover, women-centered, gender-sensitive tobacco exposure questions are recommended as routine parts of the antenatal and postnatal care programs, targeting smoking and tobacco smoke exposure in the mother at the household level. Other important initiatives that have been relatively underused are the sex-targeted mass media campaigns, aimed at addressing sex-related concerns and misconceptions. Our study showed that smoking prevalence among peers and misconceptions about weight control have differential explanatory roles in the sex gaps. Hence, there is a potential need for the delivery of sex-specific messages via information and promotion activities.

This is the first multi-country investigation to decompose the sex gap in smoking susceptibility and smoking prevalence among adolescents in Latin America. Our study also innovates in approaching the status of the tobacco epidemic in Latin America through the lens of human development, corroborating reports from other regions that show a direct association between higher levels of human development and smoking

trends among women. Through stratification, our study deals with the challenges derived from analyzing a highly unequal and heterogeneous region, which tends to provide misleading results when analyzed as a whole. However, this same characteristic of Latin America in terms of dispersion and inequality needs to be considered among the limitations for the interpretation of our results. Inequalities in the sub-region are pervasive not only across countries, but also across sub-national regions, states, and provinces. This fact calls for caution when reporting national data. In relation to this limitation, it must be mentioned that, upon the absence of nationally representative surveys for a certain time periods, large-city surveys were used after assessing that their information did not differ markedly from known national indicators. This could have introduced distortions in contexts where the size of the rural-urban gap was not marginal.

Other limitations arise from the selected definition of smoking susceptibility, which was originally composed of three questions. The third question (perception about smoking in five years) was not implemented in most of the surveys after the year 2009, so we decided to use the first two items to account for susceptibility after identifying other investigations on adolescents that dealt with the problem using this approach.^{15,31,32}

Finally, our study carries the limitation of not accounting for tobacco smoking substitutes, like diverse forms of smokeless tobacco. A report from the World Health Organization showed that smokeless tobacco prevalence in Latin America ranged from 3.6% in Bolivia, to 12.6% in Dominican Republic, with considerable differences across sex.³³ Although the risk of using this type of tobacco products is not yet fully understood, it is already accepted that it is not a safe substitute for tobacco smoking, and needs to be monitored.³⁴ Moreover, evidence shows that tobacco companies are incorporating

smokeless tobacco among their products and targeting teenagers as main potential consumers.^{35,36}

This study contributes by extending the body of evidence on smoking behaviors among youth in Latin America. While countries continue working on reducing the burden of tobacco consumption in the general population, targeted policies are required to address the specific characteristics and drivers of tobacco use among the youth and across sex.

References – Aim 1

1. GBD 2015 Tobacco Collaborators MB, Fullman N, Ng M, et al. Smoking prevalence and attributable disease burden in 195 countries and territories, 1990-2015: a systematic analysis from the Global Burden of Disease Study 2015. *Lancet*. 389(10082):1885-1906. 2017
2. World Health Organization. WHO | Global Health Estimates. *Glob Heal Estim*. Published online 2014.
3. WHO | WHO report on the global tobacco epidemic 2017. WHO. Published online 2017. Accessed April 28, 2018. http://www.who.int/tobacco/global_report/2017/en/
4. World Health Organization. Commission on Social Determinants of Health. *Closing the Gap in a Generation.*; Geneva, 2008.
5. Pierce JP, Choi WS, Gilpin EA, Farkas AJ, Berry CC. Tobacco industry promotion of cigarettes and adolescent smoking. *J Am Med Assoc*. 279(7):511-515. 1998
6. Warren C, Jones N, Eriksen M, Asma S, Global Tobacco Surveillance System (GTSS) collaborative group. Patterns of global tobacco use in young people and implications for future chronic disease burden in adults. *Lancet*. 367(9512):749-753. 2006.
7. Islami F, Stoklosa M, Drope J, Jemal A, Catto J. Global and Regional Patterns of Tobacco Smoking and Tobacco Control Policies. Published online 2015. Accessed July 9, 2018.
8. Hanewinkel R, Isensee B, Sargent JD, Morgenstern M. Cigarette Advertising and Adolescent Smoking. *Am J Prev Med*. Apr;38(4):359-66. 2010.
9. Linetzky B, Mejia R, Ferrante D, De Maio FG, Diez Roux A V. Socioeconomic

status and tobacco consumption among adolescents: a multilevel analysis of Argentina's Global Youth Tobacco Survey. *Nicotine Tob Res.*14(9):1092-1099. 2012

10. Pampel FC. Global Patterns and Determinants of Sex Differences in Smoking. *Int J Comp Sociol.* 47(6):466-487. 2006

11. Lopez AD, Collishaw NE, Piha T. A descriptive model of the cigarette epidemic in developed countries. *Tob Control.* 3(3):242-247.1994

12. Riahi M, Mohammadi AA, Rohani H, Bidkhori M. Dataset on the prevalence of tobacco smoking in men and women of selected countries whit difference human development. *Data Br.*18:506-511. 2018

13. CDC Foundation, World Health Organization, Lung Foundation. The GATS Atlas Global Adult Tobacco Survey. <http://www.gatsatlas.org/>

14. Report on Tobacco Control for the Region of the Americas WHO Framework Convention on Tobacco Control: 10 Years Later. Published online 2016.

15. Gritz ER, Prokhorov A V., Hudmon KS, et al. Predictors of susceptibility to smoking and ever smoking: A longitudinal study in a triethnic sample of adolescents. *Nicotine Tob Res.* Aug;5(4):493-506. 2003.

16. Veeranki SP, Mamudu HM, Anderson JL, Zheng S. Worldwide never-smoking youth susceptibility to smoking. *J Adolesc Heal.* Feb;54(2):144-50. 2014.

17. Warren CW, Riley L, Asma S, et al. Tobacco use by youth: A surveillance report from the Global Youth Tobacco Survey project. *Bull World Health Organ.*78(7):868-76. 2000

18. Pierce JP, Choi WS, Gilpin EA, Farkas AJ, Merritt RK. Validation of susceptibility as a predictor of which adolescents take up smoking in the United States. *Heal Psychol.*

19. J P Pierce, A J Farkas, N Evans EG. An improved surveillance measure for adolescent smoking? *Tob Control.* Sep;15(5):355-61.1996.

20. Norton EC, Miller MM, Kleinman LC. Computing Adjusted Risk Ratios and Risk Differences in Stata. *Stata J Promot Commun Stat Stata.*13(3):492-509. 2013

21. Fairlie RW. An Extension of the Blinder-Oaxaca Decomposition Technique to Logit and Probit Models. Fairlie, Robert W., An Extension of the Blinder-Oaxaca Decomposition Technique to Logit and Probit Models. Yale University Economic Growth Center Discussion Paper No. 873, IZA Discussion Paper No. 1917. 2006

22. Jann B. The Blinder-Oaxaca decomposition for linear regression models. *Stata J.* Vol 8; Number 4: pp. 453-479. 2008.

23. Bauer TK, Sinning M. An extension of the Blinder-Oaxaca decomposition to nonlinear models. *AStA Adv Stat Anal.* 92, pages197–206. 2008.

24. Fortin N, Lemieux T, Firpo S. Decomposition Methods in Economics. Handbook of Labor Economics, 4 th Edition, Elsevier North Holland. 2011.
25. United Nations Development Programme. Human Development Indices and Indicators 2018 Statistical Update.; 2018.
26. Thun M, Peto R, Boreham J, Lopez AD. Stages of the cigarette epidemic on entering its second century. *Tob Control*. 21(2):96-101. 2012
27. World Health Organization. Gender-Responsive Tobacco Control. Accessed June 3, 2019. <https://www.who.int/fctc/cop/sessions/cop8/Gender-Responsive-Tobacco-Control.pdf>
28. Hibell B, Guttormsson U, Ahlström S, et al. The 2011 ESPAD Report: Substance Use Among Students in 36 European Countries. Stockholm. 2012.
29. Üyesi Ö, Elitaş Z. Gender Gap In Smoking: A Nonlinear Decomposition Analysis for Turkey. *J Manag Econ Res*. 16:358-376. 2018
30. Chung W, Lim S, Lee S. Factors influencing gender differences in smoking and their separate contributions: Evidence from South Korea. *Soc Sci Med*.70:1966-1973. 2010
31. Fulmer EB, Neilands TB, Dube SR, Kuiper NM, Arrazola RA, Glantz SA. Protobacco Media Exposure and Youth Susceptibility to Smoking Cigarettes, Cigarette Experimentation, and Current Tobacco Use among US Youth. *PLoS ONE* 10(8): e0134734. 2015
32. Moskowitz JM. Assessment of Cigarette Smoking and Smoking Susceptibility among Youth: Telephone Computer-Assisted Self-Interviews versus Computer-Assisted Telephone Interviews. *Public Opin Q*. 68(4):565-587. 2004
33. World Health Organization. WHO | WHO Report on the Global Tobacco Epidemic 2013. World Health Organization. Geneva, 2013.
34. World Health Organization, International Agency for Research on Cancer. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 89: Smokeless Tobacco and Some Tobacco-Specific N-Nitrosamines. 2007.
35. Kostygina G, Ling PM. Tobacco industry use of flavourings to promote smokeless tobacco products. *Tob Control*.25(Suppl 2):ii40-ii49. 2016
36. Mejia AB, Ling PM. Tobacco industry consumer research on smokeless tobacco users and product development. *Am J Public Health*.100(1):78-87. 2010

Chapter 2 Acknowledgements

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Supplemental Material - Aim 1

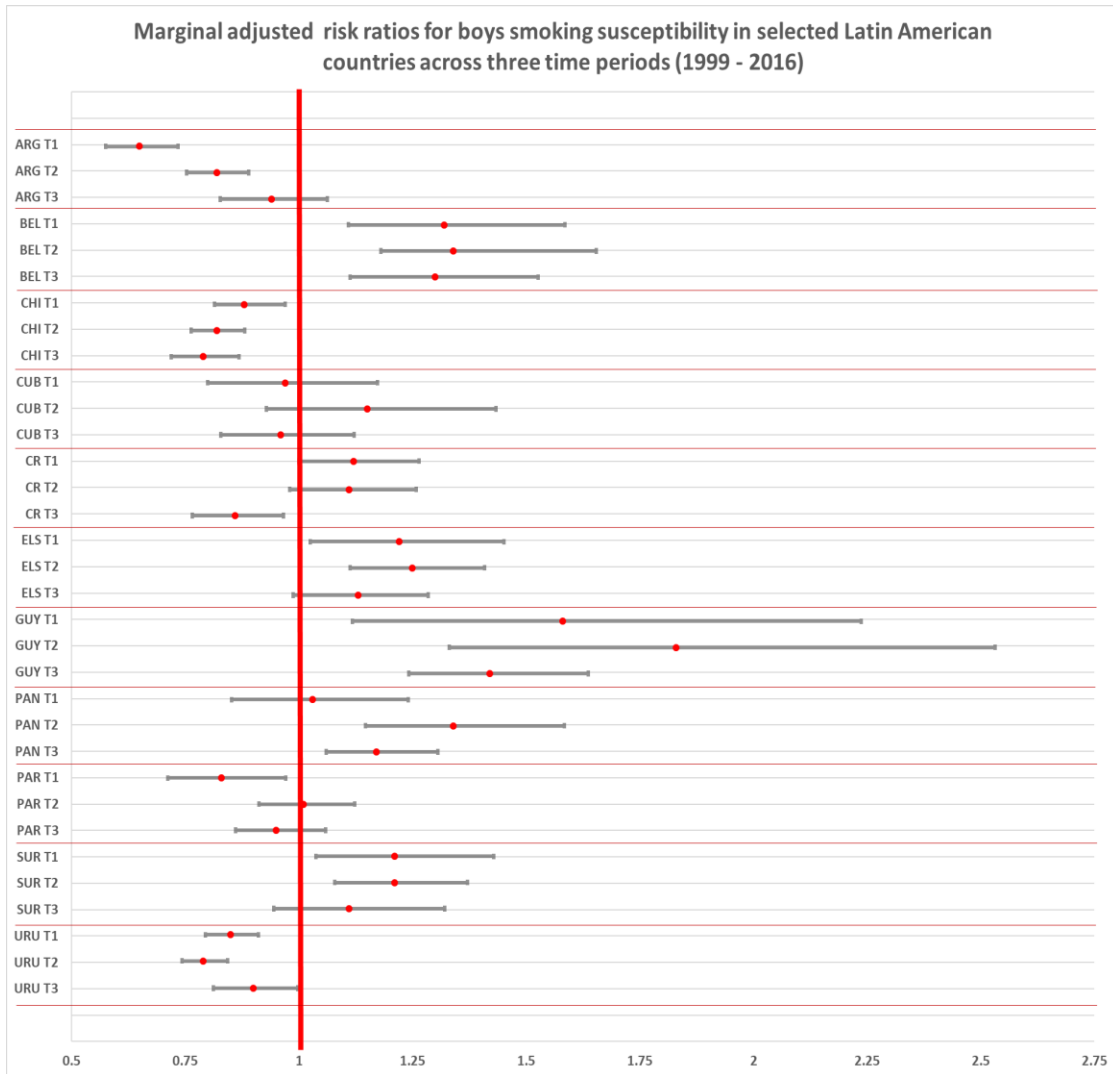


Figure 2-3 Marginal risk ratios for boys' smoking susceptibility in selected Latin American Countries (1999-2016)

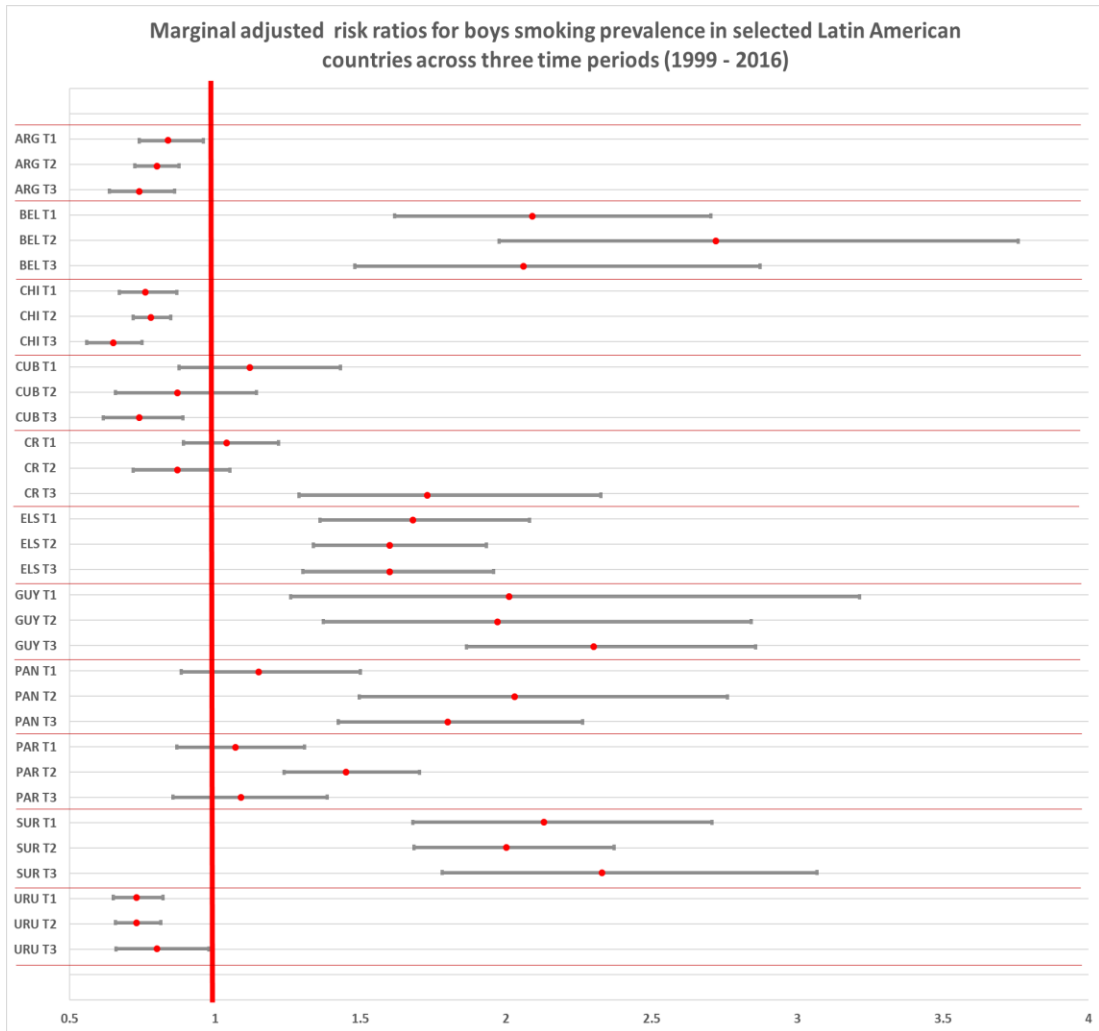


Figure 2-4 Marginal risk ratios for boys' smoking prevalence in selected Latin American Countries (1999-2016)

Supplemental Tables

Table 2-6 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Argentina

Sex differences (%)	Susceptibility	Smoking
Girls	42.3	28.4
Boys	34.2	22.9
Gap (boys-girls)	-8.2	-5.5
Percent difference explained		
Age	0.5	-0.6
Resources	-0.4	21.7
Environmental/Behavioral factors		28.2
Weight concerns	5.3	0.0
SHTS at home	2.6	4.3
Believe harms	-0.2	-1.0
Friends smoke	2.9	25.0
TV advertising	0.0	-0.1

Table 2-7 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Belize

Sex differences (%)	Susceptibility	Smoking
Girls	23.6	6.6
Boys	32.1	15.8
Gap (boys-girls)	8.5	9.2
Percent difference explained		
Age	7.8	5.5
Resources	7.3	4.8
Environmental/Behavioral factors		
Weight concerns	-0.2	0.0
SHTS at home	N/A	N/A
Believe harms	1.8	2.2
Friends smoke	12.7	20.5
TV advertising	0.9	1.1

Table 2-8 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Chile

Sex differences (%)	Susceptibility	Smoking
Girls	54.0	31.9
Boys	45.1	24.9
Gap (boys-girls)	-8.9	-7.0
Percent difference explained		
Age	-0.4	-0.6
Resources	-3.0	21.7
Environmental/Behavioral factors		
Weight concerns	-1.0	0.0
SHTS at home	9.1	4.3
Believe harms	0.9	-1.0
Friends smoke	14.5	25.0
TV advertising	1.0	-0.1

Table 2-9 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Costa Rica

Sex differences (%)	Susceptibility	Smoking
Girls	26.9	10.7
Boys	27.5	11.4
Gap (boys-girls)	0.6	0.7
Percent difference explained		
Age	1.6	-8.2
Resources	N/A	N/A
Environmental/Behavioral factors		
Weight concerns	-0.9	14.7
SHTS at home	1.1	-3.5
Believe harms	0.0	4.4
Friends smoke	3.4	-7.8
TV advertising	5.7	-3.9

Table 2-10 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Cuba

Sex differences (%)	Susceptibility	Smoking
Girls	18.3	12.4
Boys	18.7	10.6
Gap (boys-girls)	0.4	-1.8
Percent difference explained		
Age	-0.5	1.5
Resources	-10.4	23.1
Environmental/Behavioral factors		
Weight concerns	0.7	-1.8
SHTS at home	10.4	-32.6
Believe harms	-1.9	-0.2
Friends smoke	3.7	-11.9
TV advertising	-0.4	1.6

Table 2-11 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for El Salvador

Sex differences (%)	Susceptibility	Smoking
Girls	22.3	9.2
Boys	27.1	15.7
Gap (boys-girls)	4.8	6.5
Percent difference explained		
Age	-2.8	10.1
Resources	19.8	12.2
Environmental/Behavioral factors		
Weight concerns	-26.9	-7.4
SHTS at home	2.6	0.9
Believe harms	2.6	2.2
Friends smoke	10.1	22.4
TV advertising	14.9	8.8
Total difference explained	20.3	49.2

Table 2-12 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Guyana

Sex differences (%)	Susceptibility	Smoking
Girls	14.7	6.0
Boys	22.0	13.6
Gap (boys-girls)	7.3	7.6
Percent difference explained		
Age	0.5	0.0
Resources	-0.4	4.4
Environmental/Behavioral factors		
Weight concerns	5.3	1.7
SHTS at home	2.6	5.4
Believe harms	-0.2	2.2
Friends smoke	2.9	11.5
TV advertising	0.0	0.1

Table 2-13 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Panama

Sex differences (%)	Susceptibility	Smoking
Girls	21.5	6.9
Boys	20.6	8.8
Gap (boys-girls)	-0.9	1.9
Percent difference explained		
Age	-0.2	15.0
Resources	-32	21.5
Environmental/Behavioral factors		
Weight concerns	18.9	3.9
SHTS at home	N/A	N/A
Believe harms	0.4	-0.3
Friends smoke	0.6	-5.9
TV advertising	4.0	3.4

Table 2-14 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Paraguay

Sex differences (%)	Susceptibility	Smoking
Girls	42.3	28.4
Boys	34.2	22.9
Gap (boys-girls)	-8.2	-5.5
Percent difference explained		
Age	0.5	2.9
Resources	-0.4	N/A
Environmental/Behavioral factors		
Weight concerns	5.3	0.9
SHTS at home	2.6	N/A
Believe harms	-0.2	8.5
Friends smoke	2.9	17.6
TV advertising	0.0	0.4

Table 2-15 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Suriname

Sex differences (%)	Susceptibility	Smoking
Girls	14.6	6.4
Boys	22.0	13.6
Gap (boys-girls)	7.4	7.2
Percent difference explained		
Age	0.04	-0.1
Resources	4.4	7.6
Environmental/Behavioral factors		
Weight concerns	1.7	0.6
SHTS at home	5.4	15.6
Believe harms	2.2	0.9
Friends smoke	11.5	16.8
TV advertising	0.1	1.3

Table 2-16 Country analysis. Decomposition of smoking susceptibility and smoking prevalence for Uruguay

Sex differences (%)	Susceptibility	Smoking
Girls	44.0	18.6
Boys	37.4	14.1
Gap (boys-girls)	-6.6	-4.5
Percent difference explained		
Age	0.19	1.2
Resources	0.62	1.4
Environmental/Behavioral factors		
Weight concerns	0.7	-5.0
SHTS at home	N/A	N/A
Believe harms	0.7	-1.2
Friends smoke	5.1	12.2
TV advertising	0.3	0.3

Supplemental Figures



Figure 2-5 Trends in smoking susceptibility for boys and girls in eleven Latin American Countries (1999-2016)

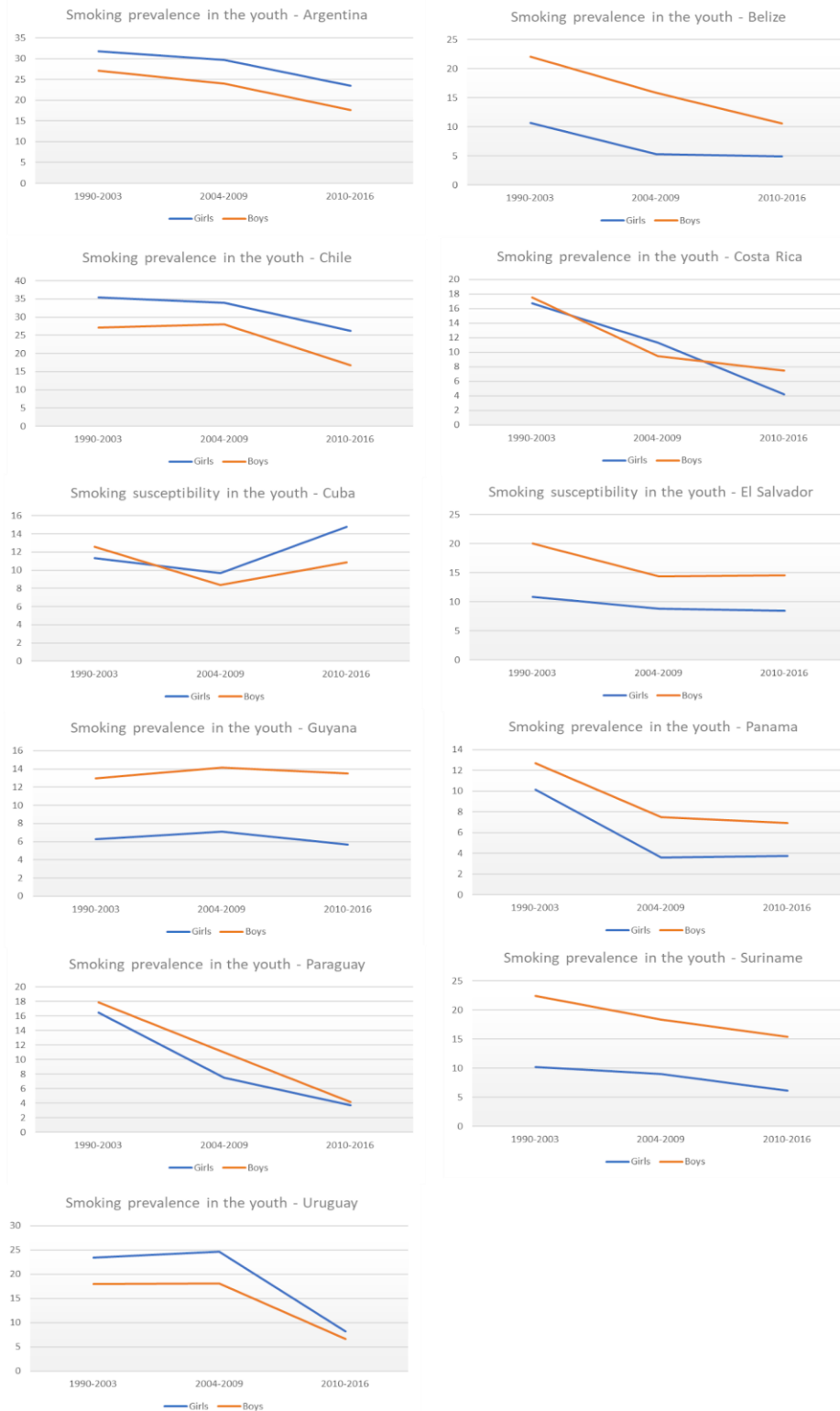


Figure 2-6 Trends in smoking susceptibility for boys and girls in eleven Latin American Countries (1999-2016)

Chapter 3 - Aim 2 – Sex-specific trends in smoking prevalence across income categories during periods of changing cigarette prices in Mexico between 2000 and 2018

Abstract

Introduction

While most of the countries in the world report an inverse association between adult tobacco smoking prevalence and income categories, Mexico represents an exception to the rule. In this scenario, changes in smoking prevalence across income categories in the context of varying cigarettes prices was not yet fully explored. We analyzed smoking prevalence and income inequalities among the adult smoking population in Mexico across two tobacco taxation periods between the years 2000 and 2018.

Methods

Data was obtained from six nationally representative cross-sectional surveys conducted in Mexico between 2000 and 2018. Smoking prevalence and income inequality indices for the adult smoking population were analyzed in the context of a relatively aggressive tobacco taxation policy, before the year 2012, and a more relaxed one between 2012 and 2018. The analysis was expanded to the Mexican federative entities level in search for geographical variations and patterns.

Results

The inverse association between income and smoking prevalence persisted in Mexico during the entire period. Individuals in the lowest income groups, particularly

women, seemed to be affected by the relaxation of the tobacco taxation policy, increasing their smoking prevalence. Income inequalities among the smoking population were reduced during the lower taxation phase. No geographical patterns were identified.

Conclusions

Mexico is an outlier in terms of the association between population income and smoking prevalence. As the income inequalities among the smoking population are already favoring the most disadvantage groups (fewer negative outcomes in the lowest income groups) the reduction in income inequalities during the relaxation of the taxation policy after the year 2012 represents an adverse result. Poor women in Mexico showed to be relatively more sensitive to changes in cigarettes prices.

Introduction

The tobacco epidemic claims over 8 million lives each year worldwide, including 7 million dying from direct consequences of smoking and over 1.2 million from second-hand exposure to tobacco smoke.¹ One million deaths every year are attributable to tobacco use with a general prevalence of 17.1% in adults, equivalent to 125 million smokers. The direct costs over the health systems attributed to smoking are approximately US\$33 billion, and to 7% of Latin America's total annual spending on health.²⁻⁴

Tobacco consumption is associated with lower income levels, as reported by two large meta-analyses. There is strong evidence regarding an inverse dose response between income and cigarette consumption.⁵⁻⁷ Among the potential explanations for this type of association, educational disparities, reduced access to information, normalization of smoking, less concerns about long term harms, and reduced affordability and access to cessation support like nicotine replacement therapies, have been proposed.^{5,6,8} In addition, the association seems to be stronger among women.⁷ However, other studies analyzing the socio-economic gradients of smoking showed a positive gradient (higher smoking prevalence among higher socio-economic status) in certain world regions and a negative gradient in others, as well as significant difference between younger and older women. In the case of Latin America, no clear gradients were observed among either sex, but overall, most of the countries converge in showing higher smoking prevalence among the more disadvantaged populations, Mexico being one of the exceptions.^{9,10,11}

Although diverse studies report the relatively atypical direct association between income and tobacco use in Mexico, the reasons why the Mexican population does not

fulfill the general rule are yet to be explained. A study addressing the relation between socio-economic status and smoking in 13 low-and middle-income countries found Mexico as the only exception to the finding of higher smoking prevalence among the lower wealth strata, but no explanatory hypotheses were proposed.¹² Moreover, a study conducted on a sample of 2,540 Mexican smokers from the International Tobacco Control Survey between 2010 and 2012 showed that higher neighborhood deprivation was associated with less intense smoking, above and beyond individual-level income and educational factors. The study did not propose a hypothesis to explain these findings.¹¹ Another Mexican study conducted on adolescents and young adults reported that availability of economic resources was a significant factor in the transition from experimentation to active smoking, increasing the smoking prevalence in this population.

10

In terms of sex differences, both globally and in Latin America, tobacco use prevalence has increased in women, particularly in teenagers and low-income groups. The World Health Organization (WHO) already warned about a growing feminization of tobacco use in 2017, with an emphasis on teenagers.¹ The tobacco industry's active targeting of this population is considered a main driver of this trend.¹³ A similar pattern is observed in Mexico, where smoking prevalence among adult women was 8.2% in 2015, but 12.9% among girls 13-15 years old.¹⁴ Moreover, the percentage of occasional smokers between 2009 and 2015 had increased 2.3% among adult men, and 12.1% among adult women.¹⁵

Measuring both the absolute (slope) and the relative index of inequalities is a useful approach to observe and analyze the effect of factors that directly affect individual or families' income and expenditures, as is the case of price changes of goods like cigarettes. The slope index of inequalities (SII) is estimated as the expected difference in

smoking prevalence between the bottom versus the top of the socio- economic distribution, and the relative index of inequalities (RII) is the ratio of the same two estimates. In terms of income and educational inequalities in association with tobacco use, the evidence shows variations according to country income levels. Income inequalities in the smoking population seem to be higher in low-income countries and lower in upper middle countries, with wide variations in lower-middle countries, where most of Latin American are categorized.¹⁶ In terms of sex differences, income inequalities among men show lower smoking prevalence among higher SES men who smoke. Among women, these inequalities follow the same pattern in low- and lower-middle-income countries, but reverse in many upper-middle income countries, like Mexico, meaning that lower income women appear to smoke less than higher income women in this group.¹⁷

Understanding the case of Mexico both in terms of smoking prevalence and the income inequalities among smoking men and women is key to contextualize tobacco control policies that have a direct impact on individual and family income and expenditures, like tobacco taxation. This understanding can contribute to explaining the effect of this policy for a scenario that does not necessarily compare to other countries and can inform a more effective policymaking process.

A study exploring potential taxation scenarios in Mexico showed that introducing a higher tax on cigarettes would have a progressive effect on the income distribution, allowing the population with lowest income to increase their income level through a reduction in their expenditures on cigarettes, healthcare, and ultimately allowing them to be more productive.¹⁸ Moreover, the relative effect on income would be higher among the households with the lowest income. Another study using simulation reported that a 10% increase in the cigarette tax would yield a 6.4% decrease in consumption of

cigarettes.¹⁹ Nonetheless, Mexico has been applying relatively erratic tobacco taxation policies during the past 20 years, including a relatively aggressive phase up to year 2012, followed by a relaxed period in which taxes did not change, making cigarettes more affordable as a result of inflation and the evolution of the population's income.²⁰

Our investigation used national surveys to explore the sex-specific changes in smoking prevalence across income categories in the smoking population in Mexico between the years 2000 and 2018, measuring the relative and absolute inequalities in smoking prevalence between high- and low-income groups as changes in the taxation policies took place. We used panel data to explore the association between changes in price and variations in smoking inequalities across income categories. Finally, we explored whether variation in prices were associated to changes in the inequality indices across Mexican Federative Entities (equivalent to states or provinces in other countries).

Methods

Study population and variables

Data were pooled from six nationally representative cross-sectional surveys conducted in 2000, 2006, 2008, 2012, 2016, and 2018 by the Mexican Institute of Statistics and Geography (INEGI) using the same multistage cluster design. In total 264,411 observations were recorded, representing 386 million respondents. In line with the two clear time periods in terms of cigarettes taxation, the surveys from 2000, 2006 and 2008 were grouped as phase 1 (higher taxation), and those from years 2012, 2016, and 2018 as phase 2 (stable taxation). Since population age varied across surveys, we removed all observations from individuals under 18 years old.

Smoking (yes/no) was considered positive for respondents who reported smoking at least one cigarette during the past 30 days. Income was collected in a

continuous scale, including the income obtained through employment and other sources, and was categorized into quintiles. Age was used as a continuous variable and sex was reported as male/female. Other covariates used in the analyses include the historic price of cigarettes, which was collected from INEGI, as well as annual inflation rates that allowed for the incorporation of two variables to the dataset: nominal price and inflation-adjusted price. In both cases, prices belong to the most consumed brand and type of cigarettes (Marlboro Red with filter, 20 cigarettes per pack). This measure for tobacco cigarettes prices was used because it was available consistently across years and federative entities.

Analysis

All analyses were stratified by sex. Smoking prevalence was weighted to be nationally representative and was estimated overall and by income quintile (Q1, lowest to Q5, highest) for each survey year.

The relative index of inequality (RII) and the slope index of inequality (SII) are two major measures used in epidemiologic studies to quantify the socioeconomic gradient in relative and absolute terms.²¹ For both absolute and relative calculations, a weighted sample of the whole population is ranked from the most-disadvantaged subgroup to the most-advantaged subgroup. This ranking is weighted, accounting for the proportional distribution of the population within each subgroup. We estimated absolute RII and SII in smoking men and women in Mexico, which are regression-based summary indices of inequality that provide a measure of the gradient in smoking across income groups. SII and RII were estimated for each sex and for each taxation phase, adjusting by age and using fixed effects to control for differences between the federative entities. For the estimations, we used General Linear Models with a binomial distribution, with an identity link function for the SII and log link function for the RII.

The SII can be interpreted as the population-adjusted prevalence difference and the RII as the prevalence ratio between those at the hypothetical bottom vs. top of the income hierarchy. $SII > 0$ or $RII > 1$ indicates a higher prevalence in lower vs. higher income groups, $SII < 0$ or $RII < 1$ indicates higher prevalence in higher vs. lower income groups, and $SII = 0$ or $RII = 1$ indicates no inequality. Nice description.

Finally, we estimated the percentage changes in the sex specific RIIs across the two taxation phases for each Federative Entity and generated heatmaps to present the results.

Results

Six surveys from the National Institute for Statistics and Geography of Mexico, between 2000 and 2018 were analyzed. Mean age of the respondents was 42.5 years and the proportion of males remained stable between 46% and 48%.

Table 3.1 shows that, overall, both men and women showed increasing smoking prevalence in correlation to higher income, from Q1 (lowest income) to Q4 in all surveys, with relative reductions between Q4 and Q5 in most cases. Smoking prevalence decreased 5.4 percentage points over the 18-year period in men and 0.8 percentage points in women. Overall, the maximum reductions in men were observed in the highest and the lowest income categories (9% reduction for both?) followed by 6.1% in Q4, while the middle category (Q3) remained stable. All the income groups among women increased their smoking prevalence between 3% to 4%, except for the lowest income quintile, which showed a reduction of around 1.5 percentage points. All income groups showed increased smoking prevalence by the end of the high taxation phase (year 2012), except for the highest income group among men which showed a reduction of 4.6 percentage points.

Table 3-1 Smoking prevalence in Mexico between 2000 and 2018 by sex and across income quintiles

	Year						Total/Mean
	2000	2006	2008	2012	2016	2018	
Individuals	52,271,216	59,975,492	61,456,826	69,889,608	59,922,506	82,760,759	386 M
Percent males	48.1	45.3	46.8	47.3	45.3	45.4	46.3
Mean age	38.7	42.4	36.3	42.0	42.4	44.2	42.5
Smoking prevalence in men	33.8	30.3	30.7	35.7	30.3	28.4	31.4
Income Q1	33.9	N/A	25.4	34.5	27.4	24.5	28.3
Income Q2	33.4	N/A	29.2	37.2	28.7	32.9	32.1
Income Q3	32.7	N/A	34.4	41.5	34.6	32.7	35.1
Income Q4	34.0	N/A	34.5	40.4	35.2	27.9	34.3
Income Q5	33.9	N/A	30.4	29.2	27.7	24.6	22.5
Smoking prevalence in women	10.0	9.5	10.8	11.9	9.5	9.2	10.1
Income Q1	8.1	N/A	5.1	14.1	8.7	6.7	7.6
Income Q2	8.6	N/A	8.8	14.6	11.0	12.3	11.0
Income Q3	10.3	N/A	13.7	16.4	14.5	14.6	13.9
Income Q4	10.2	N/A	18.4	17.2	15.5	14.9	15.6
Income Q5	10.4	N/A	19.3	21.6	16.3	13.7	16.1
Nominal price of cigarettes	14.4	20.1	28.2	40.0	47.5	52.0	24.1
Inflation-adjusted price of cigarettes	18.9	21.7	32.4	40.0	40.9	39.6	26.2

Cigarettes prices refer to the most sold band in Mexico: Marlboro Red x 20 Cigarettes. Both nominal and adjusted prices are presented in Mexican Pesos (\$ Mx). N/A: Not-available

Figure 3.1 presents the evolution of nominal and inflation-adjusted price of cigarettes in Mexico. The nominal price of cigarettes increased over time from 14.4 Mexican Pesos in 2000 to 52.0 Mexican Pesos in 2018. However, the inflation-adjusted price increased markedly between 2006 and 2012 (from 21.7 to 40.0 pesos), during the aggressive phase of the taxation policy, but remained stable afterwards, between 2012 and 2018, when taxes remained unchanged.

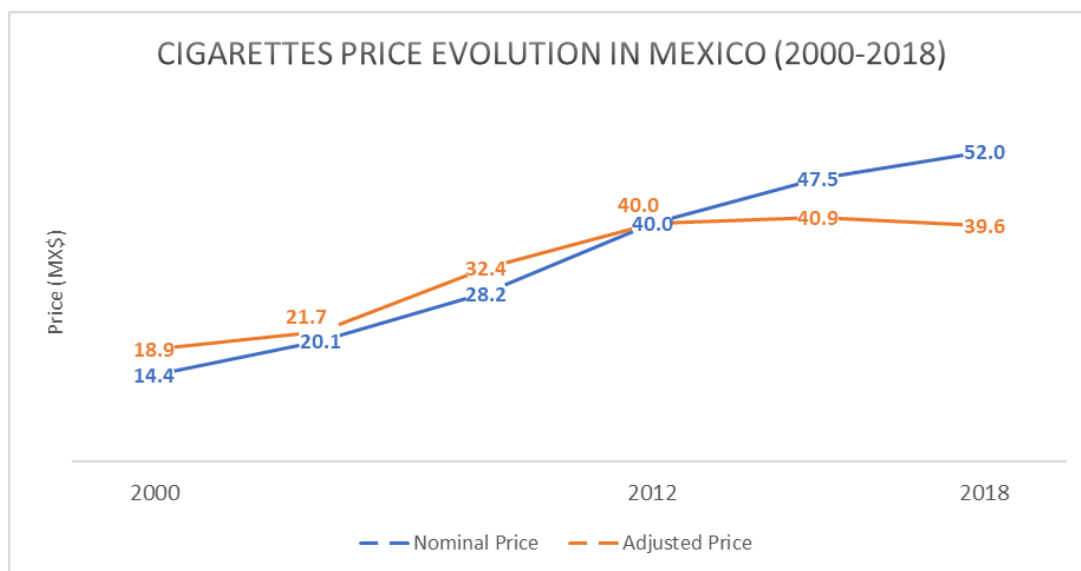


Figure 3-1 Nominal and inflation adjusted cigarettes price in Mexico (2000 to 2018)

Prices refer to the most sold band in Mexico: Marlboro Red x 20 Cigarettes. Both nominal and adjusted prices are presented in Mexican Pesos (\$ Mx)

Collapsing the six surveys into two taxation phases, where the first one (increasing, before 2012) and the second (stable, between 2012 and 2018) allows to explore certain effects of the policy across sex and income categories.

Figure 3.2 shows the prevalence of tobacco smoking for each income quintile and sex, across the two taxation phases. The two lowest income groups among women smoked 36% and 26% more during phase two (stable taxes) as compared to the increasing taxation phase, suggesting a favorable effect of the policy within this group. On the other hand, men in the lowest income group did not show changes in smoking prevalence between the two phases. For the middle-income category, minor benefits were registered for both sexes. On the other limit of the income spectrum, Q4 and Q5 did not seem to be positively affected. In fact, men in these groups smoked more during the increasing taxation phase as compared to the period after 2012.

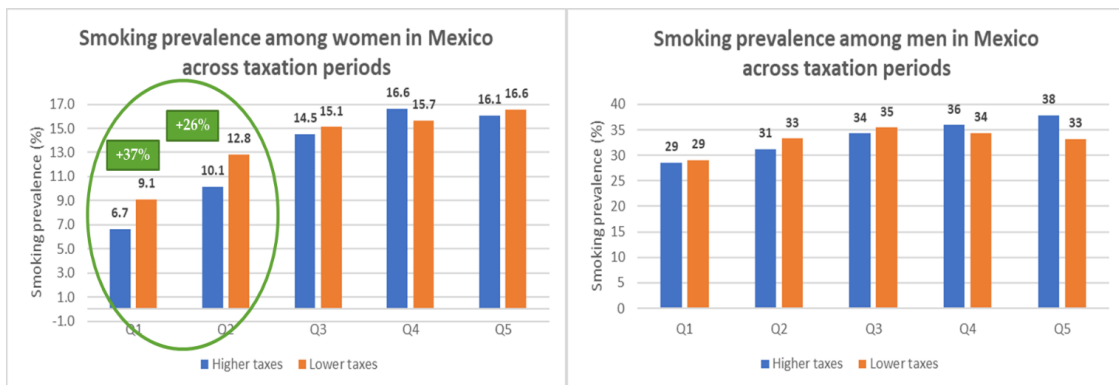


Figure 3-2 Changes in smoking prevalence by sex across taxation phases in Mexico

Table 3.2 presents relative income inequalities and slope income inequalities in smoking prevalence for each taxation phase, stratified by sex and adjusted for age and federative entity. SII over zero or RII above one indicate a higher prevalence of smoking

in lower vs. higher income groups. Conversely, SII below 0 or RII below 1 indicate higher smoking prevalence in higher vs. lower income groups. For example, the table shows a relative inequality of 0.84 in smoking women during the higher taxation phase, suggesting that the relative difference in smoking among women between the first and last income quantile was 16% (poor women smoking less). During that same phase of high taxation, inequalities among men were less marked, with men in the lowest income group smoking 5% less than those with the highest income. In the stable taxation phase, after year 2012, income inequalities in smoking decreased among both men and women, becoming almost nonexistent among men (RII of 0.98).

The slope index of inequality shows absolute differences between the adjusted means of smoking prevalence between the lowest and highest income groups. For example, women in the lowest income quantile during the high taxation phase smoked 1.6% less than women in the highest income group. This difference narrowed to 1.4% in phase two. Overall, the table shows higher income inequalities during the high taxation phase, that were apparently driven by a positive effect of reduced smoking (mostly for women) among those in the lowest income groups.

*Table 3-2 Relative and absolute income inequality indices on smoking prevalence across taxation phases for men and women in Mexico**

	Increasing taxation			Stable taxation		
Relative Inequalities	95% CI			95% CI		
	RII	Lower	Upper	RII	Lower	Upper
Women	0.84	0.82	0.88	0.86	0.84	0.88
Men	0.95	0.94	0.97	0.98	0.97	0.99
Absolute Inequalities	95% CI			95% CI		
	SII	Lower	Upper	SII	Lower	Upper
Women	-0.016	-0.013	-0.018	-0.014	-0.012	-0.015
Men	-0.015	-0.010	-0.020	-0.005	-0.001	-0.008

*-Adjusted for age and Federative Entity.

Finally, in exploration of income inequalities in smoking across the Mexican Federative Entities, we estimated the percentage change in RII by sex between the two taxation phases. Figure 3.3 below shows heatmaps of Mexico for women and for men. The color spectrum varies from green to red, where green means negative change (income-related smoking inequalities were increased during high taxation in relation to the low taxation period), yellow represents no change, and orange/red show increased income-related smoking inequality during low taxation in relation to the high taxation period.

The figures reflect that inequalities varied with more intensity in women, with two federative entities (Durango and Campeche) showing high rises during low taxation and several other showing less marked increases. The chart on men shows less dispersion in general with no federative entity reaching high variations in any direction. Geographically, no regional pattern was identified for neither sex.



Figure 3-3 Changes in income inequalities among smoking men and women adults in Mexico across two cigarette taxation phases, by Federative Entity

Discussion

Our research explored sex-specific changes in smoking prevalence and income inequalities in Mexico across two different stages of tobacco taxation, characterized by a first phase (up to year 2012) of increasing cigarette prices, and a second one (after

2012) where prices remained relatively unchanged when adjusted by inflation. Our analysis shows that smoking prevalence remained higher among high income groups in both sexes. In association to varying tobacco taxation strategies, adjusted prices on tobacco products increased between 2006 and 2012.

When aggregating tobacco smoking prevalence by sex in the two mentioned taxation phases, we observed that income-related inequalities among the smoking population were higher during the high taxation stage, predominantly in women. These higher inequalities resulted mostly from reductions in smoking prevalence among low-income populations, who were already reporting lower smoking prevalence. This suggests that higher taxation was overall effective among them. On the other side of the income spectrum, the two highest income categories, among both men and women, did not seem to be affected by increased taxation. This finding goes in line with previous research reporting that tobacco taxation carries higher benefits and more frequent behavioral changes in low income populations^{18,22}

In the analysis of income inequalities in the smoking population, we observed pro-equity indices (lower prevalence among lower income groups) across both stages of tobacco taxation. In addition, we found that increasing prices were associated to increased inequalities in both sexes, which meant an expansion of a gap that was already protective of the lowest income population quantiles. Higher inequalities during the higher taxation phase resulted mostly from reductions in smoking prevalence among low-income populations and particularly among women. These findings suggest that higher prices had a pro-equity effect since the most vulnerable received higher benefits from the regulatory policy when applied more intensively. Our results partially align with those presented in a meta-analysis analyzing income and educational inequalities in the smoking population across country income categories. Although Mexico was not part of

the study, upper-middle-income countries in general showed pro-equity inequality indices among women, but not in men. ¹⁷

One of the limitations of our study is the fact that we collected and used price information on a single type and brand of cigarettes. Changes in the price of a specific and massively consumed brand is likely to represent changes in other brands, but the extent of those changes are unknown to us, introducing the possibility that the actual effect of taxation on prices was in fact accentuated.

Our study adds to the existing evidence that shows Mexico as an anomaly in terms of the widely reported direct association between smoking and poverty. Overall, smoking prevalence dropped mildly in the country between 2000 and 2018. However, women in the lowest income categories were sensitive to increasing tobacco prices as shown by a reduced smoking prevalence during the increasing taxation phase. The fact that low-income groups were already reporting lower smoking prevalence made the expansion of the inequality gap a pro-equity factor. On the other hand, men in the lowest income group showed a minimal response in terms of smoking reductions and those in the highest income groups even increased their smoking prevalence. These findings were also visible at the subnational level, in which Mexican women showed higher variations in the relative indices of income inequalities across taxation phases as compared to men.

Our analysis reinforces the need to conduct research at the country level, given that regional aggregates can mislead the interpretations in regions as heterogeneous as Latin America. Regional differences within and between countries need to be examined, keeping into consideration the relevance of addressing sex differences.

References - Aim 2

1. WHO | WHO report on the global tobacco epidemic 2017. Geneva. 2018
2. Pan American Health Organization. Report on Tobacco Control for the Region of the Americas WHO Framework Convention on Tobacco Control: 10 Years Later. Washington DC. 2016
3. Etienne CF. Curbing the tobacco epidemic in the Americas. *Rev Panam Salud Publica*. 40(4). 2016.
4. Pan American Health Organization. Report on Tobacco Control in the Region of the Americas. Washington DC. 2018.
5. Casetta B, Videla AJ, Bardach Phd A, et al. Review Association Between Cigarette Smoking Prevalence and Income Level: A Systematic Review and Meta-Analysis. *Nicotine Tob Res*.19(12):1401-1407. 2017
6. Bardach A, Andrés H, Perdomo G, Amanda R, Gándara R, Ciapponi A. Niveles de ingreso y prevalencia de tabaquismo en América Latina: revisión sistemática y metaanálisis. *Rev Panam Salud Publica Pan Am J Public Heal*. 40(4). 2016
7. B C, AJ V, A B, et al. Association Between Cigarette Smoking Prevalence and Income Level: A Systematic Review and Meta-Analysis. *Nicotine Tob Res*.19(12). 2017
8. Bardach A, Andrés H, Perdomo G, Amanda R, Gándara R, Ciapponi A. Income levels and prevalence of smoking in Latin America: a systematic review and meta-analysis*. *Rev Panam Salud Publica Pan Am J Public Heal*. 40(4). 2016
- Kunst AE. Socioeconomic inequalities in smoking in low- and mid-income countries: Positive gradients among women? *Int J Equity Health*.13(1). 2014.
10. Reddy Jacobs C, Tellez-Rojo MM, Meneses-Gonzalez F, CDampuzano-Rincon J, Hernandez-Avila M. Pobreza, jóvenes y consumo de tabaco en México. *Salud Publica Mex*. 48:s83-s90. 2006
11. Fleischer NL, Thrasher JF, de Juárez BSM, et al. Neighbourhood deprivation and smoking and quit behaviour among smokers in Mexico: Findings from the ITC Mexico survey. *Tob Control*. 24(Suppl 3):ii56-iii63. 2015.
12. Palipudi KM, Gupta PC, Sinha DN, Andes LJ, Asma S, McAfee T. Social Determinants of Health and Tobacco Use in Thirteen Low and Middle Income Countries: Evidence from Global Adult Tobacco Survey. *Plos One*. 7(3):e33466. 2012.
13. Pierce JP, Choi WS, Gilpin EA, Farkas AJ, Berry CC. Tobacco industry promotion of cigarettes and adolescent smoking. *J Am Med Assoc*.279(7):511-515.1998
14. Campaign for Tobacco-Free Kids. The Toll of Tobacco in Mexico - Campaign for Tobacco-Free Kids (en). Accessed January 16, 2021. <https://www.tobaccofreekids.org/problem/toll-global/latin-america/mexico>

15. The World Bank. Mexico: Overview of Tobacco Use, Tobacco Control Legislation, and Taxation. Mexico DF. 2019.
16. Sreeramareddy CT, Harper S, Ernstsen L. Educational and wealth inequalities in tobacco use among men and women in 54 low-income and middle-income countries. *Tob Control*. Jan;27(1):26-34. 2016.
17. Sreeramareddy CT, Harper S, Ernstsen L. Educational and wealth inequalities in tobacco use among men and women in 54 low-income and middle-income countries. *Tob Control*. Jan;27(1):26-34. 2016.
18. Macias Sánchez A, Mx A. Increasing Tobacco Taxes Benefits the Poor. *Tobbaconomics*. Policy Brief. Apr 2020
19. Jiménez-Ruiz JA, Sáenz de Miera B, Reynales-Shigematsu LM, Waters HR, Hernández-Avila M. The impact of taxation on tobacco consumption in Mexico. *Tob Control*.17(2):105-110. 2008
20. Assessment of Tobacco Use and Control: Mexico | Institute for Health Metrics and Evaluation. Accessed August 2, 2020. <http://www.healthdata.org/policy-report/assessment-tobacco-use-and-control-mexico>
21. Moreno-Betancur M, Latouche A, Menvielle G, Kunst AE, Rey G. Relative Index of Inequality and Slope Index of Inequality. *Epidemiology*. 26(4):518-527. 2015.
22. Hill S, Amos A, Clifford D, Platt S. Impact of tobacco control interventions on socioeconomic inequalities in smoking: review of the evidence. *Tob Control*. 23(e2):e89-97. 2014

Chapter 3 Acknowledgements

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Chapter 4 - Aim 3 - Impact of Uruguay's comprehensive tobacco control policy on smoking among the youth

Abstract

Introduction

Smoking affects teenagers in Latin America with large variations across countries, in a prevalence spectrum between 2% and over 20%. Evidence shows that adolescents do not necessarily respond in the same way to tobacco control policies that showed effectiveness among the adults, as well as a progressive feminization of the smoking trends among higher income countries. We analyzed sex-specific smoking prevalence among the youth in Uruguay, one of the leading countries in the fight against tobacco in the region, after the implementation of a comprehensive tobacco control policy.

Methods

We used data from the Global Youth Tobacco Survey in Uruguay to capture prevalence, access, media exposure and attitudes related to tobacco smoking among teenagers. We selected Argentina as a comparison group, based on close population similarities with Uruguay and since no comprehensive tobacco control policy was implemented during the time period under evaluation. We designed a difference-in-differences (DiD) model to assess smoking prevalence before and after the implementation of the Uruguayan policy in 2008.

Results

Both countries showed reductions in smoking prevalence in boys and girls, although Uruguay presented larger reductions, from 25.8% to 8.6% among girls and from 19.9% to 7.2% among the boys as compared to 31.8% to 25.5% and 27.8% to 20.6% among girls and boys respectively in Argentina. The DiD model showed significant differences in Uruguay, with adjusted pre-post reductions of 66% (IRR 0.34, 95% CI 0.28-0.41) and 59% (IRR 0.41, 95% CI 0.32-0.50) for girls and boys respectively.

Discussion

Although existing evidence supports the idea of increased use of tobacco among females in higher income countries, Uruguay, a middle-high income country in Latin America, showed higher reductions in smoking prevalence among young women than young men after the implementation of a comprehensive tobacco control policy. Our study supports the need for local assessments at the country level as a key tool for policy design in tobacco control.

Introduction

Smoking is a leading risk factor for early death and disability worldwide, claiming over 7 million lives per year since 1990, with projections reaching 10 million by 2030. Although many countries are showing remarkable improvements in tobacco control, the burden of disease and disability associated with tobacco use is growing, especially in low- and middle-low- income countries.^{1,2} In addition, smoking prevalence among the youth is showing concerning trends in several countries across the planet.³

The global tobacco epidemic is evolving differently across countries and population groups. In particular, adolescent smoking patterns often do not reflect that of the general adult population. Latin America shows a significant heterogeneity in the prevalence of cigarette smoking among youth, ranging from 2.4% in Dominican Republic, to around 20% in Argentina, Colombia and Chile.⁴ Higher rates of tobacco uptake among youth are associated with a reduced ability to resist peer pressure, lack of awareness of tobacco harms, and psychosocial stress, among others.⁵ Moreover, specific targeting actions by the tobacco industry also play a significant role in youth smoking. Several studies have reported on diverse risk factors for experimentation with tobacco among youth, including exposure to second hand tobacco smoke in the household, peer pressure, misinformation on the harms of tobacco, and the influence of advertising and youth-targeted campaigns.⁶⁻⁹

Latin American countries also show heterogeneity by sex in smoking prevalence among teenagers. While most countries show higher prevalence among boys, others report similar prevalence (Brazil, Colombia, and Uruguay), and a third group presents an inverted ratio (Argentina and Chile). Because young women tend to be affected by a wide range of social disparities, it is important to pay special attention to sex gaps within

the policy design process, as a way to decrease unjustified inequalities in health and social outcomes. In the case of cigarette smoking, changes in gender equality, economic development, and countries' cultural characteristics can potentially drive differences between men and women in tobacco use.^{8,10,11}

As a regional and global leader in the fight against tobacco, Uruguay passed Law No. 18.256 in 2008, which became the principal law governing tobacco control policies, covering smoke free places, tobacco advertising, promotion and sponsorship, and packaging and labeling of tobacco products, among other regulatory measures. Among other innovative regulations, Uruguay became the first in the region in enforcing large pictorial warnings (with 80% coverage on the front and back of the package).¹² A study in 2017 comparing the 2007 and 2014 Global Youth Tobacco Surveys before and after the implementation of the national policy in Uruguay showed a marked reduction in cigarette smoking among adolescents 13 to 15 years old and found no significant differences between boys and girls.¹³ However, the analysis was based on a pre-post comparison, with no control group.

The current body of evidence regarding differential use of tobacco between boys and girls is mostly based on work in high-income countries, providing little information to understand the Latin American scenario.^{12,14,15} Moreover, the effect of a comprehensive tobacco control policy in the region, like the one adopted by Uruguay, on the youth population is not yet fully known. This study explores the trends in tobacco smoking among youth in Uruguay before and after the implementation of the package of measures that took place in 2008. We specified a difference-in-differences (DID) model using a comparison country (Argentina), given that it had similar trends in smoking prevalence before 2008 and did not implement a comprehensive tobacco control policy

during the time of this analysis, between 1999 and 2016. The DID approach allows for an estimation of the causal effect of the policy, by estimating how youth smoking trends would have progressed in Uruguay had the policy not been implemented in 2008.

Methods

We used data from the Global Youth Tobacco Survey (GYTS), a school-based survey developed by the World Health Organization (WHO) and the U.S. Centers for Disease Control and Prevention (CDC) to track tobacco use and perceptions among young individuals across countries using a standardized methodology. The survey captures prevalence, access, media exposure and attitudes related to tobacco use among individuals in school grades corresponding to ages 13–15 years old.¹⁶ Our primary country of interest was Uruguay.

We used a difference-in-differences (DID) design, using interaction terms in the regression analysis between the post-intervention time and the exposed country (Uruguay). This way, smoking prevalence among youth in Uruguay was compared before and after tobacco control policy implementation in 2008. T1 (1999 to 2003) and T2 (2004 to 2008) were defined as data points before the exposure, and T3 (2009 to 2016) represented the post-exposure period. The main assumptions of DID analyses are that the trends in the control group represent a good approximation for the counterfactual trend of the treated group in the absence of the treatment, that the trends in the pre-intervention phase are parallel, and that there are no other interventions contemporaneous with the implementation of the policy of interest.^{17,18}

The selection of potential control countries was defined by the availability of at least one round of nationally representative (or comparable major city) GYTS within each of the following time periods: 1999 to 2003, 2004 to 2009, and 2010 to 2016. From

the initial list of countries, we selected those that had not reported major tobacco control policy changes in relation to health warnings in tobacco packages. The initial group of potential controls included Argentina, Guyana, Belize, Costa Rica, and Paraguay. Tobacco smoking trends among youth were analyzed in search for a suitable control, defined as a country with a similar curve before the implementation of the regulation in Uruguay (2008). As a result of this process, only Argentina fulfilled the criteria to be used as a control group.

The primary outcome was sex-specific tobacco smoking prevalence, as a dichotomous variable. Respondents who smoked at least one cigarette during the last 30 days were considered smokers. Being exposed to Uruguay's tobacco control policy was considered as the main exposure. Among the available covariates, we selected those with proposed or established associations with tobacco consumption, including: age (11 to 17 years, continuous); resources, expressed as the amount of available money for personal use (ordinal, in a scale from 0 to 7); smoking father (dichotomous, yes; no), smoking mother (dichotomous, yes; no), belief that smoking tobacco is harmful for health (dichotomous, yes; no), exposure to second hand tobacco smoke in the household (dichotomous, yes; no), recall of having been exposed to many tobacco advertisements on TV, billboards, magazines, and in the context of events, and points of sale (dichotomous, yes; no), and perceived impact of pictorial warnings in tobacco packages as stimuli to quit smoking (dichotomous, yes; no).

We first provided descriptive statistics of the youth population in Uruguay and Argentina across tobacco-related variables, stratified by sex. Trends in tobacco smoking prevalence were also analyzed graphically for both sexes. The DID models were fitted for boys and girls separately. We used inverse probability of treatment weighting (IPTW)

to increase the comparability of the two groups using age, and availability of monetary resources as a proxy of socio-economic status.¹⁹ Other covariates were not used based on incomplete information for both countries. Modified Poisson regression models were used, and results were expressed as incidence rates ratios with robust standard errors and 95% confidence intervals.

Results

Approximately 4.5 million adolescents were represented by the surveys from Argentina and Uruguay between 1999 and 2016.

Table 4.1 shows reductions in the proportion of smokers in Argentina from 31.8% in T1(1999 to 2003) to 25.5% in T3 (2009 to 2016) among girls, and from 27.8% to 20.6% among boys. In Uruguay, the percentages dropped from 25.8% to 8.6% among girls and from 19.9% to 7.2% among boys. In spite of that, the proportion of adolescents in Uruguay that wanted to stop smoking decreased, from 59.2% and 59.3% in girls and boys respectively in T1, to 39% and 36.6% in T3. In addition, the proportion of teenagers who tried to stop smoking both in Uruguay and Argentina did not change significantly. Most of the adolescents were in favor of banning all types of tobacco advertising and promotion and these proportions increased over time both in Argentina and Uruguay (64.6% and 70.6% in girls and boys in Argentina in T1, to 86.2% and 80.1% in T3; vs. 74.2% and 76.0% in girls and boys in Uruguay in T1, to 88.1% and 85.0% in T3 respectively). Approximately one quarter of Uruguayan adolescents reported health warnings in cigarettes packages as impactful messages towards not smoking (only asked in T3). Although Argentina had a less aggressive policy in that regard, approximately one third of the teenagers responded in that same way. Finally, although Uruguay's policy regarding the ban of tobacco advertisements at points of sale, half of

the adolescents reported having seen lots of them. This proportion was lower in Argentina, even without having a strict policy in that regard.

Table 4-1 Description of the youth population in Uruguay and Argentina with regards to tobacco habits, information, and perceptions

	1999-2003 n=192,423				2004-2008 n=2,076,762				2009-2016 n=2,226,281			
	Argentina (n=135,393)		Uruguay (n=57,030)		Argentina (n=1,872,065)		Uruguay (n=204,697)		Argentina (n=2,035,605)		Uruguay (n=170,676)	
	Girls (n=67,552)	Boys (n=67,851)	Girls (n=29,247)	Boys (n=27,783)	Girls (n=973,061)	Boys (n=889,004)	Girls (n=113,248)	Boys (n=91,449)	Girls (n=1,049,267)	Boys (n=986,338)	Girls (n=92,099)	Boys (n=78,557)
Tobacco smokers (%)	31.8	27.8	25.8	19.9	29.7	24.0	24.7	18.0	25.5	20.6	8.6	7.2
Mean age (sd)	14.8 (2.2)	14.8 (2.4)	13.6 (1.1)	13.7 (1.2)	14.7 (2.5)	14.6 (2.6)	14.7 (2.0)	14.5 (2.3)	14.8 (2.1)	14.6 (2.4)	14.4 (1.8)	14.4 (1.7)
Wants to stop smoking	45.3	48.0	59.2	59.3	48.6	50.1	47.5	46.6	47.0	59.5	39.0	36.6
Tried to stop smoking	51.9	52.2	62.2	65.8	63.4	61.6	57.8	60.7	59.8	65.0	51.3	47.5
Tried or experimented with tobacco	62.6	57.3	51.8	51.0	56.6	53.6	53.0	48.2	47.8	46.2	25.5	23.2
Susceptibles (%)	50.4	33.6	55.2	50.1	44.3	36.3	57.1	45.4	34.0	32.0	26.3	23.3
No money (%)	16.5	23.0	26.1	33.5	N/A	N/A	23.1	24.6	21.2	20.7	15.7	15.2
Higher money (%)	54.9	54.7	24.8	29.3	N/A	N/A	28.4	32.7	4.6	5.9	18.3	22.3
Parent smokes (%)	58.7	56.5	58.0	54.8	52.0	47.8	49.0	50.1	N/A	N/A	80.5	77.2
Associates smoking with weight control (%)	50.2	37.7	52.1	40.7	48.4	37.1	55.2	45.3	N/A	N/A	N/A	N/A
Believes smoking boys are more attractive (%)	13.3	11.1	14.2	17.8	18.3	20.5	14.2	13.4	N/A	N/A	N/A	N/A
Believes smoking girls are more attractive (%)	6.5	9.4	6.7	13.3	10.1	13.8	10.2	13.6	N/A	N/A	N/A	N/A
Believes smoking is harmful (%)	98.2	97.2	95.9	95.1	96.1	95.5	97.7	96.8	N/A	N/A	N/A	N/A
Most/all close friends smoke (%)	31.2	23.8	23.4	20.2	25.8	21.5	19.0	17.4	N/A	N/A	N/A	N/A
Would be in favor of banning tobacco promotion	64.6	70.6	74.2	76.0	81.3	82.9	83.0	82.4	86.2	80.1	88.1	85.0
Saw lots tobacco advertisements on TV (%)	49.4	43.1	57.3	52.1	25.4	26.8	36.1	36.9	61.4	65.2	N/A	N/A
Saw lots tobacco advertisements on billboards (%)	42.1	43.1	41.2	39.5	46.9	49.8	42.1	42.6	N/A	N/A	N/A	N/A
Saw lots tobacco advertisements on magazines (%)	44.8	47.0	46.5	42.2	91.7	87.7	54.2	53.1	N/A	N/A	N/A	N/A
Saw lots tobacco advertisements on events (%)	25.7	24.1	30.1	32.3	11.7	14.2	24.6	27.0	N/A	N/A	N/A	N/A
Thought about quitting after package warnings (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	35.4	30.2	25.3	22.9
Saw lots advertisements at points of sale (%)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	45.6	41.4	49.9	45.7

Figure 4.1 shows the trends in tobacco smoking among boys and girls for Uruguay and Argentina. The trend in Argentina shows a steady decrease with some downward acceleration after T2, mostly due to the reduction in the prevalence among the girls. In Uruguay, instead, there is a marked change from T2 to T3, when the prevalence falls at least 10 percentage points during that time. The change seems to be more pronounced among the girls.

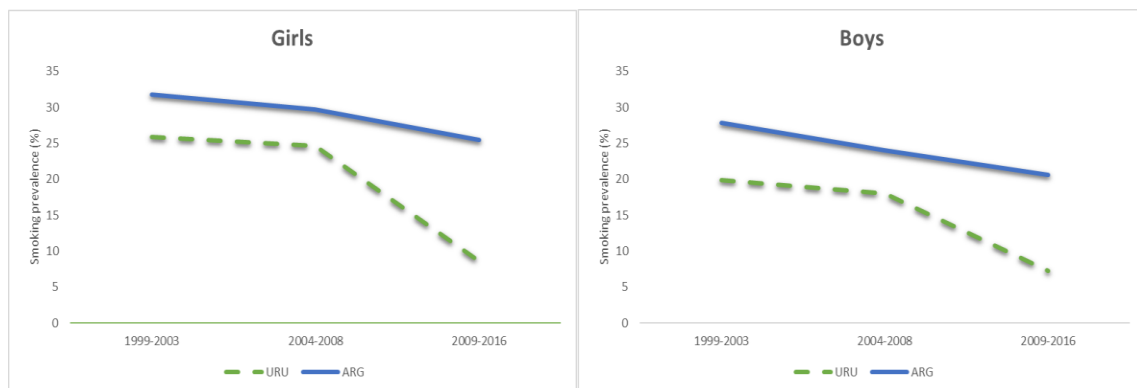


Figure 4-1 Unadjusted trends in smoking among youth between 1999 and 2016 in Uruguay and Argentina

The difference-in difference models assessing smoking prevalence between Uruguay and Argentina before and after the implementation of the tobacco control policy in Uruguay, and controlling for age and availability of monetary resources (Table 4.2) showed a significant pre-post reduction in smoking prevalence in Uruguay, with a slightly stronger effect among the girls.

Table 4-2 Results of the Difference-in-Differences models for the effect of the tobacco policy in Uruguay

Diff-in-Diff models for Uruguay	IRR*	95% CI
Smoking in girls	00.34	0.28-0.41
Smoking in boys	00.41	0.32-0.50

*- Incidence Rate Ratio, adjusted by age and availability of monetary resources. Cochran Q test for heterogeneity estimator 2.95, P=0.08

Discussion

This work analyzed the trends and prevalence in smoking among adolescents between 1999 and 2016 in Uruguay, before and after the implementation of a comprehensive tobacco control policy in the year 2008. Smoking prevalence showed a higher decrease in Uruguay, where the drop was more marked among girls (17.2 percentage points as compared to 12.7 percentage points in boys) as opposed to milder reductions in Argentina. After controlling for age and socio-economic status, the impact of Uruguay’s tobacco control policy seemed to have a positive effect on the reduction of smoking prevalence among youth, with a somewhat stronger effect among girls.

Our findings are in line with a population-based study that also compared Uruguay and Argentina in 2012, in which the 30-day prevalence of tobacco use in Uruguayan students had decreased by an estimated 8.0% per year (4.5 to 11.6),

compared with a decrease of 2.5% (0.5 to 4.5) in Argentinian students ($p=0.02$ for difference in trends). The study concluded that Uruguay's comprehensive tobacco-control campaign has been associated with a substantial and unprecedented decrease in tobacco use both in adults and adolescents.²⁰ Although the study used regression models to explore the changes in the trends of tobacco consumption after the implementation of the policy in Uruguay, it did not use a quasi-experimental approach to obtain an estimation of the pre-post differences between the two countries. The use of these type of designs allows for a representation of the counterfactual, which is not possible in observational studies.

Although the existing evidence is showing higher uptake in tobacco use among females among the relatively more developed countries in the world,^{21,22} Uruguay, one of the countries in the region with the highest human development index, presents higher reductions in girls. This speaks to the importance of national and sub-national strategies, given that no homogeneous pattern is present in terms of the tobacco epidemic trends. Moreover, Latin America is characterized by large heterogeneities that make tailor-made policies even more relevant.²³

Among the limitations of our analysis, the selection of Argentina as control may not provide a fully accurate representation of the counterfactual. Although the country had not implemented a tobacco control policy until after 2012, certain isolated measures were enforced in the capital city and other provinces during the timespan of this study, including taxation, certain restrictions in tobacco advertising within government buildings, and provincial regulations that banned smoking in enclosed public spaces. Nonetheless, Argentina still represented a relatively appropriate control as compared to every other Latin American country, both in terms of macro-economic, health related and tobacco related variables.²⁴ Additionally, the use of year 2008 as a cut-point for a pre-post

analysis in Uruguay also allows for some inaccuracies, since the country initiated strong actions against tobacco around 2005 with the implementation of measures that were later formalized and enforced by law in 2008. However, the fact that our study considers data collected up to year 2008 as pre-exposure and the data points that provide post-exposure information for Uruguay arises from a survey conducted in 2014, it is likely that those partial measures until the enforcement of the comprehensive law do not represent a bias that greatly impacts our estimations. Finally, our assessment does not allow for a more granular analysis of the individual components of the policy in Uruguay. Even though the law included unprecedented requirements that could have an impact on their own (e.g., 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), our analysis only allows for consideration of the policy as a whole. As of now, the existing data does not allow for a population-based analysis on the impact of single measures within the policy, controlling for its other components.

Our study enlarges the body of evidence that supports the implementation of wide and comprehensive tobacco control policies within the national regulations as an effective means to reduce smoking prevalence and its health burden among the youth. An important feature was our focus on sex differences. Although girls showed a greater reduction in tobacco use in response to the tobacco control policies than boys, smoking prevalence still remained higher in the girls, underscoring the need for sex-targeted strategies. A report from the WHO addresses this topic and provides examples of the differential impact of certain policies across sex and age. For instance, young people of both sexes seem to be more sensitive to price/taxation policies, while the style and appearance of cigarettes packages can be used to address or persuade boys and girls differentially.²⁵

In summary, countries inside and outside the region could implement a closer examination to the Uruguayan experience as a case of success in tobacco control among youth, while considering those aspects of the policy that can be improved, adapted, and further evaluated.

References - Aim 3

1. World Health Organization. WHO | Global Health Estimates. Glob Heal Estim. Published online 2014.
2. GBD 2015 Tobacco Collaborators MB, Fullman N, Ng M, et al. Smoking prevalence and attributable disease burden in 195 countries and territories, 1990-2015: a systematic analysis from the Global Burden of Disease Study 2015. *Lancet*. 389(10082):1885-1906. 2017
3. Zachary Cahn W, Drope J, Hamill S, et al. The Tobacco Atlas. Sixth Edition.; 2018. https://tobaccoatlas.org/wp-content/uploads/2018/03/TobaccoAtlas_6thEdition_LoRes_Rev0318.pdf.
4. Pan American Health Organization. Report on Tobacco Control in the Region of the Americas. Washington DC. 2018.
5. World Health Organization. Commission on Social Determinants of Health. Closing the Gap in a Generation.; Geneva, 2008.
6. Islami F, Stoklosa M, Drope J, Jemal A, Catto J. Global and Regional Patterns of Tobacco Smoking and Tobacco Control Policies. *Eur Urol Focus* Aug;1(1):3-16. 2015.
7. Hanewinkel R, Isensee B, Sargent JD, Morgenstern M. Cigarette Advertising and Adolescent Smoking. *Am J Prev Med*. Apr;38(4):359-66. 2010.
8. Pampel FC. Global Patterns and Determinants of Sex Differences in Smoking. *Int J Comp Sociol*.47(6):466-487. 2006.
9. Warren CW, Riley L, Asma S, et al. Tobacco use by youth: A surveillance report from the Global Youth Tobacco Survey project. *Bull World Health Organ*.78(7):868-76. 2000.
10. Linetzky B, Mejia R, Ferrante D, De Maio FG, Diez Roux A V. Socioeconomic status and tobacco consumption among adolescents: a multilevel analysis of Argentina's Global Youth Tobacco Survey. *Nicotine Tob Res*.14(9):1092-1099. 2012.
11. Lopez AD, Collishaw NE, Piha T. A descriptive model of the cigarette epidemic in developed countries. *Tob Control*. 3(3):242-247. 1994.
12. Costa e Silva VL da, Koifman S. Smoking in Latin America: a major public health problem. *Cad Saude Publica*.14(suppl 3):S109-S115.1998.

13. Abascal W, Lorenzo A. Impacto de la política de control de tabaco en población adolescente en Uruguay. *Salud Publica Mex.* 59(Supl.1):40. 2017.
14. Cumming RG. Epidemiology of osteoporosis and osteoporotic fractures. In: *Australian Prescriber.* Vol 20;13-17.1997.
15. Tobacco control in Latin America: past, present and future. Accessed April 28, 2018. <http://www.ftc.org/fca-media/opinion-pieces/947-tobacco-control-in-latin-america-past-present-and-future>
16. WHO | Global youth tobacco survey (GYTS). Geneva. 2016.
17. Abadie A, Diamond A, Hainmueller J. Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program. *J Am Stat Assoc.* 105(490):493-505. 2010.
18. Bertrand M, Duflo E, Mullainathan S. How Much Should We Trust Differences-In-Differences Estimates? *Q J Econ.* 119(1):249-275. 2004.
19. Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behav Res.* May; 46(3): 399–424. 2011.
20. Rey J, Harris E, Abascal W, et al. Tobacco control campaign in Uruguay: a population-based trend analysis. *Lancet.* 380:1575-1582. 2012
21. Riahi M, Mohammadi AA, Rohani H, Bidkhori M. Dataset on the prevalence of tobacco smoking in men and women of selected countries whit difference human development. *Data Br.*18:506-511. 2018.
22. Thun M, Peto R, Boreham J, Lopez AD. Stages of the cigarette epidemic on entering its second century. *Tob Control.*21(2):96-101. 2012.
23. Bárcena A, Byanyima W. Latin America is the world's most unequal region. Here's how to fix it. Economic Commission for Latin America and the Caribbean. Published Online 2016. <https://www.weforum.org/agenda/2016/01/inequality-is-getting-worse-in-latin-america-here-s-how-to-fix-it/>
24. World Bank Open Data. 2021. <https://data.worldbank.org/>
25. World Health Organization. Gender-Responsive Tobacco Control. Geneva. 2018. <https://www.who.int/fctc/cop/sessions/cop8/Gender-Responsive-Tobacco-Control.pdf>.

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Chapter 5 - Overall Conclusions

Overview

Globally, tobacco is responsible for 7 million deaths annually, 1 million of which occur in Latin America. ¹ In Latin America the smoking prevalence is 17.1% in adults, equivalent to 125 million smokers. The majority of the burden falls on the region's health systems as a result of diseases attributed to smoking amount to approximately US\$33 billion, equivalent to 0.5% of the gross domestic product (GDP), and to 7% of Latin America's total annual spending on health.^{2,3} In addition, over 80% of the 1.3 billion tobacco users in the world live in low- and middle-income countries and even in highly developed environments, those at higher vulnerability experience disproportionately worse health, social and economic outcomes than the general population.² This dissertation used different methodologies to quantify gender and income inequalities in different LA countries among different age groups and to assess the impact of a comprehensive tobacco control policy in Uruguay.

The first study (Aim 1) focused on the entire Latin American region and used the Global Youth Tobacco Survey to look at the smoking prevalence and smoking susceptibility in the youth between 1999 and 2016. The analysis included gap decomposition analysis and assessed these outcomes by the countries' Human Development Indices (HDI). We found wide inter-country variability both for smoking susceptibility and for smoking prevalence, with an overall reduction in both outcomes since 1999. We also showed that susceptibility to tobacco smoking and smoking prevalence tended to increase among girls in correlation with the countries' HDI. In

addition, social, behavioral, and environmental factors that potentially explain the gaps varied widely (true?) across and within country development groups.

The second aim of the investigation (Aim 2) explored temporal changes in smoking prevalence and income inequalities for adult male and female smokers in Mexico, across two different tobacco taxation periods. The analyses showed that smoking prevalence remained higher among high income groups in both sexes, and that income inequalities in smoking were higher during the high taxation stage, predominantly in women. These higher inequalities resulted mostly from reductions in smoking prevalence among low-income populations and among women, which were already reporting lower smoking prevalence. These results suggest that higher taxation was pro-equity and effective overall since the most vulnerable received higher benefits from the regulatory policy when applied more intensively.

The third part of the investigation (aim 3) used a quasi-experimental design (difference-in-differences) and a comparison country (i.e., Argentina) to analyze the trends and prevalence of smoking among adolescents in Uruguay between 1999 and 2016, before and after the implementation of a comprehensive tobacco control policy in the year 2008. We found that the policy contributed to reduce smoking prevalence as compared to Argentina, and that such impact was more marked among the girls.

The three aims together present Latin American heterogeneities across tobacco related variables. The focus on certain subpopulations was based on the fact that certain policies, although effective overall, may become less effective or even detrimental when social disparities are not considered within the planning and implementation process. The entire investigation analyzed men and women, or boys and girls, separately. Girls and women are a major industry-targeted population, and although wide variations are

observed from one region to another, the WHO highlights the growing feminization of tobacco smoking, especially in teenagers.³⁻⁵ Two of the three aims of the investigation are focused on the youth, considering that most current smokers initiate tobacco consumption during youth or early adulthood. This is the result of multiple factors, including aggressive targeting strategies by the tobacco industry. The low-income subpopulations are the third area of focus, based on the fact that reduced access to healthcare services, less education, discrimination, and other factors can negatively impact the outcomes of tobacco control policies. In addition, the three factors (gender, age, and income) tend to converge in the same individuals and families. For example, globally it is more likely for a young woman to be poor than for a man of any age.⁶

Recommendations for future research

A first aspect points to the dangers of failing to view Latin America as a complex and unequal scenario when it comes to the impact of tobacco control policies. The investigation showed heterogeneities and wide variations between countries (aim 1), atypical scenarios where certain policies were not sufficiently explored (aim 2), and cases of success (aim 3). In this sense, as the FCTC evidence-based package of “best-buys” remains true, it is important to acknowledge that most of the evidence supporting these measures was collected in high or medium-high income countries, posing generalizability challenges for other countries and regions, like Latin America.

The first aim of this work showed wide variations in the evolution of tobacco smoking susceptibility and prevalence among the youth in eleven Latin American countries. After obtaining minor or no differences between boys and girls for the pooled sample, one of the main findings was a direct relation between sex and these outcomes when the analysis was restricted to higher HDI. This supports the need to incorporate

country development indicators in similar analyses, as opposed to a regional unadjusted approach. Moreover, being the HDI a relatively complex index, involving gross national income per capita, education, and life expectancy, future research could address the differential impact of these components to refine the association between tobacco outcomes and sex among the youth.

Also, among the analyzed participating in the sex gaps in smoking susceptibility and prevalence among the youth, certain variables showed relatively high explanatory power regardless of the sign of the gap (whether boys or girls reported higher susceptibility or prevalence). Having smoking friends seems to be a strong explanatory factor for almost one third of the sex differences among the very high HDI countries and 22.8% among those in the medium HDI group. This was already explored and summarized in a large meta-analysis, which showed that having friends who smoke doubled the odds for teenagers to pick up the habit.⁷ This association was increased by four in countries where the societies were characterized as collectivistic, as opposed to individualistic. None of the countries that provided data for the meta-analysis belonged to Latin America, where more research is needed. In this sense, additional research in the region, potentially using mixed-methods approaches, could shed light on this and other drivers that stimulate adolescents to pick up the smoking habit and inform evidence-based strategies.

Another recommendation points to the need to analyze specific components within general tobacco control regulations, which are usually incorporated in the form of comprehensive laws. The third part of this work showed important changes in Uruguay's smoking prevalence among the youth after the implementation of a comprehensive tobacco control policy. However, the impact of its specific components could not be assessed. For example, Uruguay is a leading country in the world with regards to

aggressive cigarettes packaging policies, including large pictorial warnings and purposely-unappealingly-colored and plain packaging. Nonetheless, the effect of this measure remains relatively unknown since its incorporation took place amid other strategies, like tobacco advertisement banning and smoke free regulations. The design of specific studies to address individual components within tobacco control policies would provide valuable information to inform policy worldwide. For example, experimental studies in North America, Europe and Asia assessed changes in beliefs and behavioral changes associated to health warnings and plain packaging, by designing specific surveys and data collection tools, and showing diverse grades of effectiveness.⁸⁻¹⁰

The second component of the investigation analyzes changes in income inequalities among the adult population in Mexico during two different tobacco taxation policies. Tobacco taxation is considered among the most effective regulatory measures to decrease tobacco consumption worldwide.^{11,12} However, the scenarios where taxation was previously evaluated mostly involve countries where the inverse relation between income and tobacco consumption is the rule. Nonetheless, Mexico is one of the few exceptions in the world where that relation was repeatedly proven to be positively correlated, meaning that higher income groups report higher tobacco smoking prevalence. The finding that women in the lowest income strata showed higher smoking reductions during the high taxation phase suggest that increasing cigarettes prices remains being a pro-equity strategy in this scenario. Nonetheless, the atypical relation between income and smoking prevalence in Mexico remains unexplained. Finally, while the tobacco smoking prevalence in Mexico showed minor reductions in both sexes between the years 2000 and 2018, the country passed new legislation to approve a raise in tobacco taxes in 2019, accounting for the inflation of the previous seven years.

Additional research replicating this work's methods could add valuable information as new tobacco data arrives after the implementation of the measure.

In terms of the methodological contribution of this work, the vast majority of the literature evaluating the impact of tobacco control policies is based on cross-sectional, pre-post analyzes of population surveys, both among the adult and the youth population. Strengthening the usefulness of the evidence requires, in contexts where randomization is not possible, the use of quasi experimental designs and the availability of suitable comparators, as we present in the third component of this investigation. In this line, the difference-in-differences approach allows for considering the counterfactual (i.e., what the situation of tobacco smoking among the youth in Uruguay would be if the policy was not implemented). This becomes key when concluding that the observed outcomes are potentially attributable to the policy in place beyond secular trends. Moreover, when significant gaps are identified, decomposition techniques, as the ones used in aim 1, can improve the understanding of their roots and explanatory factors. Our analysis showed that smoking prevalence among peers, exposure to secondhand tobacco smoke, and misconceptions about weight control have differential explanatory roles in the cigarette smoking sex-gaps among the youth. In this regard, additional research in Latin America, potentially through qualitative and mixed methods approaches could uncover roots, predisposing factors, and causal pathways for these differences. For example, a study conducted in Serbian adolescents found that depression was associated with smoking as a mean to lose weight ¹³, while a study conducted in high-school students in Minnesota, US, reported that smoking for weight control was not shown in African-American girls. ¹⁴

Recommendations for policy

Besides of the identified opportunities to enlarge the existing evidence on tobacco control in Latin America through research, some of this work's findings could be used to orient current or prospective policies.

Prepare to monitor specific components on general tobacco laws.

Improved planning from a monitoring and evaluation perspective within the policymaking process before the implementation of a given strategy would allow for the assessment of single components within general tobacco control policies. This would in turn allow for further refinements and reinforcements of those components that result in a higher impact. The identified success of Uruguay's tobacco law on aim 3, for example, would benefit from an improved knowledge of the impact of its specific measures. However, the country did not implement a detailed monitoring system that would allow for the incorporation of policy changes as a part of a systematic process. Surveys targeted on specific populations, consumer reports, healthcare utilization data, and mandatory reports from the industry are examples of some of the sources that can be combined in a systematic policy monitoring system, allowing for rapid cycle evaluations, and enabling regulatory changes.

Advance further targeted and gender-responsive policies.

Another recommendation refers to the need to target and/or adapt the policy interventions to the particular characteristics of the population, paying special attention to vulnerable groups, such as young women. The first part of this investigation showed, for example, that beliefs about cigarette smoking as a useful way to control weight were pervasive, especially among teenage girls. Results from the analyzes also showed that

less girls attempted to quit smoking because of health concerns as opposed to boys (34% vs. 25% between 2010 and 2016). On the other hand, the results from the third part of the investigation showed that young women in Uruguay tended to be more impacted by health warnings enforced in cigarettes packages as a measure to generate awareness and reduce the chances of smoking, while aim 2 showed that adult women in the lowest income groups in Mexico appeared to be more responsive to intense taxation policies. As evidence shows that young and adult women are being targeted by the tobacco industry, ¹⁵⁻¹⁷ the WHO/FCTC Conference or the Parties is recommending gender-responsive initiatives to counteract these actions and reduce the burden of disease among women. In this line, targeted communication campaigns, gender-based participatory processes in the policy design, and strengthening gender-oriented healthcare services are among the prioritized actions for policy development. ¹⁸

Conduct broader identification of success cases.

Several success cases can be identified within the region, both at the national and subnational levels. For example, Uruguay is a relatively small country, whose population (3.5M) represents 0.5% of Latin America. However, the country has been implementing successful tobacco control policies for over a decade whose outcomes have arguably not been highlighted, disseminated, and utilized enough. The analysis showed achievements in tobacco smoking reductions among the youth that are outliers within Latin America and across regions. The fact that success cases like Uruguay's are not fully assessed and disseminated to inform policy, advocacy, and research elsewhere gives the tobacco industry room to plan innovative ways to block or derail comparable initiatives in other countries or regions.

Improve enforcement of regulatory measures.

The presence of relatively weak enforcement capacities is a known characteristic of many Latin American countries, which creates enabling scenarios for the tobacco industry in the region.^{19–21} Results from this investigation support the need to improve or increase the enforcement of current or future policies. As example, almost half of the adolescent surveyed in Uruguay after the implementation of the general tobacco control policy reported having seen lots of tobacco advertising at points of sale, even though they were prohibited by law across the country.

Improve healthcare services and providers' awareness and response.

Many of the findings on the first component of this work suggest that a stronger role of healthcare providers is still needed in the fight against tobacco among the youth. For example, 30% of the smoking boys and almost 40% of the smoking girls surveyed between 2010 and 2016 in the analyzed Latin American countries reported not having received advice or help to stop smoking by a healthcare provider during the past year, even though over a half of them mentioned failed attempts to quit during that period. In addition, over 20% of the boys and girls did not consider smoking as harmful. These responses suggest that additional education efforts on youth tobacco consumption, updated clinical guidelines, smoking cessation resources, mandatory screening, and quality improvement measures across healthcare providers and services are needed to improve and consolidate the impact of tobacco control policies in the region.

Limitations

Several limitations need to be acknowledged. From a comparability perspective, certain approximations were included, one of them being related to the study populations across countries. For most of the countries we utilized nationally representative surveys, but upon the absence of national assessments for certain time periods, large-city

surveys -usually nations capitals- were used after assessing that their characteristics in terms of social, economic and health variables did not differ markedly from known national indicators. This could have introduced differences in contexts where the size of the rural-urban gap in terms of smoking prevalence and related outcomes were not marginal. In addition, we used time periods in all three components of the investigation. For this, we used any survey conducted between given years as indicative of a period, potentially introducing biases in cases when we used different years within the same period for country comparisons.

An additional limitation that crosses the entire investigation is the lack of analysis of the role of smokeless tobacco, and other cigarette substitutes. As a result, we were not able to assess the substitution effect that potentially took place in those countries where cigarette smoking showed reductions. This is of particular importance among the youth, in which the uptake of alternative ways of tobacco and nicotine consumption shows marked increments.^{22,23} As evidence shows that tobacco companies are incorporating smokeless tobacco (e.g. e-cigarettes, chewing tobacco, etc.) among their products and targeting teenagers as main potential consumers.^{24,25} Overall, there is an ongoing debate on the role of cigarettes substitutes, both in terms of their effectiveness to help smoking cessation among adults as well as regarding their role as gateways to cigarette smoking among the youth. However, several reports suggest that the use of smokeless tobacco, and particularly e-cigarettes, during the youth is associated with higher rates of tobacco smoking in the future. A study conducted in the US on 4 waves of the US Population Assessment of Tobacco and Health Study (PATH) showed that, among individuals 15 to 24 years old, ever use of an e-cigarette (versus never use) increased the risk of later daily cigarette smoking by threefold in the span of three to four years.²⁶ These results align with another investigation from the same cohort on

adolescents between 12 and 17 years old who had never smoked a cigarette at baseline. Adjusted odds of any cigarette use initiation in this group after one year were approximately double for ever users of e-cigarettes.²⁷ Moreover, a large systematic review involving over seventeen thousand adolescents and young adults in the US showed pooled adjusted odd ratios of smoking cigarettes of 3.50 (95% CI, 2.38-5.16) for ever e-cigarettes smokers as compared to never e-cigarettes smokers.²⁸

Nonetheless, the presence of e-cigarettes in Latin American markets is relatively small as compared to the United States or Canada. Although enforcement is relatively weak, vaping is either illegal and banned in major countries, like Argentina, Brazil, Mexico, Uruguay, and Venezuela. In addition, there are no definite laws in countries, like Peru and Colombia, and e-cigarettes are legal only in Chile, Ecuador, Honduras, Paraguay, and Costa Rica.^{29,30} This early stage, in which e-cigarettes are not yet massively available in most of Latin American countries, reduces the impact of substitution by other forms of nicotine as opposed to quitting tobacco.

In addition, the Framework Convention for Tobacco Control (FTCT) package of measures is widely heterogeneous in terms of the involved implementing actors, levels of enforcement, and participating mechanism at the psychological, sociological, economic, and political levels. As some are more associated with preventing tobacco uptake (e.g., banning of tobacco advertisement), others are more focused on enabling smoking cessation (e.g., offer to quit, or taxation). Moreover, while certain strategies rely heavily on enforcement mechanisms by the local authorities (e.g., smoking free environments), others rely on individual behavioral change (e.g., reduced smoking due to taxation or package health warnings). As a result, the implementation of a comprehensive tobacco control policy involving many of these measures at the same time implies challenges in isolating the effect of a single component when the outcome

of interest is smoking prevalence. Two of the three parts of the investigation (aim 1 and 3) lacked the capacity to isolate the effect of single measures within general tobacco control policies. Furthermore, although the second aim considered the effect of taxation, the characteristics of the analyzed data did not allow for adjustments to assess the conditional effect of this measure within the full package.

Conclusion

This investigation aimed to analyze the impact of tobacco control policies in Latin America, with a particular focus on certain vulnerable groups. Results showed a highly heterogenic region, with dissimilar trends in smoking prevalence, smoking susceptibility, and associated factors to smoking behaviors both among the youth as among the adult populations. In addition, we identified marked differences across sex, age and income. These differences suggest the need to consider certain subpopulations when analyzing the effect of tobacco control policies to avoid misleading generalizations.

Key findings from this investigation show that trends in smoking susceptibility and prevalence among adolescents not necessarily follow the adult population trends in Latin America, being the adolescents affected by a potentially different set of factors that play different roles in boys and in girls. Moreover, a growing feminization of tobacco consumption became apparent in certain Latin American countries with relatively higher human development indices. We also showed how income inequalities are affected over time within the adult smoking population in Mexico, with potentially pro-equity effects of increased relative prices of cigarettes, that seem to be accentuated among women. In addition, we presented a successful case of tobacco control on the youth population in Uruguay, based on a general tobacco control policy enforced by law, which contributed

to significant reductions in smoking prevalence in this population, with reductions that were relatively higher in girls as compared to boys.

Upon recognizing that the WHO/FTCF package of evidence-based tobacco control policies proved to be effective across countries and regions, Latin America's population's and subpopulation's characteristics suggest additional questions. Beyond whether a given policy is effective, additional research needs to build further evidence to identify which population groups are being benefited, and which ones are being left behind. This will enable policy makers not only to design effective interventions, but also increasingly fair strategies.

References – Conclusions

1. WHO | WHO report on the global tobacco epidemic 2017. Geneva. 2017. http://www.who.int/tobacco/global_report/2017/en/
2. World Health Organization. Tobacco. Accessed December 11, 2020. <https://www.who.int/news-room/fact-sheets/detail/tobacco>
3. WHO Report on the Global Tobacco Epidemic, 2017 Country Profile Panama WHO Framework Convention on Tobacco Control (WHO FCTC) Status Socioeconomic Context. Geneva. 2017.
4. Zachary Cahn W, Drope J, Hamill S, et al. The Tobacco Atlas. Sixth Edition.; 2018. https://tobaccoatlas.org/wp-content/uploads/2018/03/TobaccoAtlas_6thEdition_LoRes_Rev0318.pdf.
5. Pan American Health Organization. Report on Tobacco Control in the Region of the Americas 2018. Washington DC. 2018.
6. UN Women. UN Women and the World Bank Unveil New Data Analysis on Women and Poverty | UN Women – New York. 2017.
7. Liu J, Zhao S, Chen X, Falk E, Albarracín D. The influence of peer behavior as a function of social and cultural closeness: A meta-analysis of normative influence on adolescent smoking initiation and continuation. *Psychol Bull.*143(10):1082-1115. 2017.
8. Reid JL, Mutti-Packer S, Gupta PC, et al. Influence of health warnings on beliefs about the health effects of cigarette smoking, in the context of an experimental study in four Asian countries. *Int J Environ Res Public Health.* 14(8). 2017.
9. Al-Hamdani M. The effect of cigarette plain packaging on individuals' health warning recall. *Health Policy.* 8(3):68-77. 2013.
10. Mutti-Packer S, Collyer B, Hodgins DC. Perceptions of plain packaging and health warning labels for cannabis among young adults: Findings from an experimental study. *BMC Public Health.*18(1):1361. 2018.
11. Etienne CF. Curbing the tobacco epidemic in the Americas. *Rev Panam Salud Publica.* 40(4). 2016.
12. Sandoval RC, Belausteguigoitia I, Hennis A. The case of tobacco taxation: where we are and how to accelerate its use for public health. *Themat issue. Pan Am J Public Heal.* 40(4). 2016.
13. Kilibarda B, Gudelj Rakic J, Mitov Scekcic S, Krstev S. Smoking as a weight control strategy of Serbian adolescents. *Int J Public Health.* 65(8):1319-1329. 2020.
14. Fulkerson JA, French SA. Cigarette smoking for weight loss or control among adolescents: Gender and racial/ethnic differences. *J Adolesc Heal.* 32(4):306-

313. 2002.

15. Schmidt L. Tobacco industry targetting of women and girls. Dec(1):1-5. 2012.

16. Carpenter CM, Wayne GF, Connolly GN. Designing cigarettes for women: New findings from the tobacco industry documents. *Addiction*. Jun;100(6):837-51 2005.

17. Brown-Johnson CG, England LJ, Glantz SA, Ling PM. Tobacco industry marketing to low socioeconomic status women in the USA. *Tob Control*. Nov;23(e2):e139-46. 2014.

18. World Health Organization. Gender-Responsive Tobacco Control. Accessed June 3, 2019. <https://www.who.int/fctc/cop/sessions/cop8/Gender-Responsive-Tobacco-Control.pdf>

19. Cummings M, Sebrie E. Latin America: a laboratory for tobacco control research. *Salud Publica Mex*. 52:S91-S93. 2010.

20. Barnoya J, Glantz S. Tobacco industry success in preventing regulation of secondhand smoke in Latin America: The "Latin project." *Tob Control*.11(4):305-314. 2002.

21. Fichtenberg CM, Glantz SA. Effect of smoke-free workplaces on smoking behavior: Systematic review. *Br Med J*. 325(7357):188-191. 2002.

22. Krishnan-Sarin S, Jackson A, Morean M, et al. E-cigarette devices used by high-school youth. *Drug Alcohol Depend*. Jan 1;194:395-400. 2019.

23. Walley SC, Wilson KM, Winickoff JP, Groner J. A public health crisis: Electronic cigarettes, vape, and JUUL. *Pediatrics*. 143 (6) e20182741. 2019.

24. Mejia AB, Ling PM. Tobacco industry consumer research on smokeless tobacco users and product development. *Am J Public Health*.100(1):78-87. 2010.

25. Kostygina G, Ling PM. Tobacco industry use of flavorings to promote smokeless tobacco products. *Tob Control*. 25(Suppl 2):ii40-ii49. 2016.

26. Pierce JP, Chen R, Leas EC, et al. Use of E-cigarettes and Other Tobacco Products and Progression to Daily Cigarette Smoking. *Pediatrics*. Feb;147(2):e2020025122. 2021.

27. Lea Watkins S, Glantz SA, Chaffee BW. Association of noncigarette tobacco product use with future cigarette smoking among youth in the population assessment of tobacco and health (PATH) study, 2013-2015. *JAMA Pediatr*.172(2):181-187. 2018.

28. Soneji S, Barrington-Trimis JL, Wills TA, et al. Association between initial use of e-cigarettes and subsequent cigarette smoking among adolescents and young adults a systematic review and meta-analysis. *JAMA Pediatr*. 171(8):788-797. 2017.

29. Global Center for Good Governance in Tobacco Control (GGTC). E-

Cigarette ban & regulation: Global Status as of February 2020
www.ggtc.world/2020/02/24/e-

30. Manero P. El panorama de los cigarrillos electrónicos en Latinoamérica. Notipress. Accessed January 30, 2021. <https://notipress.mx/vida/panorama-cigarrillos-electronicos-en-latinoamerica-1936>

Chapter 5 Acknowledgements

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