

- 31 Giskes K, Kunst AE, Benach J, et al. Trends in smoking behaviour between 1985 and 2000 in nine European countries by education. *J Epidemiol Community Health* 2005;59:395–401.
- 32 Pärna K, Pürjer M-L, Ringmets I, Tekkel M. Educational differences in cigarette smoking among adult population in Estonia, 1990–2010: does the trend fit the model of tobacco epidemic? *BMC Public Health* 2014;14:709.
- 33 Vitoria PD, Nunes C, Precioso J. Parents' educational level and second-hand tobacco smoke exposure at home in a sample of Portuguese children. *Rev Port Pneumol* 2017;23:221.
- 34 Vozoris N, Loughheed MD. Second-hand smoke exposure in Canada: prevalence, risk factors, and association with respiratory and cardiovascular diseases. *Can Respir J* 2008;15:263–9.
- 35 Hwang JH, Park S-W. Sex and age differences in exposure to secondhand smoke at home among Korean adolescents: a nationally representative survey. *Int J Environ Res Public Health* 2016;13:241.
- 36 Fischer F, Kraemer A. Factors associated with secondhand smoke exposure in different settings: results from the German Health Update (GEDA) 2012. *BMC Public Health* 2016;16:327.
- 37 Hu Y, van Lenthe FJ, Borsboom GJ, et al. Trends in socioeconomic inequalities in self-assessed health in 17 European countries between 1990 and 2010. *J Epidemiol Community Health* 2016;70:644–52.
- 38 Mackenbach JP, Kulhanova I, Bopp M, et al. Variations in the relation between education and cause-specific mortality in 19 European populations: a test of the “fundamental causes” theory of social inequalities in health. *Soc Sci Med* 2015;127:51–2.

.....
The European Journal of Public Health, Vol. 29, No. 4, 778–784

© The Author(s) 2019. Published by Oxford University Press on behalf of the European Public Health Association.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs licence (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial reproduction and distribution of the work, in any medium, provided the original work is not altered or transformed in any way, and that the work is properly cited. For commercial re-use, please contact journals.permissions@oup.com

doi:10.1093/eurpub/ckz110 Advance Access published on 5 June 2019

Smoking and school absenteeism among 15- to 16-year-old adolescents: a cross-section analysis on 36 European countries

Julian Perelman¹, Teresa Leão², Anton E. Kunst³

1 Centro de Investigação em Saúde Pública, Escola Nacional de Saúde Pública, Universidade NOVA de Lisboa, Lisbon, Portugal

2 Escola Nacional de Saúde Pública, Universidade NOVA de Lisboa, Lisbon, Portugal

3 Department of Public Health, Amsterdam UMC, University of Amsterdam, Amsterdam Public Health Research Institute, Amsterdam, The Netherlands

Correspondence: Julian Perelman, Escola Nacional de Saúde Pública, Universidade NOVA de Lisboa, Avenida Padre Cruz, 1600-560 Lisbon, Portugal, Tel: +351 (0) 21 75 12196, Fax: +351 217 582 754, e-mail: jperelman@ensp.unl.pt

Background: Schools have a crucial role to play in preventing youth smoking. However, the well-known long-term health consequences of youth smoking may be insufficient to convince education stakeholders to devote efforts to implement school-based programmes. However, if youth smoking were to have short-term consequences, this evidence could prompt education stakeholders' action. In this article, we investigate the link between smoking and school absenteeism. **Methods:** We used data from the 2011 wave of the European School Survey Project on Alcohol and Other Drugs, on adolescents aged 15–16. We applied logistic models to assess the risk of more than 3 missed school days, by cause, as function of smoking intensity, adjusting for age, sex, socioeconomic status, academic performance, parental involvement and other risk behaviours (alcohol and cannabis consumption). Consistency was assessed by replicating the analyses for each sex and age group and further adjusting for depression and self-esteem. **Results:** Smoking more than five cigarettes per day was significantly linked to school absenteeism, with a 55% excess risk of missing more than 3 school days per month due to illness (OR = 1.55, 95% CI 1.46–1.64), and a more than two times excess risk due to skipping (OR = 2.29; 95% CI 2.16–2.43). These findings were consistent across age and sex groups. **Conclusion:** We observed an association between smoking intensity and absenteeism among youth in Europe. This implies that, to the extent that this association is causal, school tobacco control policies may reduce the short-term consequences of smoking on adolescents' education and health.

Introduction

Smoking addiction generally starts early in life, mostly during adolescence. In the USA, figures indicate that 88% of adults who smoke daily have started by the age of 18;¹ a recent study for the Netherlands observed that, among persons aged 15–35 years old, 67.2% initiated smoking between 12 and 16 years of age.² This raises a serious public health concern because the earlier the initiation, the greater the risk of nicotine dependence,^{3,4} and of subsequent smoking-related morbidity and all-cause mortality.⁴

Thus, prevention of youth smoking is a cornerstone of tobacco control policies.

Schools have a crucial role to play. Indeed, schools represent the physical environment where adolescents spend a large share of their time, and are an important location to implement measures to reduce tobacco consumption.⁵ A review of 31 studies observed that there is much evidence of the effectiveness of smoking prevention policies targeting adolescents, even though there was variation across studies.⁶ Some school-based actions, such as the use of comprehensive bans, clear rules against tobacco use and

consistent enforcement, were essential to a higher effectiveness of these policies.⁶ Also, in regard to educational health promotion programmes, a realist review highlighted the need to engage the school staff and students, to integrate the programme in school activities and its routine delivery as conditions to achieve a successful implementation.⁷

These findings expose the importance of the engagement and commitment of the school staff. However, the involvement in tobacco control represents an additional task for school educators and teachers. Indeed, evidence shows that schools are often reluctant to sustain the implementation of cost-effective programmes because of lack of time and finances, and support from administration.⁸ The reluctance of school staff to implement smoking prevention strategies may imply that, to their perception, the short-term perceived benefits of smoking prevention may not be large enough to compensate these additional costs.

It is thus crucial to show that smoking prevention may not only be beneficial in the long run, but also for the school, in the very short term. Earlier studies suggested, for example, that smoking was associated to a poorer school performance⁹; and smoking may also have an impact on school absenteeism, further enhancing the interest of school-based smoking prevention.

There are two reasons to expect school absenteeism to be related to smoking. First, adolescents evade school gates because of alluring activities that attract them to the exterior world. Kearney¹⁰ mentions the existence of reinforcers outside school, such as 'watching television, playing videogames, spending time with friends, or engaging in day parties or substance use' (p. 458); clearly, smoking may be one of these activities. Second, absenteeism is linked to medical and psychiatric disorders,¹⁰ whose onset may be caused by smoking behaviour. Smoking among young adolescents was associated to an almost four-time higher risk of asthma,¹¹ to impaired lung function,¹² to chest illness, chronic cough, acute bronchitis and wheezing.¹³ Also, in a cohort of US adolescents aged¹²⁻¹⁸, smoking status was the most significant predictor of developing notable depressive symptoms.¹⁴

A systematic search allowed retrieve only two studies linking smoking and absenteeism among adolescents. In the 1980s, a study on adolescents aged 12 and 13 observed a three-time greater risk of absenteeism among regular smokers, compared with non-smokers.¹⁵ More recently, smoking was observed to be more frequent in schools with a higher average number of missed school days, among US adolescents.¹⁶ Additionally, three studies related absenteeism to exposure to second-hand smoke.¹⁹⁻²¹

In this article, we aim to investigate how smoking behaviours are linked to school attendance, distinguishing the different forms of absenteeism, using a sample of adolescents aged 15-17 years old from 36 European countries. The association was evaluated separately by cause of missed school days, because smoking could have different associations with absenteeism according to its cause. We thus examined the relationship with the benefit of using a large international database, including a relevant set of variables.

Methods

Data

We used the data from the last publicly available wave of the European School Survey Project on Alcohol and Other Drugs (ESPAD), from 2011 (>100 000 observations). This survey resulted from a data collection on adolescents aged 15-16 from 36 European countries (The list of countries is the following: Albania, Belgium (Flanders), Bosnia and Herzegovina (Republic of Srpska), Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, the Faroe Islands, Finland, France, Germany (five Bundesländer), Greece, Hungary, Iceland, Ireland, the Isle of Man, Italy, Latvia, Liechtenstein, Lithuania, Malta, Moldova, Monaco, Montenegro, Norway, Poland, Portugal, Romania, the Russian Federation

(Moscow), Serbia, Slovakia, Slovenia, Sweden, Ukraine and the UK.). In order to ensure comparability, surveys were conducted with common questionnaires and according to a standardized methodology, through anonymous group-administered questionnaires in classrooms. The samples are representative of national populations (see Hibell et al.²⁰).

Dependent variables

We first classified absenteeism as dichotomous variable, with a value of 1 when the student reported having missed at least 3 school days in the last month. The variable was constructed using the following question in the ESPAD survey, 'During the last 30 days on how many days have you missed one or more lessons?', whose answers were 'none', '1 day', '2 days', '3-4 days', '5-6 days', '7 days or more', with the possibility to distinguish the cause for each answer category ('because of illness', 'because you skipped or "cut"' and 'for other reasons'). We stratified absenteeism by being due to illness, due to skipping, or due to 'any cause', which groups those who missed school for any of the three reasons (skipping, illness and other reasons). Note that the 'other reasons' category in the questionnaire did not include any additional information about these possible other reasons; this is why we opted not to analyze it separately.

The choice of 3 missed days per month to define absenteeism was related to the objective of considering a situation that is more than occasional and potentially problematic.^{21,22}

Then, we also modelled absenteeism with the number of school days missed in the last month. The number of missed school days was set by taking the mid-value for each category. For the last, open-ended category, we attributed a value using the method proposed by Parker and Fenwick,²³ which roughly consisted in assuming a normal distribution, and simulating the upper tail of the curve from the available data for lower values. The calculation allowed measure an upper category with a value of 13 missed days. Again, this analysis was stratified by cause of absenteeism, namely illness, skipping or other causes.

Explanatory variable

We considered the smoking status coded into four categories, based on the answer to smoking behaviour in the last month: 'not at all', 'less than one cigarette per day', 'one to five cigarettes per day' and 'more than five cigarettes per day'.

Covariates

Evidence suggests several variables influence smoking, and possibly also absenteeism. These covariates can be grouped into demographic and socioeconomic factors, parental involvement, school climate, other risk behaviours and psychosocial conditions.

Country of residence, sex and age were included as demographic covariates. The socioeconomic background was assessed first through the parental education status, including five categories from 'completed primary school or less' to 'completed college or university'. We considered the highest completed diploma of either father or mother because the education levels of father and mother were correlated at >90%, so that the association with smoking could not jointly be estimated. The underprivileged status was assessed using a subjective social scale, using the question 'How well off is your family compared with other families in your country?'. We grouped the 'very much better off' with the 'much better off', and the 'very much less well off' with the 'much less well off', in order to get sufficient number of observations per category. We also included adolescents' school performance, to which smoking is highly correlated.^{9,24} A low performance was defined if the adolescent reported having performed poorly at school or work at least six times in the last 12 months.

Parental involvement into children's education was demonstrated to predict smoking.²⁵ We used parental control and parental

emotional support as proxies for parental involvement. The parental control was addressed in the single question 'My parents know where I am on Saturday evenings' with a four-point scale response ('always', 'often', 'sometimes', 'seldom' or 'never').²⁶ We recoded this question as dichotomous variable, with a 1 value if the adolescent answered 'always' or 'often', and zero otherwise. Parental emotional support was addressed in the single question 'I can easily get emotional support from my mother and/or my father', with the same four-point scale response. We also recoded this question as dichotomous variable, with a 1 value if the adolescent answered 'always' or 'often', and zero otherwise.

Other risk behaviours were included as covariates because arguments postulating a relationship between smoking and absenteeism may also hold for other risk behaviours, share underlying factors that influence the assignment of students to the exposure of interest (i.e. smoking).²⁷ Regular drinking was a dichotomous variable with a value one if the adolescent reported having drunk alcohol at least once a week during the last month.²⁸ Binge drinking was defined as more than five or more drinks on one occasion occurring more than twice in the last month, following the usual practice.²⁸ Finally, regular use of marijuana or hashish was defined as three or more times uses in the last 30 days.²⁹

Finally, the literature links the absenteeism to psychosocial conditions. The survey included questions about self-esteem and depression. Unfortunately, these questions were not included in several countries, which impair their inclusion in multivariate analysis. In order to estimate their potential confounding effect, we included these factors in supplementary analyses on the sub-sample of countries for which these variables were available.

We used the Rosenberg self-esteem scale,³⁰ which consists in a 10-item scale with a 4-point Likert format ranging from 'strongly agree' to 'strongly disagree'. Questions included items such as 'on the whole, I am satisfied about myself', 'at times I think I am no good at all', 'I feel I have a number of good qualities' etc. We gave one to four points from the 'strongly disagree' to the 'strongly agree',³¹ respectively. A higher score was associated to a higher self-esteem, so that a reverse coding was used for some items (e.g. 'I am not satisfied about myself'). Scores ranged from 10 to 40.

Depressive symptoms were measured by a short 6-item version of the Center of Epidemiological Studies of Depression scale.³² Items included questions regarding losing appetite, having difficulties in concentrating etc. The frequency was rated on a four-point scale running from 'rarely or never' to 'most of the times', to which we attributed values of 0–3, respectively. The scale was coded so that higher scores indicated a more depressive mood.³³ Also, in this case we followed the common practice by including this variable as continuous scale.

Statistical analysis

We performed logistic regression on the risk of more than 3 missed days, by cause, as function of smoking intensity, adjusting for all covariates but depression and self-esteem. In addition, we performed generalized linear regression models on the number of missed days as function of smoking intensity. For this latter analysis, the most adequate distribution was selected on the basis of the Akaike Information Criterion, which identified the gamma distribution as better fitting the data, with the dependent variable in logarithm (the other tested distributions were the normal, Poisson and negative binomial).

The consistency of results was assessed by testing the interaction between daily smoking and sex, and daily smoking and age, and by replicating the analyses for boys and girls and for adolescents aged 15 and 16 years old separately.

Finally, all analyses were replicated including depression and self-esteem as covariates for the sub-sample of countries where these variables were available. Note that in non-linear probability models, the sequential inclusion of covariates does not allow

interpret changes in the estimate of interest (i.e. smoking) as in linear probability models.³⁴ However, our aim was not to perform a mediation analysis requiring the comparison of estimates' magnitude. That is, we do not question to what extent the smoking-absenteeism relationship is explained by socioeconomic factors, parental control or other risk behaviours. We solely measure whether the relationship holds when these variables are factored in. All statistical analyses were performed using Stata programme (Texas: Stata Corporation, 1997).

Results

The sample included 110 850 observations. Most adolescents were aged 16. A percentage of 15.5% students had low-educated parents, and 10.7% reported a low social status. The rate of binge drinking was 13.5%, and the rate of regular cannabis use of 6.2%. Of the adolescents, 16.5% of them were daily smokers, 6.8% smoking one to five cigarettes per day and 9.7% more than five cigarettes per day (table 1). Twenty percent were absent 3 days or more due to illness in the last month, 10% due to skipping and 30.8% for any reason. The average number of missed days was 1.67, 1.01 and 3.41 for these three dimensions, respectively.

Smoking one to five cigarettes per day significantly increased the risk of absenteeism by 48% due to illness, by 87% due to any reason and 2.13 times due to skipping (Model 1, table 2). For those who

Table 1 Characteristics of the sample

| | Percentage (%) (n = 110 850) |
|---|---------------------------------|
| Absenteeism | |
| Number of days of absenteeism—illness [mean, SD] | 1.67 (3.04) |
| Number of days of absenteeism—skip [mean, SD] | 1.01 (2.27) |
| Number of days of absenteeism—any reason [mean, SD] | 3.41 (4.94) |
| Absenteeism >3 days—illness | 20.08 |
| Absenteeism >3 days—skip | 10.04 |
| Absenteeism >3 days—any reason | 30.84 |
| Smoking behaviour | |
| Never smoker | 73.01 |
| Less than one cigarette per day per month | 10.43 |
| One to five cigarettes per day | 6.83 |
| More than five cigarettes per day | 9.74 |
| Demographic characteristics | |
| Female | 51.42 |
| Age | |
| 15 | 3.06 |
| 16 | 96.94 |
| Socioeconomic status | |
| Parental education | |
| Primary school or less | 3.54 |
| Some secondary school | 11.95 |
| Completed secondary school | 32.55 |
| Some college or university | 13.41 |
| Completed college or university | 38.55 |
| Subjective social status | |
| Very much/much better off | 16.18 |
| Better off | 23.81 |
| About the same | 49.26 |
| Less well off | 8.23 |
| Much/very much less well off | 2.52 |
| Psychosocial characteristics | |
| Self-esteem [mean, SD] | 29.44 (5.07) |
| Depression [mean, SD] | 4.83 (3.77) |
| Low performance | 13.47 |
| Parental involvement | |
| Parental support | 77.96 |
| Parental control | 83.96 |
| Risk behaviours | |
| Weekly alcohol | 2.86 |
| Binge drinking | 13.55 |
| Regular cannabis | 6.23 |

Table 2 Risk of absenteeism, by cause (odds ratios, 95% CI)^a

| | Illness | | | Skip | | | Any | | |
|---|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| | Model 1 | Model 2 | Model 3 | Model 1 | Model 2 | Model 3 | Model 1 | Model 2 | Model 3 |
| Smoking intensity | | | | | | | | | |
| Less than one cigarette per day per month | 1.30 (1.23; 1.37) | 1.27 (1.20; 1.34) | 1.23 (1.16; 1.30) | 1.63 (1.54; 1.73) | 1.47 (1.39; 1.56) | 1.32 (1.25; 1.41) | 1.48 (1.41; 1.54) | 1.38 (1.32; 1.45) | 1.28 (1.22; 1.35) |
| One to five cigarettes per day | 1.48 (1.39; 1.58) | 1.42 (1.34; 1.51) | 1.35 (1.27; 1.44) | 2.13 (2.00; 2.28) | 1.84 (1.73; 1.97) | 1.56 (1.46; 1.67) | 1.87 (1.77; 1.98) | 1.70 (1.61; 1.80) | 1.51 (1.42; 1.60) |
| More than five cigarettes per day | 1.80 (1.71; 1.90) | 1.67 (1.58; 1.77) | 1.55 (1.46; 1.64) | 3.68 (3.50; 3.88) | 2.97 (2.81; 3.14) | 2.29 (2.16; 2.43) | 2.85 (2.72; 2.99) | 2.46 (2.34; 2.58) | 2.03 (1.93; 2.14) |
| Female | 1.21 (1.17; 1.25) | 1.22 (1.18; 1.26) | 1.23 (1.19; 1.28) | 0.93 (0.89; 0.96) | 0.97 (0.94; 1.01) | 1.01 (0.97; 1.05) | 1.08 (1.05; 1.11) | 1.12 (1.08; 1.15) | 1.14 (1.11; 1.18) |
| Age | | | | | | | | | |
| 15 | Ref | Ref | Ref | Ref | Ref | Ref | Ref | Ref | Ref |
| 16 | 1.12 (0.87; 1.44) | 1.12 (0.87; 1.44) | 1.13 (0.87; 1.45) | 1.20 (0.90; 1.59) | 1.22 (0.91; 1.62) | 1.24 (0.93; 1.65) | 1.17 (0.95; 1.44) | 1.18 (0.96; 1.45) | 1.19 (0.97; 1.47) |
| Parental education | | | | | | | | | |
| Primary school or less | Ref | Ref | Ref | Ref | Ref | Ref | Ref | Ref | Ref |
| Some secondary school | 0.82 (0.73; 0.91) | 0.82 (0.73; 0.91) | 0.81 (0.73; 0.90) | 0.89 (0.79; 1.00) | 0.89 (0.79; 1.00) | 0.89 (0.79; 1.00) | 0.87 (0.79; 0.95) | 0.87 (0.79; 0.95) | 0.86 (0.78; 0.95) |
| Completed secondary school | 0.78 (0.71; 0.86) | 0.78 (0.71; 0.86) | 0.78 (0.71; 0.86) | 0.85 (0.76; 0.95) | 0.85 (0.76; 0.95) | 0.85 (0.76; 0.95) | 0.84 (0.77; 0.91) | 0.84 (0.77; 0.91) | 0.84 (0.77; 0.91) |
| Some college or university | 0.79 (0.71; 0.87) | 0.79 (0.71; 0.87) | 0.78 (0.70; 0.87) | 0.92 (0.82; 1.04) | 0.92 (0.82; 1.04) | 0.92 (0.82; 1.04) | 0.89 (0.81; 0.98) | 0.89 (0.81; 0.98) | 0.89 (0.81; 0.97) |
| Completed college or university | 0.72 (0.65; 0.80) | 0.72 (0.65; 0.80) | 0.72 (0.65; 0.79) | 0.90 (0.81; 1.01) | 0.90 (0.81; 1.01) | 0.90 (0.81; 1.01) | 0.83 (0.76; 0.90) | 0.83 (0.76; 0.90) | 0.82 (0.75; 0.90) |
| Subjective social status | | | | | | | | | |
| Very much/much better off | Ref | Ref | Ref | Ref | Ref | Ref | Ref | Ref | Ref |
| Better off | 0.87 (0.83; 0.92) | 0.87 (0.83; 0.92) | 0.87 (0.83; 0.92) | 0.92 (0.87; 0.97) | 0.92 (0.87; 0.97) | 0.92 (0.87; 0.97) | 0.88 (0.84; 0.92) | 0.88 (0.84; 0.92) | 0.88 (0.84; 0.93) |
| About the same | 0.85 (0.81; 0.89) | 0.85 (0.81; 0.89) | 0.85 (0.81; 0.89) | 0.86 (0.81; 0.91) | 0.86 (0.81; 0.91) | 0.88 (0.83; 0.92) | 0.84 (0.81; 0.88) | 0.84 (0.81; 0.88) | 0.85 (0.82; 0.89) |
| Less well off | 0.94 (0.88; 1.01) | 0.94 (0.88; 1.01) | 0.95 (0.88; 1.02) | 0.97 (0.90; 1.05) | 0.97 (0.90; 1.05) | 0.97 (0.91; 1.07) | 0.94 (0.88; 1.00) | 0.94 (0.88; 1.00) | 0.95 (0.89; 1.01) |
| Much/very much less well off | 1.12 (1.00; 1.24) | 1.12 (1.00; 1.24) | 1.12 (1.01; 1.24) | 1.07 (0.94; 1.21) | 1.07 (0.94; 1.21) | 1.07 (0.95; 1.21) | 1.11 (1.01; 1.22) | 1.11 (1.01; 1.22) | 1.12 (1.01; 1.23) |
| Low performance | 1.30 (1.24; 1.36) | 1.30 (1.24; 1.36) | 1.28 (1.22; 1.35) | 2.00 (1.91; 2.10) | 2.00 (1.91; 2.10) | 1.92 (1.83; 2.02) | 1.69 (1.62; 1.76) | 1.69 (1.62; 1.76) | 1.64 (1.57; 1.71) |
| Parental support | 1.05 (1.00; 1.09) | 1.05 (1.00; 1.09) | 1.05 (1.01; 1.10) | 0.88 (0.84; 0.92) | 0.88 (0.84; 0.92) | 0.89 (0.85; 0.94) | 0.97 (0.94; 1.01) | 0.97 (0.94; 1.01) | 0.98 (0.95; 1.02) |
| Parental control | 0.93 (0.89; 0.97) | 0.93 (0.89; 0.97) | 0.95 (0.91; 1.00) | 0.69 (0.66; 0.72) | 0.69 (0.66; 0.72) | 0.73 (0.70; 0.77) | 0.78 (0.75; 0.81) | 0.78 (0.75; 0.81) | 0.82 (0.79; 0.85) |
| Weekly alcohol | 1.14 (1.03; 1.26) | 1.14 (1.03; 1.26) | 1.14 (1.03; 1.26) | 1.27 (1.15; 1.41) | 1.27 (1.15; 1.41) | 1.27 (1.15; 1.41) | 1.25 (1.15; 1.37) | 1.25 (1.15; 1.37) | 1.25 (1.15; 1.37) |
| Binge drinking | 1.24 (1.18; 1.30) | 1.24 (1.18; 1.30) | 1.24 (1.18; 1.30) | 1.64 (1.56; 1.73) | 1.64 (1.56; 1.73) | 1.64 (1.56; 1.73) | 1.48 (1.41; 1.54) | 1.48 (1.41; 1.54) | 1.48 (1.41; 1.54) |
| Regular cannabis | 1.00 (0.93; 1.07) | 1.00 (0.93; 1.07) | 1.00 (0.93; 1.07) | 1.39 (1.30; 1.49) | 1.39 (1.30; 1.49) | 1.39 (1.30; 1.49) | 1.24 (1.17; 1.32) | 1.24 (1.17; 1.32) | 1.24 (1.17; 1.32) |
| n | 92 463 | 92 463 | 92 463 | 92 463 | 92 463 | 92 463 | 92 463 | 92 463 | 92 463 |

a: All regressions included country fixed effects, which are not presented to ease the reading.

Table 3 Excess missed days, by cause (betas, 95% CI)^a

| | Illness | Skip | Any |
|---|----------------------|----------------------|----------------------|
| Smoking intensity | | | |
| Less than one cigarette per day per month | 0.12 (0.08; 0.15) | 0.45 (0.41; 0.50) | 0.18 (0.16; 0.21) |
| One to five cigarettes per day | 0.21 (0.17; 0.25) | 0.62 (0.58; 0.66) | 0.26 (0.23; 0.28) |
| More than five cigarettes per day | 0.34 (0.30; 0.37) | 0.91 (0.87; 0.94) | 0.47 (0.44; 0.49) |
| Female | 0.14 (0.12; 0.17) | -0.01 (-0.04; 0.01) | 0.06 (0.05; 0.08) |
| Age | | | |
| 15 | Ref | Ref | Ref |
| 16 | -0.03 (-0.28; 0.22) | 0.01 (-0.35; 0.37) | 0.09 (-0.09; 0.26) |
| Parental education | | | |
| Primary school or less | Ref | Ref | Ref |
| Some secondary school | -0.13 (-0.19; -0.07) | -0.16 (-0.22; -0.09) | -0.16 (-0.20; -0.12) |
| Completed secondary school | -0.18 (-0.23; -0.12) | -0.15 (-0.20; -0.09) | -0.19 (-0.23; -0.15) |
| Some college or university | -0.20 (-0.26; -0.14) | -0.10 (-0.16; -0.04) | -0.19 (-0.23; -0.14) |
| Completed college or university | -0.23 (-0.29; -0.18) | -0.19 (-0.24; -0.13) | -0.22 (-0.26; -0.18) |
| Subjective social status | | | |
| Very much/much better off | Ref | Ref | Ref |
| Better off | -0.08 (-0.12; -0.05) | -0.04 (-0.07; 0.00) | -0.06 (-0.09; -0.04) |
| About the same | -0.10 (-0.13; -0.07) | -0.10 (-0.13; -0.07) | -0.10 (-0.12; -0.08) |
| Less well off | -0.02 (-0.07; 0.02) | 0.03 (-0.01; 0.08) | -0.02 (-0.05; 0.01) |
| Much/very much less well off | 0.12 (0.06; 0.18) | -0.12 (-0.07; 0.05) | 0.12 (0.07; 0.16) |
| Low performance | 0.14 (0.12; 0.17) | 0.55 (0.53; 0.58) | 0.32 (0.30; 0.33) |
| Parental support | 0.02 (0.00; 0.05) | -0.10 (-0.13; -0.07) | -0.03 (-0.05; -0.01) |
| Parental control | -0.02 (-0.05; 0.01) | -0.26 (-0.29; -0.23) | -0.12 (-0.14; -0.11) |
| Weekly alcohol | 0.08 (0.02; 0.13) | 0.16 (0.11; 0.21) | 0.10 (0.06; 0.14) |
| Binge drinking | 0.12 (0.09; 0.15) | 0.41 (0.38; 0.43) | 0.23 (0.20; 0.25) |
| Regular cannabis | 0.02 (-0.02; 0.06) | 0.32 (0.29; 0.35) | 0.16 (0.14; 0.19) |
| <i>n</i> | 92 463 | 92 463 | 92 463 |

a: All regressions included country fixed effects, which are not presented to ease the reading.

Table 4 Stratified analysis by age and sex: odds ratios for high smoking intensity (more than five cigarettes per day) (95% CI)

| | Illness | Skip | Any |
|--------------------------|--------------------------------|----------------------------|----------------------------|
| Dichotomous variable | | | |
| Sex | | | |
| Interaction ^a | Significant ($P < 0.01$) | Significant ($P < 0.01$) | Significant ($P < 0.01$) |
| Female | 1.68 (1.54; 1.83) | 2.58 (2.36; 2.83) | 2.25 (2.08; 2.44) |
| Male | 1.43 (1.32; 1.55) | 2.05 (1.90; 2.23) | 1.85 (1.72; 1.99) |
| Age | | | |
| Interaction ^a | Non-significant ($P = 0.64$) | Significant ($P < 0.01$) | Significant ($P = 0.01$) |
| 15 | 1.95 (1.03; 3.69) | 3.52 (1.88; 6.56) | 2.39 (1.43; 4.00) |
| 16 | 1.55 (1.46; 1.64) | 2.28 (2.15; 2.42) | 2.03 (1.92; 2.14) |
| Continuous variable | | | |
| Sex | | | |
| Interaction ^a | Significant ($P < 0.01$) | Significant ($P < 0.01$) | Significant ($P = 0.02$) |
| Female | 0.39 (0.33; 0.46) | 1.19 (1.06; 1.31) | 0.56 (0.51; 0.62) |
| Male | 0.30 (0.23; 0.36) | 1.00 (0.89; 1.12) | 0.44 (0.39; 0.49) |
| Age | | | |
| Interaction ^a | Significant ($P < 0.01$) | Significant ($P < 0.01$) | Significant ($P < 0.01$) |
| 15 | 0.73 (0.12; 1.35) | 1.57 (0.36; 2.77) | 0.91 (0.39; 1.43) |
| 16 | 0.34 (0.29; 0.38) | 1.08 (1.00; 1.16) | 0.50 (0.46; 0.53) |

a: The 'interaction' row mentions the significance of the interaction between smoking intensity and sex, and smoking intensity and age, in the complete model (Model 3).

smoked more than five cigarettes per day, the increased risk of absenteeism was of 80% due to illness, 2.85 times higher due to other causes, and 3.68 times higher due to skipping. Although lower, these estimates remained high and significant when controlling for socioeconomic factors and parental support and control (Model 2), and for other risk behaviours (Model 3).

Absenteeism was significantly and positively linked to low school performance, and weekly alcohol drinking and binge drinking. The link with low performance, binge drinking and cannabis use was greatest in magnitude for absenteeism due to skipping than to absenteeism due to illness. The risk of absenteeism due to skipping or any cause was significantly reduced by a higher parental control, and by parental emotional support; in contrast, a greater parental support increased the risk of absenteeism due to illness.

Smoking one to five cigarettes per day increased the number of missed days due to illness by 21%, and due to skipping by 62% (table 3). The excess number of missed days was of 34 and 91%, respectively, for those who smoked more than five cigarettes per day. Low performance, binge drinking and regular cannabis use (for skipping and any cause only) also increased the number of missed days, higher parental control and support reduced it for skipping and greater parental control increased the number of missed days due to illness.

Overall, the interaction between daily smoking and age, and between daily smoking and gender was significant, except for absenteeism due to illness, with smoking as dichotomous variable interacted with age (table 4). The link was greater in magnitude among 15-year-old adolescents, compared with those aged 16, and

greater among girls compared with boys. However, the association was always significant for both boys and girls, and for adolescents aged 15 and 16.

The associations were affected when adjusting for depression and self-esteem, for the countries where these variables were collected, but without removing the estimates' significance ($n = 35\,458$) (Supplementary appendix S1). For example, the excess risk of absenteeism due to illness was reduced from 55 to 42%, due to skipping from 2.29 to 2.13, and due to any reason from 2.03 to 1.87, among the heaviest smokers (Supplementary appendix table SA1). Note also that depression was significantly linked to a greater risk of absenteeism, while the relationship with self-esteem was weakly or non-significant.

Discussion

Key findings

The study shows that smoking is significantly and strongly linked to school absenteeism, with a dose–response relationship between the smoking intensity and the risk of absenteeism, and between the smoking intensity and the number of missed school days. This association was more marked for absenteeism due to skipping, followed by absenteeism due to illness, and less marked for absenteeism due to other causes. These findings were consistent across age and sex groups and remained statistically significant, although with a reduced association, after adjustment for depression and self-esteem for the sub-sample of countries that collected this information.

Interpretation

There is little evidence to which our findings can be confronted, namely, a study performed in the USA in the eighties, on a younger group,¹⁵ and a more recent ecological study using,¹⁶ whose results were in line with our findings. In contrast, among adults the relationship between smoking and productivity has long been demonstrated,^{35–38} while absenteeism in children and adolescents was linked to exposure to parental smoking.¹⁷ Even if causal pathways may be different, our findings confirm that smoking is linked to lower school participation, possibly contributing to adverse school outcomes and worse socioeconomic conditions in the future.

The magnitude of the association between smoking and absenteeism was much higher when absenteeism was due to skipping than due to illness. In the case of diseases, the findings are in line with the hypothesis that smoking causes physical diseases, mostly respiratory ones¹² and psychiatric disorders,³⁹ which precludes students to attend classes. In contrast, absenteeism due to skipping seems to be linked to a specific adolescent profile, which may involve school refusal, or even truancy. Kearney¹⁰ mentions the use of substances to explain school refusal as due to the '(...) pursuit of tangible reinforcers outside the school setting.'

Limitations

First, data limitations do not allow fully reject possible biases in inferring causal mechanisms from smoking to absenteeism. It may well be, in particular, that both smoking and absenteeism are explained by a third factor, which we were not able to control for, such as other psychiatric conditions or family conflicts. We however controlled for a large array of diverse covariates.

Second, in the case of absenteeism due to skipping, there is also a risk of reverse causation, if those who miss school are also more vulnerable to peers' out-of-school influence towards smoking. Missing school may thus be the cause of unhealthy lifestyles, and not its consequence, because adolescents spend time out of the more controlled school environment. In particular, the literature refers that school dropout is related

to membership into more aggressive groups, linked to unhealthy behaviours.⁴⁰

However, even if adolescents start skipping classes for other reasons than smoking, these adolescents are probably more exposed to peer pressure while skipping. As adolescents are out of the protection of school bans, norms probably change, and they may be challenged to experiment smoking together with their peers. Skipping and smoking may become more regular, first within the group, and then individually. Considering that nicotine is highly addictive, smoking may change from a consequence from skipping classes, to become their main reason.

Conclusion

We observed an association between smoking intensity and absenteeism among youth in Europe. This implies that, to the extent that this association is causal, school tobacco control policies may reduce the short-term consequences of smoking on adolescents' education and health.

Supplementary data

Supplementary data are available at *EURPUB* online.

Acknowledgements

This article includes data from a database produced within the European School Survey Project on Alcohol and Other Drugs (ESPAD) <http://www.espad.org/>. This article is written in line with the rules for the use of the ESPAD database. The National Principal Investigators and Contact Persons providing data for this study can be found in www.espad.org/report/acknowledgements.

Funding

This research is part of the SILNE-R project, which received funding from the European Commission (EC), Horizon2020 programme, Call PHC6-2014 (Grant Agreement No. 635056).

Conflicts of interest: None declared.

Key points

- Schools staff is often reluctant to implement tobacco control policies;
- We used data from the 2011 on adolescents from 36 countries aged 15–16;
- We measured a strong and consistent link between smoking and school absenteeism;
- Beyond long-term effects, tobacco control at school may have short-term benefits;
- School-level smoking prevention may be worth it for short-term reasons.

References

- 1 U.S. Department of Health and Human Services. *Preventing Tobacco Use among Youth and Young Adults: A Report of the Surgeon General*. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2012.
- 2 Nuyts PA, Kuipers MA, Willemsen MC, Kunst AE. Trends in age of smoking initiation in the Netherlands: a shift towards older ages? *Addiction* 2018;113:524–32.
- 3 Lanza ST, Vasilenko SA. New methods shed light on age of onset as a risk factor for nicotine dependence. *Addict Behav* 2015;50:161–4.

- 4 Choi SH, Stommel M. Impact of age at smoking initiation on smoking-related morbidity and all-cause mortality. *Am J Prev Med* 2017;53:33–41.
- 5 Wilson LM, Avila Tang E, Chander G, et al. Impact of tobacco control interventions on smoking initiation, cessation, and prevalence: a systematic review. *J Environ Public Health* 2012;2012:1.
- 6 Galanti MR, Coppo A, Jonsson E, et al. Anti-tobacco policy in schools: upcoming preventive strategy or prevention myth? A review of 31 studies. *Tob Control* 2014;23:295–301.
- 7 Pearson M, Chilton R, Wyatt K, et al. Implementing health promotion programmes in schools: a realist systematic review of research and experience in the United Kingdom. *Implement Sci* 2015;10:149.
- 8 Friend S, Flattum CF, Simpson D, et al. The researchers have left the building: what contributes to sustaining school-based interventions following the conclusion of formal research support? *J School Health* 2014;84:326–33.
- 9 Moor I, Rathmann K, Lenzi M, et al. Socioeconomic inequalities in adolescent smoking across 35 countries: a multilevel analysis of the role of family, school and peers. *Eur J Public Health* 2015;25:457–63. doi:10.1093/eurpub/cku244.
- 10 Kearney CA. School absenteeism and school refusal behavior in youth: a contemporary review. *Clin Psychol Rev* 2008;28:451–71.
- 11 Gilliland FD, Islam T, Berhane K, et al. Regular smoking and asthma incidence in adolescents. *Am J Respir Crit Care Med* 2006;174:1094–100.
- 12 Gold DR, Wang X, Wypij D, et al. Effects of cigarette smoking on lung function in adolescent boys and girls. *N Engl J Med* 1996;335:931–7.
- 13 Gold DR, Rotnitzky A, Damokosh AI, et al. Race and gender differences in respiratory illness prevalence and their relationship to environmental exposures in children 7 to 14 years of age. *Am Rev Respir Dis* 1993;148:10.
- 14 Choi WS, Patten CA, Gillin JC, et al. Cigarette smoking predicts development of depressive symptoms among US adolescents. *Ann Behav Med* 1997;19:42–50.
- 15 Charlton A, Blair V. Absence from school related to children's and parental smoking habits. *BMJ* 1989;298:90–2.
- 16 Hill D, Mrug S. School-level correlates of adolescent tobacco, alcohol, and marijuana use. *Subst Use Misuse* 2015;50:1518–28.
- 17 Levy DE, Winickoff JP, Rigotti NA. School absenteeism among children living with smokers. *Pediatrics* 2011;128:650–6.
- 18 Gilliland F, Berhane K, Islam T, et al. Environmental tobacco smoke and absenteeism related to respiratory illness in schoolchildren. *Am J Epidemiol* 2003;157:861–9.
- 19 Freeman NC, Schneider D, McGarvey P. Household exposure factors, asthma, and school absenteeism in a predominantly Hispanic community. *J Expo Sci Environ Epidemiol* 2003;13:169.
- 20 Hibell B, Guttormsson U, Ahlström S, et al. The 2011 ESPAD report: substance use among students in 36 European countries: ESPAD, 2012.
- 21 Balfanz R, Byrnes V. The importance of being in school: A report on absenteeism in the nation's public schools. *The Education Digest* 2012;78:4.
- 22 García E, Weiss E. *Student Absenteeism: Who Misses School and How Missing School Matters for Performance*. Economic Policy Institute, 2018.
- 23 Parker RN, Fenwick R. The Pareto curve and its utility for open-ended income distributions in survey research. *Social Forces* 1983;61:872–85.
- 24 Shukla K, Konold T, Cornell D. Profiles of student perceptions of school climate: relations with risk behaviors and academic outcomes. *Am J Community Psychol* 2016;57:291–307.
- 25 Harakeh Z, Scholte RH, Vermulst AA, et al. Parental factors and adolescents' smoking behavior: an extension of the theory of planned behavior. *Prev Med* 2004;39:951–61.
- 26 Choquet M, Hassler C, Morin D, et al. Perceived parenting styles and tobacco, alcohol and cannabis use among French adolescents: gender and family structure differentials. *Alcohol Alcohol* 2008;43:73–80.
- 27 de Looze M, Ter Bogt TF, Raaijmakers QA, et al. Cross-national evidence for the clustering and psychosocial correlates of adolescent risk behaviours in 27 countries. *Eur J Public Health* 2015;25:50–6.
- 28 Bosque-Prous M, Kuipers MAG, Espelt A, et al. Adolescent alcohol use and parental and adolescent socioeconomic position in six European cities. *BMC Public Health* 2017;17:646.
- 29 Carter M, McGee R, Taylor B, Williams S. Health outcomes in adolescence: associations with family, friends and school engagement. *J Adolesc* 2007;30:51–62.
- 30 Rosenberg M. *Society and the Adolescent Self-Image*. Princeton, NJ: Princeton University Press, 1965.
- 31 Schmitt DP, Allik J. Simultaneous administration of the Rosenberg Self-Esteem Scale in 53 nations: exploring the universal and culture-specific features of global self-esteem. *J Pers Soc Psychol* 2005;89:623.
- 32 Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. *Appl Psychol Meas* 1977;1:385–401.
- 33 Shackleton N, Hale D, Bonell C, Viner R. Intraclass correlation values for adolescent health outcomes in secondary schools in 21 European countries. *SSM Popul Health* 2016;2:217–25.
- 34 Kohler U, Karlson KB, Holm A. Comparing coefficients of nested nonlinear probability models. *The Stata Journal* 2011;11:420–38.
- 35 Halpern MT, Shikiar R, Rentz AM, Khan ZM. Impact of smoking status on workplace absenteeism and productivity. *Tob Control* 2001;10:233–8.
- 36 Tsai S, Wen C, Hu S, et al. Workplace smoking related absenteeism and productivity costs in Taiwan. *Tob Control* 2005;14:i33–7.
- 37 Bunn IHW, Stave GM, Downs KE, et al. Effect of smoking status on productivity loss. *J Occup Environ Med* 2006;48:1099–108.
- 38 Weng SF, Ali S, Leonardi-Bee J. Smoking and absence from work: systematic review and meta-analysis of occupational studies. *Addiction* 2013;108:307–19.
- 39 Steuber TL, Danner F. Adolescent smoking and depression: which comes first? *Addict Behav* 2006;31:133–6.
- 40 Farmer TW, Estell DB, Leung M-C, Trott H, Bishop J, Cairns BD. Individual characteristics, early adolescent peer affiliations, and school dropout: An examination of aggressive and popular group types. *J Sch Psychol* 2003;41:217–32.