Smoke-Free Adolescents. Effectiveness of an educational intervention. Controlled, before and after study

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ABSTRACT

Smoking is considered the main cause of preventable death worldwide. Most smokers start using tobacco at an early age, especially during adolescence. The objective of this study was to identify the determinants of adolescent use of tobacco and assess the impact of an educational intervention on the prevalence of smoking.

Methods. Controlled, before and after study conducted between 2010 and 2012 at two secondary schools in the city of La Plata. A baseline survey was administered at both schools followed by two subsequent measurements; an educational intervention aimed at youth aged 12 and 13 years was implemented in one of the schools. Multiple regression models were used to identify the outcome measures associated with smoking and assess the impact of the intervention.

Results. A total of 1911 surveys were included (school A: 617; school B: 1294). The outcome measures associated with adolescent smoking were having a sibling who smokes (odds ratio [OR]: 2.55), a mother who smokes (OR: 2.32), age (OR: 1.92), and female sex (OR: 1.75). The OR adjusted for these determinants to be a current smoker at the intervention school versus the control school was 0.54 (95% confidence interval [CI]: 0.35-0.83) in the first year of follow-up and 0.98 (95% CI: 0.60-1.61) in the second year.

Conclusions. Having a mother or a sibling who smokes, age, and female sex were strongly correlated to cigarette smoking. The educational intervention had a positive effect in the first year of follow-up, which was not maintained over time.

Key words: *smoking, adolescents, education, prevention.*

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INTRODUCTION

Tobacco use causes 5.1 million deaths every year worldwide[1] and is considered the leading cause of preventable death and one of the most serious public health problems.[2,3] Most of these deaths take place in developing countries, where tobacco use has increased, especially among the more vulnerable groups:[4] youth and women.[5,6]

The damaging effects of tobacco use on health start since initiation during adolescence, and it has been observed that 88% of adult smokers started smoking before 18 years old.[7,8] The most recent Worldwide Survey on School Health in Argentina,[9] administered to secondary school students, showed that a high rate of youth had tried tobacco, that they were highly exposed to secondhand smoke and knew little of the harmful effects of tobacco, and that there was a high tendency to start smoking among non-smokers.

Several articles in National Law No. 26687 and the MPOWER Measures of the World Health Organization (WHO)[2] for the regulation of the advertising, promotion, and use of tobacco products are aimed at smoking prevention among youth. Although positive advances have been reported in implementing the law,[10-13] there is a significant gap in relation to studies and field work focused on smoking prevention among youth. Data on the effectiveness of interventions aimed at the primary prevention of smoking at an early age show, in general, positive results, in spite of the heterogeneity of the methodologies used and the controversies regarding the maintenance of the changes brought about.[14-19] Using simulation models, it has been estimated how the age restriction at smoking initiation among youth might help to reduce the proportion of smoking

among adults.[20] As far as we know, no health interventions on this topic in the education sector of Argentina have been scientifically evaluated.

The objective of the Smoke-Free Adolescents (SMA) study was to identify the determinants of adolescent use of tobacco and assess the impact of an educational intervention on the prevalence of smoking.

POPULATION AND METHODS
Design

The SMA is a controlled, before and after study that used a survey administered for three years in a row to the students of two secondary schools in the city of La Plata. This type of quasi-experimental design is especially useful to assess the effectiveness of educational interventions.[21] Measurements from the control group are strongly helpful to know the baseline differences between groups and assess secular changes, which makes it possible to determine the external outcome measures that influence the desired effect for reasons other than the intervention.

Population and data collection

Schools were selected by convenience; it is worth noting that these national public schools were the largest ones in town. The number of enrolled students accounted for approximately 13.5% of all secondary school students enrolled in the public sector of the center of La Plata.[22] Both participating secondary schools were public, coeducational institutions that admitted students by lot, so the school population was heterogeneous in terms of social and cultural characteristics. The school where the intervention was implemented was referred to as school A (SA) and the control school, as school B (SB).

For analysis and follow-up purposes, students were classified based on their school year in 2010: first year students (G1), second and third year students (G2), and fourth and fifth year students (G3). The same school year groups from SB made up the control group. The final analysis included only those school year groups that completed the follow-up.

In September 2010, a baseline survey *(Annex 1)* was administered to the students of participating schools. The survey was re-administered in November 2011 and November 2012. The instrument was a structured, anonymous, voluntary, and self-administered survey. The questionnaire structure was based on the outcome measures described in studies on smoking among student populations from Argentina and Ibero-America.[23-28] Current adolescent smokers were defined as students who reported smoking on a daily or almost daily basis.

The Higher Institute of Information Processing (*Centro Superior para el Procesamiento de la Información*, CeSPI), the computing center of Universidad Nacional de La Plata, helped to load data into the study database.

The educational intervention

The educational intervention was aimed at preventing smoking initiation and was exclusively implemented in G2 of SA following the baseline survey in 2010 (direct intervention). G1 and G3 of SA were considered indirect intervention groups taking into account the possibility that the students at this school could have siblings or teachers in common or could be indirectly exposed to any of the components of the direct intervention received by G2 (e.g., final exhibition of posters in the school corridors).

The intervention's thematic units *(Annex 2)* included the main topics of the Manual for Smoke-Free Schools[29] and were developed through the following three activities: (1) two debate-talks on the damages caused by smoking, a public health approach to the problem, and the current Argentine laws on this issue; (2) small group workshops where students were asked to design posters based on the thematic units; and (3) exhibition of the final posters made by the students at school. Each talk lasted 40 minutes, and the last 10 minutes were allocated to questions. The team responsible for implementing the intervention included research physicians, who conducted the talks, and the schools' Biology teachers, who helped with the coordination. Both talks were interactive and included images related to the thematic unit and an invitation for students to discuss and reflect on the topic. Then teachers discussed the thematic units analyzed at the meetings with physicians in each classroom for at least 4 months. Teachers coordinated poster design in small groups of students in a final workshop. Ten workshops were conducted, one for each school year in the intervention group of SA, with a maximum of 30 students per workshop. Workshops lasted two teaching hours each and were conducted over three months once each group had worked on the topics discussed in the debate-talks for at least four months. The last step of the intervention consisted in the display of all posters designed by G2 of SA in the school

corridors. This way, posters were shown to the entire school community and remained in place until the end of the last workshop.

Statistical analysis

To compare the population's baseline characteristics, Fisher's exact test was used for categorical outcome measures and the t test, for continuous outcome measures. A multivariate logistic regression model was developed for outcome measures associated with cigarette smoking in this population. The multiple models were compared using tests for nested models (likelihood ratio tests) and the Akaike information criterion/Bayesian information criterion (AIC/BIC).[30,31] The calibration of the final model was assessed using the Hosmer-Lemeshow test and the c-statistic was estimated to build a receiver operating characteristic (ROC) curve. At each assessed cut-off point, the proportions of the primary endpoint were compared using Fisher's exact test so as to establish the statistical significance. In turn, the odds ratio (OR) was estimated for the "current smoker" outcome in SA versus SB, adjusted for the factors associated with smoking included in the initially developed model. For all analyses, a two-tailed p value < 0.05 was considered a statistically significant difference. The statistical software package used was Stata 13.0.

RESULTS
Baseline measurement

Based on the total number of enrolled students at the time of the survey, the rate of overall response was 88% in SA and 77.5% in SB; *Table 1* shows the absolute values. A total of 1911 surveys (617 from SA and 1294 from SB) administered to first through fifth year students were included.

Table 2 describes the characteristics of the surveyed population. It is worth noting the higher proportion of girls in SA. No significant differences were observed in the overall prevalence of smoking between both schools before the intervention (SA: 7.8% versus SB:

TABLE 1. *Sample distribution by school, group, and survey year*

* Surveys excluded because they corresponded to school years that did not complete the follow-up.
** G3 was not assessed in 2012 because half of students had graduated from school.

TABLE 2. *Baseline characteristics of students from participating schools before the intervention*

	School A (intervention) N= 617	School B (control) N= 1294	p[¥]
Average age (SD)	14.2 (± 1.18)	14.2 (± 1.20)	0.793
Female sex, n (%)	341/613 (55.6)	522/1284 (40.7)	0.01
Overall prevalence of smoking, n (%)	48/611 (7.8)	91/1277 (7.1)	0.572
Prevalence of smoking per school year:			
First year, n (%)	3/134 (2.2)	2/273 (0.7)	0.339
Second year, n (%)	4/119 (3.4)	7/282 (2.5)	0.738
Third year, n (%)	12/137 (8.8)	16/278 (5.8)	0.297
Fourth year, n (%)	14/125 (11.2)	32/226 (14.2)	0.510
Fifth year, n (%)	15/96 (15.6)	34/218 (15.6)	1.000
Former smoker, n (%)	23/611 (3.7)	30/1277 (2.3)	0.100
Experimental smoker, n (%)	127/611 (20.8)	276/1277 (21.6)	0.719
Friends who smoke, n (%)	456/607 (75.1)	980/1269 (77.2)	0.322
Living with at least 1 smoker, n (%)	318/617 (51.5)	637/1294 (49.2)	0.353
Father who smokes, n (%)	172/617 (27.9)	336/1294 (26)	0.376
Mother who smokes, n (%)	164/617 (26.6)	329/1294 (25.4)	0.615
Siblings who smoke, n (%)	65/617 (10.5)	130/1294 (10)	0.747

¥ Two-tailed p value for the t test in the case of the continuous outcome measure "age" and two-tailed Fisher's exact test for the remaining outcome measures.
SD: standard deviation.

7.0%, p= 0.572). Among the 139 smokers in 2010, 48.6% corresponded to daily smokers. Among smokers, 91.5% had started before 16 years old. Participants' average age at initiation was 13.40 ± 1.67 years. Also, the baseline survey did not find significant differences in the prevalence of smoking per school year, and it clearly increased among older students.

Predictors of smoking among adolescents

The outcome measures included in the final multiple model were having a sibling who smokes, having a mother who smokes, age, and female sex. *Table 3* shows the ORs and their corresponding 95% confidence intervals. The final model was assessed using the Hosmer-Lemeshow test (p= 0.133) and an area under the ROC curve of 0.83.

Population follow-up and the impact of the intervention

The overall response rate in G2 of SA, who received the intervention, was 89.2% and 85.4% before and after the intervention. The same group of SB showed a baseline response rate of 89.9% and 83.2% during follow-up.

Table 4 shows the prevalence of students who smoked per group, sex, and school in each survey (the baseline survey from 2010 and the two surveys following the educational intervention, in 2011 and 2012). When comparing the overall proportions, a significant difference was observed only in the prevalence of smoking in the first year following the intervention (SA: 4.6% versus SB: 11.4; p= 0.005), which disappeared in the second year of follow-up. The stratified analysis by sex showed a statistically significant difference among girls and only in the first year of the intervention (SA: 4.7% versus SB: 11.4; p= 0.048).

Figure 1 shows the detailed ORs for current smokers in the direct intervention group of SA compared to the corresponding control group of SB by year of follow-up. These ORs were adjusted for the most important determinants of smoking observed in this population (sex, age, mother who smokes, and sibling who smokes).

DISCUSSION

In relation to the baseline characteristics of both schools, it is worth noting as a big difference that SB was larger and included twice as much classrooms than SA and that SA had a higher

TABLE 3. *Outcome measures associated with smoking in the baseline population included in the final multiple model*

	Odds ratio	95% confidence interval	p
Sibling who smokes	2.55	(1.61-4.04)	‹ 0.001
Mother who smokes	2.32	(1.58-3.40)	‹ 0.001
Age	1.92	(1.67-2.21)	‹ 0.001
Female sex	1.75	(1.20-2.54)	0.003

TABLE 4. *Prevalence of current smoking by age group and sex in relation to the year of follow-up*

	School A (intervention) %			School B (control) %			$p^{¥}$
	Girls	Boys	Overall	Girls	Boys	Overall	
Group 1* (first year, 12 years old at baseline)							
Year 2010	1.3	1.6	1.5	2.3	0	0.7	0.604
Year 2011	1.3	0	0.7	3.4	3.4	3.4	0.104
Year 2012	3.6	6.9	5.3	8.3	7.4	7.7	0.527
Group 2 (second-third year, 13-14 years old at baseline)**							
Year 2010	3.9	8.8	6.2	3.7	2.3	3.0	0.050
Year 2011	4.7	4.6	4.6	11.4	11.1	11.4	0.005
Year 2012	8.0	13.8	11.0	12.2	8.2	10.1	0.777
Group 3* (fourth-fifth year, 15-16 years old at baseline)**							
Year 2010	15.6	9.0	12.9	17.0	13.0	15.1	0.525
Year 2011	12.5	14.1	12.9	20.8	15.3	18.2	0.187

¥ Two-tailed p value for Fisher's exact test for the overall proportions. * Total N of group 1, school A: 138 (2010), 148 (2011), and 132 (2012); school B: 276 (2010), 267 (2011), and 260 (2012). ** Total N of group 2, school A: 256 (2010), 240 (2011), and 209 (2012); school B: 431 (2010), 306 (2011), and 355 (2012). *** Total N of group 3, school A: 201 (2010), and 170 (2011); school B: 332 (2010), and 281 (2011).

rate of girls. The latter is related to the fact that before being coeducational institutions, SA had historically been a girls' school and SB, a boys' school. No qualitative differences were observed in the other studied outcome measures in terms of tobacco epidemiology in both schools at baseline. In the studied population, having a mother or a sibling who smokes, age, and female sex were strongly correlated to cigarette smoking. As described in national surveys, the following was observed: there is a higher rate of cigarette smoking among girls, most students started smoking between 13 and 15 years old, and half of students reported exposure to second-hand smoke at home.[32]
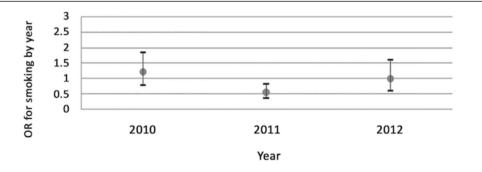
In relation to the impact on the prevalence of smoking in the direct intervention group, the natural increase of the prevalence of smoking shown in the first survey lessened following the intervention, although this effect completely disappeared by the time the third survey was conducted, 27 months later. This means that, whereas a statistically significant difference of 6.8% was observed in the prevalence of smoking in the first follow-up, such gap faded in the second follow-up. The lower rate of adolescent use of tobacco found in the first survey was reflected in an OR for smoking in SA versus SB of 0.54 (0.35-0.83). It is worth noting that this tendency was statistically significant among girls. Although a potential contamination effect had been foreseen, no significant differences were observed between the indirect intervention groups and the control groups.

This study poses the following limitations: first of all, the sample exclusively represents data of two downtown schools from the city of La Plata, so the results cannot be generalized; second, as in the national surveys on tobacco use among youth in Argentina, these results are only applicable to students who were present on the day of the survey; and, finally, all data were self-reported, so youth behaviors might have been under- or over-reported. However, the reliability of surveys on smoking habits among youth has demonstrated to be among the highest ones in relation to adolescent risk behaviors.[33]

The reasons why the primary effect (significant reduction in the prevalence of smoking at the end of follow-up) was not maintained may be: (1) Insufficient intervention duration, given that it was implemented only following the baseline survey in the first year of the study. This may suggest that primary prevention interventions should be continuous or, at least, that the implementation of "booster doses" should be considered, as in the case of immunizations at a population level. (2) A late intervention: students who received the intervention in 2010 were 12-13 years old and 14-15 years old at the end of follow-up. (3) The high prevalence of smoking at home, which is one of the determinants for smoking initiation among youth.

From the public health perspective, the challenge of adolescent smoking is to continue developing and strengthening a favorable environment for smoking cessation among youth that would also help to reduce initiation, and to include innovative strategies that can be adapted to the reality of youth. In relation to the format and components of the educational intervention, the team proposes the following improvements for future assessment: (A) to conduct interventions among youth at a younger

FIGURE 1. *Odds ratio for smoking by year (school A or intervention versus school B or control)**

* The dots indicate the estimated OR for SA versus SB adjusted for sex, age, mother who smokes, and sibling who smokes; the accompanying pins indicate the corresponding 95% CI. 2010: 1.2 (0.79-1.84); 2011: 0.54 (0.35-0.83); 2012: 0.98 (0.60-1.61). OR: odds ratio.

age, (B) to implement shorter interventions that could be repeated throughout the school year (e.g., strengthening or creating a space for "health education" at school); (C) to considering the assessment of sex-specific interventions, given that women start smoking at this age but, in turn, they are the ones who better responded to the intervention; and (D) to include new technologies that are widely used by adolescents, such as text messages, social media, etc. To our knowledge, this is the first study that has assessed the effect of an educational intervention on primary smoking prevention implemented in secondary schools of Argentina.

The SMA educational intervention to control tobacco use resulted in a significant reduction in the prevalence of smoking in the first year of follow-up, which was not maintained in the second year.

CONCLUSIONS

Having a mother or a sibling who smokes, age, and female sex were strongly correlated to cigarette smoking. A deeper understanding of the results of this type of interventions, the epidemiology of smoking among youth, and their behavior in relation to tobacco are essential tools to develop more effective and longer-lasting educational interventions. The development of healthy lifestyle behaviors at an early age should be one of the main targets of research and public health investments. ∎

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Annex 1.
Survey template

SURVEY ON SMOKING AMONG YOUTH

Sex: Male. □   Female. □   **Age:** _____.   **School year:**_____.   **School:**_____.

1. In relation to cigarettes (choose one):

   a)   I have never smoked cigarettes. □

   b)   I do not smoke but I have tried cigarettes. □

   c)   I used to smoke but I have quit (choose one): More than 1 year ago.□/ Less than 1 year ago. □

   d)   I smoke but not every day. □

   e)   I smoke every day. □

2. If you do not smoke (choose one):

   I have considered starting smoking. □   I have considered smoking again. □   I do not want to try. □

3. Do you live with smokers?

Father.□	Sibling.□
Mother.□	Others…………………………………………. (Who?):

4. Do you have friends or family who quit smoking in the past year?   Yes. □   No. □

5. What do you do when you are with someone who smokes?

   □ I do not mind people smoking.   □ I do not like it but I do not say anything.   □ I advise them to stop smoking.

6. Do you have friends who smoke?   Yes. □   No. □

7. Do you know the harmful effects of cigarettes on your heart?   Yes. □   No. □

IF YOU SMOKE:

8. At what age did you start smoking? At _____ years old.

9. Why did you start smoking? (you may choose one or more options).

   □Because my friends smoked.   □ Because it made me feel safe.

   □Because my family smoked.   □ Because it made me look cool.

   □Other (Why?):

10. Does your family know you smoke?   Yes. □   No. □

11. Do you see your physician as someone who could help you quit?   Yes. □   No. □

Annex 2.
Thematic units of the educational intervention

1. Smoking in the world and in Argentina: *Epidemiology of tobacco, impact on smoking-related mortality worldwide and in Argentina, tobacco-related expenses.*

2. Harmful effects of tobacco on your body I: *Main harmful effects of tobacco use on the heart, brain, and peripheral arteries.*

3. Harmful effects of tobacco on your body II: *Main harmful effects of tobacco use on the lungs, neoplasms, and aesthetics.*

4. Smokers and others: *Second-hand smoking, smoking and pregnancy, smoking and children.*

5. Anti-smoking campaign: *Anti-smoking poster proposed by the team.*