

The Intergenerational Transmission of Smoking Across Three Cohabitant Generations: A Count Data Approach

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Abstract This paper examines the extent to which parent and grandparent smoking influences adolescent smoking and its quantitative implications for tobacco control. It extends similar prior studies by investigating the effects on the probability of becoming a smoker and on the number of cigarettes smoked. Count regressions were used to assess the intergenerational transmission of smoking across three cohabitant generations, simultaneously, using data from the 2010 survey “Encuesta Estatal Sobre Uso De Drogas en Estudiantes de Enseñanzas Secundarias”. This survey, of 32,234 students, constitutes a representative sample of Spanish students between 14 and 18 years of age. Living with a mother who smokes, a father who smokes, or a grandparent who smokes reduces the odds of being a non-smoker by 36.1 % (OR 0.639), 26.1 % (OR 0.739) and 20.3 % (OR 0.797), respectively. Parental smoking increases cigarette consumption levels among adolescents. Having a cohabitant mother who smokes increases the number of cigarettes smoked by children by around 18.7 % (IRR 1.187), while having a cohabitant father who smokes increases the number by around 12.1 % (IRR 1.121). Estimates support the hypothesis that visibility of smoking among parents and grandparents is a strong predictor of smoking among adolescents. Accordingly, quitting smoking by parents and grandparents before children become adolescents appears to be a powerful means to both reduce

smoking rates among adolescents and the number of cigarettes smoked by smokers; such decisions appear to exert a stronger influence on the prevalence of smoking and consumption levels than exposure to smoking prevention campaigns at school.

Keywords Intergenerational transmission · Tobacco consumption · Adolescents

Introduction

According to the World Health Organization’s (WHO) recent *Report on the Global Tobacco Epidemic* [1, p. 12], tobacco consumption continues to be the leading global cause of preventable death. This report points out that tobacco is responsible for approximately 6 million deaths each year, and that, if the WHO Framework Convention on Tobacco Control (WHO FCTC) is not implemented in the near future, tobacco will kill about 1 billion people this century alone. In order to reduce smoking prevalence, it is essential to prevent smoking among youth, who are at the age when people are most likely to start regular smoking [2–4]. This is in line with the WHO’s *Report on the Global Tobacco Epidemic* [1, p. 23] that warns: “Young people are especially vulnerable to becoming tobacco users and, once addicted, will likely be steady customers for many years”.

However, interventions designed to reduce smoking among adolescents are less effective when parents and other family members smoke [5] and more than one-third of children live in a household with at least one smoker [6]. Family smoking, including prenatal smoking, has various adverse health effects on children, such as decreased lung growth, increased rates of respiratory tract infections, otitis

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media, childhood asthma, neuro-cognitive decrements, and sudden infant death syndrome, with the severity of these problems increasing with increased exposure [7]. In addition to these detrimental health effects on children, parents' smoking increases the rates of adolescent smoking [5].

The link between parent's smoking and their children's smoking, often referred to as the intergenerational transmission of smoking [8, 9], is a special case of the association between health-risk behaviours of parents and the corresponding health-risk behaviours of their offspring [10]. The intergenerational transmission of smoking can be explained by at least two mechanisms. First, similar smoking behaviours could be due to shared genes, in particular, some genes involved in the metabolism of nicotine (ex. CYP2A6) or related to the brain availability of neurotransmitters such as dopamine and serotonin (ex. DRD2 and ex. 5HTTLRP) [11]. Secondly, according to Social Learning Theory [12], children learn within a social environment through observing others' behaviours and attitudes, consequently, adolescents who are exposed to parents' smoking will be more prone to smoke by emulating their parents through the process of social learning.

Although there is strong evidence that supports the hypothesis that parental smoking is an important predictor of their children smoking [6, 9, 13, 14], there is a dearth of empirical research on the intergenerational transfer of smoking across more than two generations, for an exception see [15]. The current analysis contributes to this scarce literature by analysing the extent to which parent and grandparent smoking simultaneously influences adolescent smoking. Moreover, it extends similar prior studies on the intergenerational transmission of smoking by considering the effect, not only on the probability of becoming a smoker or not, but also the effect on the number of cigarettes smoked. The magnitude of these results has implications for the design and evaluation of tobacco control interventions and policies.

Materials and Methods

Sample

The data utilized in this study come from the State Survey on Drug Use among High School Students [“Encuesta Estatal Sobre Uso De Drogas en Estudiantes de Enseñanzas Secundarias 2010, (ESTUDES 2010)”. This survey, which constitutes a nationally representative sample of Spanish students aged 14–18 years old, was carried out by the Spanish Government's Delegation for the National Plan on Drugs. This is a government organisation under the auspices of the Ministry of Health and Consumer Affairs that

works in accordance with the guidelines established by the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA).

A total of 32,234 students were surveyed. All data were obtained directly from the adolescents at school, where they answered the questionnaire anonymously. Parents were informed about the study purpose, however, in order to reduce under-reporting and grant total confidentiality, parents were not present during the survey administration nor were they informed about their children's responses.

Dependent Variable

The dependent variable in the current analysis, *Cigarettes*, is the response to the question: “How many cigarettes per day did you smoke on average?” This question was only answered by those who reported smoking during the last 30 days. Due to a skip pattern in the survey those who reported that they had never smoked in their lives, skipped several questions about smoking, including reporting the number of cigarettes smoked per day. Consequently, the dependent variable for these adolescents takes the value of zero.

Intergenerational Variables

The main independent variable of interest is the intergenerational transmission of smoking across three cohabitant generations. The intergenerational variables consist of three dichotomous indicator variables: whether or not the mother (1 = yes, 0 = no), father (1 = yes, 0 = no), and grandparents (1 = yes, 0 = no) smoke. It is important to note that the survey provides information about smoking behaviour only for those who cohabit with the adolescent. The survey does not provide information on the smoking status of parents and grandparents who live outside the adolescent's home. Moreover, for the case of a cohabiting grandparent, there is no gender information, so if the adolescent declares that a grandparent smokes, it is only known that at least one grandparent lives with him/her and smokes.

Control Variables

The analyses also controlled for the following variables that could affect smoking behaviours [16]: sex (1 = male, 0 = female), age, immigrant status (1 = yes, 0 = no), immigrant mother (1 = yes, 0 = no), immigrant father (1 = yes, 0 = no), living without mother (1 = yes, 0 = no), living without father (1 = yes, 0 = no), living with grandparents (1 = yes, 0 = no), working status of parents (unemployed and retired) (1 = yes, 0 = no), university degree of parents (1 = yes, 0 = no), state school

(1 = yes, 0 = no), school campaign (1 = yes, 0 = no), working (1 = yes, 0 = no), and adolescent's disposable income in Euros.

Statistical Analysis

A range of count data models were considered: Poisson, Negative Binomial, Zero Inflated Poisson and Zero Inflated Negative Binomial (ZINB) in order to account for the nonnegative integer-valued nature of the dependent variable [17]. Both zero inflated models combine two processes. The first is governed by a binary distribution, usually a logistic process. The second process follows the corresponding distribution, this is to say, a Poisson or a Negative Binomial distribution, respectively. Both models assume the existence of two types of zeros or subpopulations, those individuals who never participate in the activity (smoking), and those individuals who may or may not smoke depending on the restrictions that they face. Young and LR tests were applied to discriminate between nested models and the ZINB model was selected over the more restrictive models. Consequently, we will focus only on this model.

Given that the conditional mean is not linear in count data models, it is not easy to interpret the coefficients directly. Instead, the Incidence Rate Ratios (IRRs) and the Odds Ratios (ORs) were estimated. All count data models were estimated with Stata software.

Results

The overall smoking prevalence for adolescents is 27.13 %; more females (29.98 %) than males (24.10 %) reported smoking (Table 1). Similarly 30.59 % of the mothers and 29.66 % of the fathers smoke. However the smoking prevalence among grandparents is lower at 2.53 %.

The estimates, reported in Tables 2 and 3, support the hypothesis that parental smoking increases the probability of the adolescent being a smoker. In this sense, our results suggest that children of smoking parents have a lower probability of being non-smokers in the last month (OR less than one) compared to children of non-smoking parents. Having a mother who smokes reduces the odds of being a non-smoker by 36.1 % (OR 0.639). Similarly, having a smoking father reduced the odds by 26.1 % (OR 0.739). However, the effect of parents' smoking not only affects the probability of being a smoker or not, it also has a significant influence on the consumption level. Thus, the estimates indicate that children who have a smoker mother, smoke

around 18.7 % more cigarettes than their peers whose mothers do not smoke (IRR 1.187). Similarly, having a father who smokes is associated with more cigarettes smoked by children, approximately a 12.1 % increase (IRR 1.121).

The intergenerational transmission of smoking across three cohabitant generations is not as strong as across two generations; however, it is also important. Adolescents who have a grandparent who smokes have a lower likelihood of being non-smokers. The estimates suggest that the odds of not smoking are reduced by around 20.3 % (OR 0.797). However, unlike with parental smoking, there is no association between having a grandparent who smokes and the amount of cigarettes consumed.

Although the focus of the paper is analysing the intergenerational transmission of smoking, it is important to highlight that school-based smoking prevention programs are effective in reducing smoking initiation. They increase the odds of being a non-smoker by 29.4 % (OR 1.294) and reduce the consumption level by 9.1 % (IRR 0.909). At the same time, there are differences in the likelihood of smoking among boys and girls. Thus, boys have a higher probability of being non-smokers (OR 1.690) but, once they have decided to smoke, they smoke more cigarettes, approximately 15.4 % more (IRR 1.154), than girls. This result provides additional support for the zero inflated models over the basic models, because these models permit more flexibility as some variables can affect the probability of being a smoker or not, as well as the level of consumption, but in opposite directions. The sex variable is significant in both equations, thus the question of whether the intergenerational transmission of smoking differs by gender is addressed.

Separate estimates for boys and girls, also reported in Tables 2 and 3, reveal some differences. Having a grandparent who smokes reduces the probability of being a non-smoker for boys (OR 0.595) but not for girls (OR 1.053 and statistically insignificant). The estimates also reveal that, although both mothers' and fathers' smoking influence smoking behaviour among boys and girls, the level of cigarette consumption is primarily influenced across the same sex. Thus, having a mother who smokes increases the number of cigarettes smoked by daughters by around 20.6 % (IRR 1.206), however, having a father who smokes increases the quantity smoked by daughters by about 8.3 % (IRR 1.083). Similarly, among sons the consumption level of cigarettes increases by around 17.2 % if they have a father who smokes (IRR 1.172), compared to around 15.5 % (IRR 1.155) if they have a mother who smokes. For both boys and girls, the influence of having a mother who smokes is stronger than having a father who smokes, on the decision to smoke or not.

Table 1 Sample characteristics of survey respondents

	N	Percentage or mean (SD)	
Cigarettes	27,271	1.414	(0.478)
Smoking (all sample)	29,633	27.13 %	
Smoking (female) ^a	15,263	29.98 %	
Smoking (male) ^a	14,370	24.10 %	
Mother smokes	31,576	30.59 %	
Father smokes	31,703	29.66 %	
A grandparent smokes	31,991	2.53 %	
Sex (male)	32,234	48.57 %	
Age 14 (reference category)	32,234	22.95 %	
Age 15	32,234	30.03 %	
Age 16	32,234	25.34 %	
Age 17	32,234	16.27 %	
Age 18	32,234	5.40 %	
Immigrant	32,186	11.18 %	
Immigrant mother	32,109	15.34 %	
Immigrant father	32,035	13.87 %	
Live without mother	32,234	4.69 %	
Live without father	32,234	16.77 %	
Live with grandparents	32,234	9.67 %	
Unemployed mother	32,234	5.86 %	
Retired mother	32,234	1.22 %	
Unemployed father	32,234	7.13 %	
Retired father	32,234	3.72 %	
University mother	31,889	22.26 %	
University father	31,874	21.87 %	
Working	31,833	11.46 %	
Income	32,228	24.40€	(49.09)
State school	32,234	66.55 %	
School campaign	31,210	80.44 %	

All figures indicate percentages except for *Cigarette* and *Income* variables that indicate means (and standard deviation in parenthesis)

^a A two-sample t test with unequal variances rejects the null hypothesis of equal mean among genders for smoking prevalence: $p < 0.0001$

Discussion

Smoking remains a widespread behaviour among Spanish students between 14 and 18 years of age, as 27.13 % reported having smoked in the last month. The prevalence of smoking is more than five points higher among girls (29.98 %) than among boys (24.10 %), which is consistent with prevalence estimates in Spain [18]. This paper investigates one factor that could contribute to this high prevalence: the intergenerational transfer of smoking. The results of the count data analyses are quite conclusive: having a mother who smokes and a father who smokes increases the likelihood that adolescents begin to smoke. Similarly, having at least one grandparent who smokes is associated with a higher probability of becoming a smoker

during adolescence. This last result differs slightly from previous literature [15]. These authors did not find a significant link between grandparent ever smoking and adolescent smoking, although the relationship they found was positive.

The intergenerational transmission across three generations is weaker than across two generations. Having either a mother or father who smokes increases the probability of smoking among adolescents, or reduces the probability of being a non-smoker, more than having a grandparent who smokes. Moreover, the association between having a grandparent who smokes and the number of cigarettes smoked by grandchildren, although positive, it is not statistically significant. However, the association between adolescents' cigarette consumption level and having

Table 2 ZINB estimates for non-smoking status

Variable	All			Girls			Boys		
	OR	CI (95 %)		OR	CI (95 %)		OR	CI (95 %)	
		Low	High		Low	High		Low	High
Mother smokes	0.639***	0.589	0.693	0.621***	0.558	0.690	0.662***	0.584	0.750
Father smokes	0.739***	0.680	0.802	0.688***	0.616	0.768	0.800***	0.705	0.908
A grandparent smokes	0.797**	0.645	0.985	1.053	0.789	1.405	0.595***	0.436	0.810
Sex (male)	1.690***	1.572	1.816						
Age 15 years	0.421***	0.376	0.472	0.395***	0.341	0.458	0.464***	0.388	0.554
Age 16 years	0.280***	0.250	0.314	0.264***	0.227	0.307	0.305***	0.255	0.364
Age 17 years	0.240***	0.212	0.272	0.225***	0.191	0.266	0.262***	0.217	0.317
Age 18 years	0.198***	0.168	0.235	0.191***	0.152	0.241	0.214***	0.167	0.273
Immigrant	0.684***	0.552	0.848	0.816	0.620	1.075	0.546***	0.390	0.765
Immigrant mother	1.247**	1.052	1.478	1.283**	1.033	1.592	1.232	0.937	1.618
Immigrant father	1.267***	1.057	1.520	1.213	0.956	1.537	1.339**	1.012	1.771
Live without mother	0.761***	0.649	0.894	0.799**	0.644	0.992	0.727***	0.572	0.925
Live without father	0.736***	0.667	0.811	0.646***	0.569	0.732	0.863*	0.739	1.007
Live with grandparents	1.037	0.918	1.172	1.063	0.899	1.257	1.026	0.857	1.227
Unemployed mother	0.986	0.846	1.150	1.034	0.850	1.260	0.951	0.746	1.211
Retired mother	0.804	0.594	1.088	0.807	0.543	1.198	0.764	0.474	1.230
Unemployed father	1.113	0.969	1.279	1.138	0.952	1.360	1.077	0.864	1.341
Retired father	1.093	0.910	1.312	1.130	0.890	1.434	1.025	0.770	1.364
University mother	1.068	0.967	1.180	1.111	0.970	1.274	1.018	0.879	1.180
University father	1.004	0.908	1.111	1.017	0.885	1.168	0.984	0.850	1.140
Working	0.480***	0.431	0.533	0.543***	0.466	0.634	0.439***	0.379	0.509
Income	0.845***	0.822	0.867	0.868***	0.836	0.901	0.821***	0.790	0.854
State school	1.232***	1.140	1.331	1.171***	1.056	1.297	1.311***	1.165	1.476
School campaign	1.294***	1.186	1.411	1.302***	1.158	1.464	1.286***	1.129	1.465
Intercept	7.359***	6.297	8.601	7.998***	6.520	9.811	10.96***	8.682	13.85
No. of observations	25.462			13.098			12.364		

OR odds ratio, CI confidence interval

The variable income is introduced in logarithms

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

parents who smoke is higher, and statistically significant, for both parents who smoke. Accordingly, fathers' smoking and mothers' smoking are important predictors of their children's smoking. Consistent with prior research, these results support the notion that children with two parents who smoke have a higher risk of becoming smokers [5, 13, 19].

This strong association could be explained by several arguments. First, both generations may share genetic characteristics that predispose them to similar smoking behaviours [11]. Second, adolescents whose parents smoke may learn that smoking is acceptable or even desirable, within their family context by observing their parents' behaviour, making them more likely to imitate them through social learning processes [12]. Some authors

investigated this process and note that cognitive susceptibility and intentions to smoke precede actual smoking [14, 20]. They found that parents' smoking exerts a strong influence on the perceived advantages and safety of smoking, on the one hand, and triggered the desire to smoke on the other hand. Children with parents who smoke perceived more benefits (stress relief, concentration enhancement or appetite control), less risks of smoking, and stronger temptations in response to smoking related cues. Third, from a parental control point of view, parents can forbid their children to smoke, but it is reasonable to assume that children of smoking parents would be more reluctant to obey the rules that their parents themselves do not respect, compared to children whose parents do not smoke.

Table 3 ZINB estimates for smoking consumption

Variable	All			Girls			Boys		
	IRR	CI (95 %)		IRR	CI (95 %)		IRR	CI (95 %)	
		Low	High		Low	High		Low	High
Mother smokes	1.187***	1.117	1.263	1.206***	1.118	1.300	1.155***	1.041	1.281
Father smokes	1.121***	1.051	1.195	1.083**	1.001	1.173	1.172***	1.053	1.304
A grandparent smokes	1.092	0.937	1.271	1.142	0.935	1.394	1.032	0.814	1.308
Sex (male)	1.154***	1.089	1.222						
Age 15 years	1.159***	1.043	1.289	1.219***	1.070	1.387	1.089	0.909	1.304
Age 16 years	1.354***	1.221	1.502	1.469***	1.293	1.668	1.202**	1.010	1.431
Age 17 years	1.468***	1.318	1.636	1.537***	1.345	1.758	1.377***	1.151	1.647
Age 18 years	1.550***	1.362	1.764	1.554***	1.320	1.831	1.546***	1.253	1.908
Immigrant	0.896	0.754	1.064	0.883	0.715	1.089	0.905	0.676	1.210
Immigrant mother	0.902	0.789	1.032	0.897	0.762	1.057	0.934	0.741	1.177
Immigrant father	0.847**	0.734	0.978	0.854*	0.713	1.022	0.852	0.675	1.075
Live without mother	1.360***	1.210	1.528	1.445***	1.249	1.673	1.267**	1.047	1.534
Live without father	1.217***	1.130	1.310	1.244***	1.140	1.357	1.150**	1.009	1.310
Live with grandparents	1.030	0.934	1.135	0.953	0.842	1.078	1.142*	0.977	1.336
Unemployed mother	0.990	0.878	1.117	0.996	0.864	1.150	0.994	0.805	1.226
Retired mother	1.008	0.808	1.257	1.070	0.820	1.396	0.888	0.607	1.298
Unemployed father	1.075	0.962	1.201	1.083	0.949	1.236	1.071	0.881	1.302
Retired father	1.100	0.952	1.272	1.196**	1.004	1.425	0.949	0.741	1.215
University mother	0.998	0.922	1.081	1.014	0.917	1.121	0.983	0.864	1.118
University father	0.933*	0.861	1.011	0.857***	0.773	0.949	1.042	0.916	1.185
Working	1.262***	1.174	1.357	1.238***	1.125	1.364	1.301***	1.166	1.452
Income	1.107***	1.082	1.131	1.129***	1.095	1.164	1.083***	1.047	1.120
State school	1.088***	1.024	1.156	1.071*	0.995	1.154	1.100*	0.994	1.217
School campaign	0.909***	0.851	0.972	0.923*	0.850	1.002	0.913	0.819	1.019
Intercept	2.052***	1.792	2.348	1.957***	1.657	2.310	2.444***	1.957	3.053
No. of observations	25.462			13.098			12.364		

The variable income is introduced in logarithms

IRR incidence rate ratio, CI confidence interval

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Consistent with previous research [8, 9, 15], mothers who smoke exerted a stronger influence on their children’s probability of becoming smokers than fathers who smoke, reducing the probability of being a non-smoker more than having a smoker father. Moreover, in the present study mothers have more effect than fathers on the number of cigarettes smoked, increasing the quantity by 18.7 and 12.1 %, respectively. One possible explanation for this result is that there is a clear inequality in child care related tasks between fathers and mothers; mothers typically devote the biggest fraction of time to these tasks [21] and as a result spend more time with their children than do fathers.

Once again, when we examine the relationships by gender, the intergenerational transmission across two

generations is stronger than across three generations. Both parents smoking behaviour exert a significant effect on the probability of their adolescents smoking and on the number of cigarettes their adolescents’ smoke. These effects are found independently for both boys and girls. However, grandparents’ smoking significantly increases the probability of smoking for boys only. The results in the existing literature are mixed. Thus, some authors found no significant effects of smoker grandparents and that boys’ smoking is affected by both parents’ smoking behaviour, but girls’ smoking is not influenced by the smoking behaviour of either parent [15], while, others found that fathers’ smoking had a stronger influence on sons than on daughters, and that mothers’ smoking influenced their daughters, but not their sons [22].

All in all, the results suggest that observable smoking among adult role models, such as parents and grandparents, is a strong predictor of smoking initiation among adolescents [23]. As a consequence, parents and grandparents should know that if they do not smoke in front of their children and adolescents, the probability that their adolescents will become smokers will be reduced considerably. In addition, parents should also understand that by not smoking in front of their children and adolescents, the amount of cigarettes their adolescents smoke will be reduced. These recommendations are especially true for mothers, who exert the strongest influence on children. Moreover, the effect of having a mother who smokes is higher than the effect of exposure to school-based smoking prevention campaigns on both the probability and level of smoking. Thus our results suggest that policy makers should include parents as specific targets of anti-smoking campaigns.

Our results suggest that if parents and grandparents quit smoking, the entire family will enjoy a number of beneficial effects. First, there will be health benefits, initially for those who quit smoking, and subsequently for their descendants, that will have lower prevalence rates and lower consumption levels. This will lead to fewer smokers and, at the same time, less environmental exposure to smoke in the home for the whole family. There also will be future beneficial effects in terms of economic welfare, as smoking is negatively associated with lifetime income, even after controlling for shared environmental and genetic factors, in a sample of twins [24].

Our study has certain limitations. First, the 16–18 year age group is under-represented due to the fact that education is compulsory until age 16. Second, a possible bias due to memory effects could appear in the data. Third, although youth were guaranteed anonymity when completing the survey, there could be some residual under-reporting. Finally, the analysis is focused on past smoking behaviour, and the extent to which this can predict future behaviour is unknown.

Despite these limitations, the paper has several strengths. First, the data come from a nationally representative survey of students in their adolescence. Second, to our knowledge, this is one of the very few studies analysing intergenerational transmission of smoking to adolescents, from parents and grandparents, simultaneously, using nationally representative survey data. Third, our analyses are not limited to the effects of the intergenerational transmission of smoking on the probability of becoming a smoker or not, but also consider the effects on the quantity of cigarettes smoked.

Conclusions

This paper sheds more light on the effects of the inter-generational transmission of smoking across three cohabitant generations and its quantitative impact in order to assess the importance of quitting smoking as a means to reduce smoking prevalence and consumption among adolescents. To this end, we used nationally representative survey data from Spanish students between the ages of 14 and 18, to estimate several count data models. The analysis provides robust results for the existence of significant inter-generational transmission of smoking across three generations: the higher the number of cohabitant grandparents and parents who smoke the greater the probability that the cohabitant adolescent also will smoke. Some policy implications can be inferred. First, parents and grandparents could reduce the prevalence of smoking in adolescence by quitting smoking before the children reach adolescence. This simple measure would also reduce the number of cigarettes smoked among adolescents who do become smokers. Second, this information should be taken into account when policy makers develop policy and intervention specialists design anti-smoking campaigns to prevent adolescent smoking. Increasing parents' (and to a lesser extent grandparents') awareness of their powerful impact on their offspring behaviour will not only bring improvements to health outcomes, but also result in increased economic welfare.

Conflict of interest The authors declare that they have no conflict of interest.

References

1. World Health Organization (2013). *WHO report on the global tobacco epidemic, 2013: Enforcing bans on tobacco advertising, promotion and sponsorship*. Luxembourg. http://www.who.int/tobacco/global_report/2013/en/.
2. Smith, B. J., Phongsavan, P., Bauman, A. E., Havea, D., & Chey, T. (2007). Comparison of tobacco, alcohol and illegal drug usage among school students in three Pacific Island societies. *Drug and Alcohol Dependence*, 88(1), 9–18. doi:10.1016/j.drugalcdep.2006.08.030.
3. Yañez, A., Leiva, A., Gorreto, L., Estela, A., Tejera, E., & Torrent, M. (2013). School, family and adolescent smoking. [El instituto, la familia y el tabaquismo en adolescentes]. *Adicciones*, 25(3), 253–259.
4. Calafat, A., García, F., Juan, M., Becoña, E., & Fernández-Hermida, J. R. (2014). Which parenting style is more protective against adolescent substance use? Evidence within the European context. *Drug and Alcohol Dependence*, 138(1), 185–192. doi:10.1016/j.drugalcdep.2014.02.705.

5. Leonardi-Bee, J., Jere, M. L., & Britton, J. (2011). Exposure to parental and sibling smoking and the risk of smoking uptake in childhood and adolescence: A systematic review and meta-analysis. *Thorax*, *66*(10), 847–855. doi:[10.1136/thx.2010.153379](https://doi.org/10.1136/thx.2010.153379).
6. King, K., Martynenko, M., Bergman, M. H., Liu, Y. H., Winickoff, J. P., & Weitzman, M. (2009). Family composition and children's exposure to adult smokers in their homes. *Pediatrics*, *123*(4), e559–e564. doi:[10.1542/peds.2008-2317](https://doi.org/10.1542/peds.2008-2317).
7. DiFranza, J. R., Aligne, C. A., & Weitzman, M. (2004). Prenatal and postnatal environmental tobacco smoke exposure and children's health. *Pediatrics*, *113*(4 II), 1007–1015.
8. Brook, J. S., Rubenstone, E., Zhang, C., Finch, S. J., & Brook, D. W. (2013). The intergenerational transmission of smoking in adulthood: A 25-year study of maternal and offspring maladaptive attributes. *Addictive Behaviors*, *38*(7), 2361–2368. doi:[10.1016/j.addbeh.2013.03.008](https://doi.org/10.1016/j.addbeh.2013.03.008).
9. Melchior, M., Chastang, J. F., Mackinnon, D., Galéra, C., & Fombonne, E. (2010). The intergenerational transmission of tobacco smoking—The role of parents' long-term smoking trajectories. *Drug and Alcohol Dependence*, *107*(2–3), 257–260. doi:[10.1016/j.drugalcdep.2009.10.016](https://doi.org/10.1016/j.drugalcdep.2009.10.016).
10. Wickrama, K. A. S., Conger, R. D., Wallace, L. E., & Elder, G. H., Jr. (1999). The intergenerational transmission of health-risk behaviors: Adolescent lifestyles and gender moderating effects. *Journal of Health and Social Behavior*, *40*(3), 258–272.
11. Munafò, M. R., & Johnstone, E. C. (2008). Genes and cigarette smoking. *Addiction*, *103*(6), 893–904. doi:[10.1111/j.1360-0443.2007.02071.x](https://doi.org/10.1111/j.1360-0443.2007.02071.x).
12. Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice Hall.
13. Gilman, S. E., Rende, R., Boergers, J., et al. (2009). Parental smoking and adolescent smoking initiation: An intergenerational perspective on tobacco control. *Pediatrics*, *123*(2), e274–e281. doi:[10.1542/peds.2008-2251](https://doi.org/10.1542/peds.2008-2251).
14. Sherman, S. J., Chassin, L., Presson, C., Seo, D. C., & Macy, J. T. (2009). The intergenerational transmission of implicit and explicit attitudes toward smoking: Predicting adolescent smoking initiation. *Journal of Experimental Social Psychology*, *45*(2), 313–319. doi:[10.1016/j.jesp.2008.09.012](https://doi.org/10.1016/j.jesp.2008.09.012).
15. Vandewater, E. A., Park, S. E., Carey, F. R., & Wilkinson, A. V. (2014). Intergenerational transfer of smoking across three generations and forty-five years. *Nicotine & Tobacco Research*, *16*(1), 11–17. doi:[10.1093/ntr/ntt112](https://doi.org/10.1093/ntr/ntt112).
16. Borderias, L., Duarte, R., Escario, J. J., & Molina, J. A. (2015). Addiction and other reasons adolescent smokers give to justify smoking. *Substance use and Misuse*. doi:[10.3109/10826084.2015.1023453](https://doi.org/10.3109/10826084.2015.1023453).
17. Winkelmann, R. (2008). *Econometric analysis of count data* (4th ed.). Berlin: Springer.
18. Villalbí, J. R., Suelves, J. M., García-Continente, X., Saltó, E., Ariza, C., & Cabezas, C. (2012). Changes in smoking prevalence among adolescents in Spain. *Atención Primaria*, *44*(1), 36–42. doi:[10.1016/j.aprim.2010.12.016](https://doi.org/10.1016/j.aprim.2010.12.016).
19. Duarte, R., Escario, J. J., & Molina, J. A. (2014). Are estimated peer effects on smoking robust? Evidence from adolescent students in Spain. *Empirical Economics*, *46*(3), 1167–1179. doi:[10.1007/s00181-013-0704-7](https://doi.org/10.1007/s00181-013-0704-7).
20. Schuck, K., Otten, R., Engels, R. C. M. E., & Kleinjan, M. (2012). The role of environmental smoking in smoking-related cognitions and susceptibility to smoking in never-smoking 9–12 year-old children. *Addictive Behaviors*, *37*(12), 1400–1405. doi:[10.1016/j.addbeh.2012.06.019](https://doi.org/10.1016/j.addbeh.2012.06.019).
21. García-Mainar, I., Molina, J. A., & Montuenga, V. M. (2011). Gender differences in childcare: Time allocation in five European countries. *Feminist Economics*, *17*(1), 119–150.
22. Ashley, O. S., Penne, M. A., Loomis, K. M., et al. (2008). Moderation of the association between parent and adolescent cigarette smoking by selected sociodemographic variables. *Addictive Behaviors*, *33*(9), 1227–1230. doi:[10.1016/j.addbeh.2008.04.012](https://doi.org/10.1016/j.addbeh.2008.04.012).
23. O'Loughlin, J., Karp, I., Koulis, T., Paradis, G., & DiFranza, J. (2009). Determinants of first puff and daily cigarette smoking in adolescents. *American Journal of Epidemiology*, *170*(5), 585–597. doi:[10.1093/aje/kwp179](https://doi.org/10.1093/aje/kwp179).
24. Böckerman, P., Hyytinen, A., & Kaprio, J. (2014). Smoking and long-term labour market outcomes. *Tobacco Control*. doi:[10.1136/tobaccocontrol-2013-051303](https://doi.org/10.1136/tobaccocontrol-2013-051303).