

School smoking policies and educational inequalities in smoking behaviour of adolescents aged 14–17 years in Europe

Mirte A G Kuipers,¹ Rosaline de Korte,¹ Victoria Eugenia Soto,² Matthias Richter,³ Irene Moor,³ Arja H Rimpelä,^{4,5} Julian Perelman,⁶ Bruno Federico,⁷ Anton E Kunst,¹ Vincent Lorant²

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For numbered affiliations see end of article.

Correspondence to

Mirte Kuipers, Department of Public Health, Academic Medical Center/University of Amsterdam, Room K2-206, P.O. Box 22660, Amsterdam 1100 DD, The Netherlands; m.a.kuipers@amc.uva.nl

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ABSTRACT

Background Studies on the effects of school smoking policies are inconclusive and there is no research on whether the effects of school policies vary by educational level. We examined the association between school smoking policies and smoking behaviour among adolescents aged 14–17 years in Europe and assessed educational inequalities in these associations.

Methods Data on 10 325 adolescents from 50 schools in six European cities were obtained from the 2013 SILNE survey. We measured student perceived policy, staff reported policy and its three subscales: regulations, communication and sanctions. The association between school policies and smoking outcomes (daily smoking and smoking on school premises) was adjusted for individual characteristics and for parental smoking. We tested interaction between school policies and educational level.

Results Daily smoking was not associated with school smoking policies (eg, OR total policy=1.04, 95% CI 0.93 to 1.16 and OR student perceived policy=1.04, 95% CI 0.98 to 1.10). Smoking on school premises was less prevalent in schools with stronger staff reported total policy (OR=0.71, 95% CI 0.53 to 0.96). Other policy variables were also negatively associated with smoking on school premises, but not significantly (eg, OR student perceived policy=0.89, 95% CI 0.78 to 1.02). Associations between policy and smoking on school premises tended to be stronger in those with a low educational level, but none of the interactions tested were statistically significant.

Conclusions Our results suggest that school smoking policies may not have a direct effect on daily smoking but may reduce smoking on the school premises. We found no clear evidence for the effects of school policies to differ by educational level.

INTRODUCTION

In most European countries, adolescents from lower socioeconomic backgrounds are more likely to smoke than adolescents from higher socioeconomic backgrounds.^{1 2} Inequalities in adolescent smoking have persisted and, in some cases, even increased over time.^{3 4} These persisting inequalities demonstrate that the prevention of smoking appears to be particularly challenging in disadvantaged adolescents.^{5–7}

The little evidence that is available on the equity impact of smoking interventions and policies on

What is already known on this subject

- Evidence on the effect of policies to prevent smoking in school settings is mixed, but suggests that some school policies may decrease the prevalence of adolescent smoking.
- No studies have assessed whether school policies would contribute to a narrowing or a widening of educational inequalities in adolescent smoking.
- Since most previous studies were conducted in North America, evidence on effectiveness in European settings is sparse.

What this study adds

- When comparing 50 schools in six European cities, we did not find evidence for lower smoking rates in schools with stronger smoking policies (including smoke-free regulations and sanctions).
- However, stronger smoking policies were associated with less students smoking on the school premises, implying that school smoking policies might decrease students' exposure to smoking in school settings.
- We found no clear evidence for differential effects of school policies by educational level. This suggests that both higher and lower socioeconomic groups would benefit from school smoking policies.

adolescent smoking behaviour suggests that price/tax increases and age-of-sales laws may have an equity positive effect (higher impact on adolescents of low socioeconomic status (SES)).^{5 7} However, the findings are inconsistent and there is a high need for knowledge on what works in preventing smoking in disadvantaged adolescents.

School smoking policies may be one strategy to reach adolescents from all socioeconomic groups, since all are exposed to a school environment on a daily basis. There are many different school smoking policies and ways of implementing and enforcing these policies. A review by Galanti *et al*⁸ suggested that some school smoking policies may

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be effective in the prevention of smoking among adolescents. For example, several studies suggested that strict bans on smoking in and around schools may decrease smoking prevalence.^{9–13} However, other studies did not find a clear association between smoking bans and smoking behaviour.^{14–17}

Schools may have a comprehensive smoking policy, but if students and staff are not informed about the policy, it is unlikely that it will affect smoking behaviour. Paek *et al*¹⁸ found that communicating smoking policies to students and staff may be important in making policies effective in practice. However, other studies did not support this conclusion.^{10 19} For example, one study found that a combined construct of communicating, overseeing and developing policies was not associated with school smoking prevalence.¹⁰ Thus, it is uncertain if communication about school smoking policies adds to the potential effect of school smoking policies on adolescent smoking.

Some previous studies suggest that enforcement of policies by sanctioning students who violate non-smoking rules may be an effective strategy to reduce smoking prevalence.^{13 18 20–22} Other studies confirm that enforcement might reduce smoking rates, finding lower smoking rates in a school where there was stronger adherence to the smoking rules,²³ monitoring smoking behaviour²⁰ and staff perception of enforcement of smoking bans.²⁴ However, some other studies contradict these findings.^{10 17 25–28}

School smoking policies as perceived by students may be more directly related to their own smoking behaviour. Several studies found that students' were less likely to smoke when they perceived clear or strictly enforced school smoking rules.^{9–11 13 21} However, since the reported perceptions of students might reflect their own smoking behaviour, the direction of the association is uncertain. Few studies assessed objectively measured policies or policies reported by school staff.

Previous studies have not assessed whether the effects of school smoking policies vary by level of education. Thus, it is unknown whether school smoking policies contribute to a narrowing or a widening of educational inequalities in adolescent smoking. Additionally, since most studies were conducted in North America, evidence from Europe is needed. Therefore, the aim of this study was to investigate the association between school smoking policies and smoking behaviour among 14–17-year-old adolescents in Europe and to identify potential educational inequalities in these associations.

METHODS

Design and study population

Data were derived from the SILNE (Smoking Inequalities: Learning from Natural Experiments) survey, which was conducted between January and November 2013, in 50 secondary schools in six European cities: Namur (Belgium), Hannover (Germany), Tampere (Finland), Latina (Italy), Amersfoort (the Netherlands) and Coimbra (Portugal). The study was presented to institutional and/or national research ethics committees and found to be in accordance with the Helsinki declaration. Details on the SILNE survey have been published elsewhere.²⁹

Surveys were completed by 276 staff members and 11 015 students (79.4% response rate in students). For this analysis, we included adolescents aged 14–17 years. We excluded students aged 12, 13, 18 or 19 years (N=424), those with missing information on age (N=81) and students with missing information on smoking (N=185). The total study population consisted of 10 325 individuals. There were 281 and 1398 individuals, respectively, who had missing values on academic achievement

and parental educational level and were therefore excluded from the stratified analysis.

Measures

Student-level variables

The two outcome variables used were daily smoking and smoking on school premises. Daily smoking was defined as smoking at least one cigarette per day during the past 30 days. Smoking on the school premises was defined among daily smokers as usually smoking on or just outside the school premises.

We included the demographic characteristics age (in years), gender (male vs female) and migration background (migrant descent vs native). Respondents with one or both parents born in a country other than the country of residence were defined as being of migrant descent.

Socioeconomic position was measured with students' academic achievement and parental educational level. Educational measures are strongly associated with adolescent smoking.^{3 4 30–33} With these variables, we captured the socioeconomic position of the family as well as a precursor of the future socioeconomic position of the student.^{4 34}

Student academic achievement was measured on a country-specific scale using the grading system of each country and was recoded into 'low', 'average', 'good' or 'high'. In the stratified analysis, academic achievement was dichotomised into low ('low' or 'average') and high ('good' or 'high').

The educational level of both parents separately was measured using country-specific categories and was standardised into 'low', 'middle', and 'high'. In most countries, 'low' corresponded with primary school and/or a lower level of secondary school, 'middle' corresponded to completed secondary school and/or a lower level college and 'high' corresponded to a college or university degree. In the stratified analysis, parental educational level was measured as the highest educational level between both parents and was dichotomised into low ('low' or 'middle') and high ('high').

Parental educational level is considered a potential confounder in the association between school policies and smoking, because the education of the parents might be associated with the type of school the adolescent attends (and thus the policies to which the adolescent is exposed), and is associated with the smoking status of the adolescent.³⁵ The student's academic achievement is also a potential confounder, since higher academic achievement has been associated with lower odds of smoking³⁶ and adolescents with higher academic achievement may attend a different type of school than those who have poor academic achievement. However, academic achievement might also potentially act as a mediator if school-level factors (potentially related to the school's smoking policies) influence the student's academic achievement, which in turn influence smoking.³⁷

The smoking environment at home was measured with two variables. First, students were asked if smoking was '...not permitted in the home', '...only permitted in certain areas' or '...permitted everywhere in the home'. Second, smoking of (step) parents was divided into 'no smoking (step) parents', 'one smoking (step) parent' and 'two or more smoking (step) parents'. The smoking environment at home was considered a potential confounder in the association between school policies and adolescent smoking, because parental smoking status may be correlated with the type of school the adolescent attends (and thus the policies to which the adolescent is exposed) and non-smoking parents are more likely to set no smoking rules at

home.³⁸ Children of non-smoking parents³⁹ and children living in smoke-free homes are less likely to smoke.⁴⁰

School-level variables

Five school smoking policy variables were distinguished: student perceived policy, staff reported total policy and its three subscales regulations, communication and sanctions.

Student perceived policy was measured with one question from the student questionnaire: 'Is there a policy against smoking in your school?', with answer options 'don't know' and 'there is no policy' receiving 0 points, 'there is a policy, but it is not enforced' (1 point), 'there is a policy and it is sometimes enforced' (2 points) and 'there is a policy and it is strictly enforced' (3 points). For each school, the mean of all student responses was multiplied by $\frac{3}{2}$ to create a school-level scale from 0 to 10.

Three aspects of staff reported school smoking policy were distinguished. See online supplementary appendix I for included items from the staff questionnaire.

- ▶ 'Regulations' captured smoking bans and tobacco advertising bans. Four questions with, in total, 24 subquestions were used. For each of the subquestions, the answer options were 'yes' or 'no'. Each 'yes' received one point, adding up to a maximum score of 24 points. The total score was divided by 2.4 to create a 0 to 10 scale. Cronbach's α was 0.87, indicating good internal reliability.
- ▶ 'Communication' measured the ways of informing different subgroups on the school smoking policy and its sanctions. Five questions were asked with, in total, 15 subquestions. For each of the subquestions, the answer options were 'yes' or 'no'. Each 'yes' received one point, adding up to a maximum score of 15 points. The total score was divided by 1.5 to create a 0 to 10 scale. Cronbach's α was 0.75, indicating good internal reliability.
- ▶ 'Sanctions' measured how students were sanctioned for violating the school smoking policy. From a list of 13 possible sanctions, staff indicated all sanctions that had been applied in the current school year. One point was given for each sanction, with a maximum of 13 points. The sum of points was divided by 1.3 to create a scale ranging from 0 to 10. Cronbach's α was 0.47. A low Cronbach's α may be expected because the scale consists of a sum score of alternative sanctions that may substitute each other.

The mean score of regulations, communication and sanctions captured the staff reported total policy.

The school smoking prevalence was measured as the percentage of students in the school who were daily smokers, and was divided by 10 to present the odds of smoking with a 10% increase in school smoking prevalence. The association between school smoking policies and school smoking prevalence is likely to be bidirectional: policies may reduce smoking prevalence, but schools may also respond to a high smoking prevalence by developing and implementing stronger school policies. Therefore, the school smoking prevalence may be considered a confounder as well as a mediator in the association between school smoking policies and smoking.

Statistical analysis

Owing to the nested structure of the data, we used multilevel logistic regression analyses with random intercepts at the school and country level. Daily smoking and smoking on the school premises were used as the dichotomous outcome variables in all analyses.

First, we analysed associations between all student-level variables and the two outcomes in univariate and multivariate models. Next, all five policy variables were studied in five consecutive models, controlling for increasingly more potential confounders. Model 1 included age, sex and ethnicity; in model 2, we added parental educational level and model 3 additionally included the smoking environment at home. Since students' academic achievement and the smoking prevalence in the school potentially act as mediators as well as confounders, these variables were only included in models 4 and 5. Staff reported total policy was analysed separately from its three subscales, regulations, communication and sanctions, which were modelled simultaneously. Finally, in order to assess whether the associations with policy variables differed according to socioeconomic position, we tested interaction between each policy variable and academic achievement and parental educational level, respectively.

Analyses were conducted in R V.3.1.1 using the lme4 package.

RESULTS

Table 1 presents the characteristics of the study population. Students had a mean age of 15 years, and there were more girls than boys participating in the survey. The overall daily smoking prevalence was 14.5%. Daily smoking prevalence was relatively high in students with low academic achievement (18.4%) and students with low parental educational level (17.5%). The low socioeconomic groups were more likely to have parents who smoked and to live in a home where smoking was permitted.

Table 2 presents the characteristics of the schools. Overall, school smoking policy scores were higher in Coimbra and Tampere and lower in Latina and Amersfoort. In Latina, the student perceived policy score was particularly low. Student perceived policy and staff reported total policy were significantly correlated with each other ($r=0.636$) and with the three subscales of staff reported policy. Correlations between the three subscales were quite low, and only statistically significant between regulations and communication ($r=0.295$).

Table 3 presents the associations between covariates and smoking outcomes. Daily smoking was significantly less prevalent in students with high academic achievement (OR=0.26, 95% CI 0.19 to 0.36). Daily smoking was significantly more prevalent in students living in a home where smoking was permitted (OR=1.64, 95% CI 1.31 to 2.05), in students with smoking parents (OR=2.97, 95% CI 2.50 to 3.25) and in students of schools with a high-smoking prevalence (OR=1.64, 95% CI 1.53 to 1.77). In the univariate analysis, daily smoking was lower in students of highly educated parents (OR=0.83, 95% CI 0.70 to 1.01). However, when controlled for other covariates, the association became positive (OR=1.25, 95% CI 1.03 to 1.52). Students from schools with a higher smoking prevalence were more likely to report smoking on the school premises (OR=1.29, 95% CI 1.06 to 1.58). No clear gradient in smoking on the school premises according to academic achievement or parental educational level was found.

The multilevel structure provides insight into the percentage variance explained by the school and country level. For daily smoking, intraclass correlation coefficients (ICCs) at the school and country level were 14.1% and 2.2%, respectively. For smoking on the school premises, ICCs were 6.4% and 6.9%, respectively (results not shown in tables). Daily smoking thus varied mainly between schools, while smoking on the school premises varied about as much between schools as between countries.

Table 1 Characteristics of the study population, stratified by academic achievement and parental education

	Total population	Low academic achievement	High academic achievement	Low parental educational level	High parental educational level
Individual level					
N individuals (%)	10 325 (100)	5969 (59.3)	4091 (40.7)	4879 (53.9)	4172 (46.1)
Age (mean±SD)	15.19±0.91	15.30±0.93	15.01±0.84	15.29±0.92	15.13±0.87
14	24.7	21.7	29.6	21.2	25.6
15	40.3	37.8	45.0	39.7	42.3
16	26.1	29.6	20.6	27.9	25.2
17	8.9	10.9	4.9	11.2	6.8
Male gender	47.5	51.6	40.4	46.5	47.1
Migrant descent	20.3	21.4	18.6	19.6	20.0
Academic achievement					
Insufficient or low	17.2	29.7	–	19.0	12.8
Average	40.6	70.3	–	43.5	37.3
Good	30.4	–	76.7	28.4	24.9
High	9.2	–	23.3	6.5	13.4
Education parents					
Low	12.1	13.6	9.3	25.5	–
Middle	35.2	37.5	32.3	74.5	–
High	40.4	35.0	49.2	–	100
Do not know or other	12.3	13.9	9.2	–	–
Smoking rules at home					
Nowhere	51.2	48.3	56.4	46.2	58.7
Certain areas	29.9	32.2	27.2	35.2	24.5
Everywhere	6.1	7.1	4.8	7.7	3.9
Do not know	11.3	11.6	10.9	9.5	11.8
Smoking parents					
No smoking parents	60.3	56.3	65.8	53.5	68.7
1 smoking parent	25.7	27.1	23.7	28.7	22.3
≥2 smoking (step) parents	14.0	16.5	10.5	17.8	8.9
Daily smoking	14.5	18.4	8.0	17.5	10.9
Smoking on school premises	31.4	32.2	30.8	33.0	30.6
School level					
% Smokers at school (mean±SD)	14.79±9.03	15.30±9.23	13.86±8.73	17.19±9.66	12.05±7.54

Table 4 presents the associations between school policies and smoking outcomes. In model 1, which controlled for demographics only, stronger communication, sanctions and staff reported total policy were associated with higher odds of daily smoking (eg, OR sanctions=1.28, 95% CI 1.00 to 1.62). Other policy variables in model 1 were not significantly associated with daily smoking. This pattern persisted when other control variables were added in models 2, 3 and 4. In model 5, when

controlling for the percentage smokers in the school, all associations with daily smoking became non-significant. Smoking on the school premises was not significantly associated with school policies. In models 1 through 4, (eg, OR staff reported total policy=0.85, 95% CI 0.62 to 1.16). In model 5, higher scores of staff reported total policy were associated with lower odds of smoking on the school premises (OR=0.71, 95% CI 0.53 to 0.96). Other policy variables also tended to be associated with

Table 2 Mean and SD of school policy variables, stratified by city of residence

	Total population	Namur (BE)	Tampere (FI)	Hannover (DE)	Latina (IT)	Amersfoort (NL)	Coimbra (PT)
N schools (%)	50 (100)	7 (14.0)	8 (16.0)	13 (26.0)	8 (16.0)	8 (16.0)	6 (12.0)
N students (%)	10 325 (100)	1962 (19)	1480 (14.3)	1312 (12.7)	1996 (19.3)	1844 (17.9)	1731 (16.8)
N staff respondents (%)	276 (100)	88 (31.9)	32 (11.6)	67 (24.3)	36 (13.0)	28 (10.1)	25 (9.1)
Student perceived policy	6.01±2.07	5.42±0.80	7.28±0.68	7.29±1.09	2.80±1.11	5.04±1.91	7.83±1.24
Staff perceived total policy	5.26±0.80	5.25±0.42	5.85±0.76	5.20±0.66	4.60±0.68	5.05±1.05	5.80±0.53
Regulations	7.97±1.14	7.81±0.80	8.44±1.10	7.97±0.71	6.86±0.94	7.89±1.51	9.11±0.80
Communication	5.41±1.48	5.10±0.57	6.23±1.21	4.65±1.09	5.67±1.36	4.90±2.34	6.62±0.96
Sanctions	2.41±0.97	2.83±0.46	2.88±1.03	2.96±1.03	1.27±0.44	2.36±0.56	1.68±0.38

Table 3 The association between covariates and daily smoking and smoking on school premises

	OR with 95% confidence interval (95% CI)			
	Daily smoking (N=10 325)		Smoking on school premises (N=1461)	
	Univariate*	Multivariate†	Univariate*	Multivariate†
Individual level				
Age	1.82 (1.70 to 1.95)	1.62 (1.51 to 1.74)	1.20 (1.05 to 1.37)	1.16 (1.01 to 1.33)
Male gender	1.14 (1.01 to 1.28)	1.00 (0.89 to 1.12)	1.39 (1.09 to 1.77)	1.37 (1.06 to 1.76)
Migrant descent	0.96 (0.83 to 1.10)	0.86 (0.75 to 1.00)	1.22 (0.92 to 1.60)	1.20 (0.90 to 1.59)
Academic achievement				
Insufficient or low	Ref	Ref	Ref	Ref
Average	0.53 (0.46 to 0.62)	0.62 (0.54 to 0.72)	0.74 (0.55 to 0.99)	0.76 (0.56 to 1.02)
Good	0.27 (0.23 to 0.32)	0.36 (0.30 to 0.44)	0.80 (0.56 to 1.15)	0.86 (0.59 to 1.22)
High	0.16 (0.12 to 0.23)	0.26 (0.19 to 0.36)	0.56 (0.26 to 1.17)	0.63 (0.30 to 1.32)
Parental educational level				
Low	Ref	Ref	Ref	Ref
Middle	1.04 (0.87 to 1.24)	1.20 (0.99 to 1.44)	0.90 (0.64 to 1.27)	0.88 (0.61 to 1.25)
High	0.83 (0.70 to 1.01)	1.25 (1.03 to 1.52)	1.08 (0.74 to 1.57)	1.17 (0.79 to 1.72)
Do not know or other	0.97 (0.77 to 1.22)	1.16 (0.91 to 1.47)	0.82 (0.51 to 1.33)	0.83 (0.51 to 1.35)
Smoking rules at home				
Nowhere	Ref	Ref	Ref	Ref
Certain areas	1.99 (0.96 to 1.25)	1.23 (1.06 to 1.42)	1.44 (1.10 to 1.88)	1.34 (1.00 to 1.79)
Everywhere	2.99 (2.45 to 3.66)	1.64 (1.31 to 2.05)	1.10 (0.75 to 1.62)	0.99 (0.66 to 1.50)
Do not know	1.09 (0.88 to 1.35)	1.04 (0.83 to 1.29)	0.66 (0.39 to 1.13)	0.70 (0.41 to 1.20)
Smoking parents				
No smoking parents	Ref	Ref	Ref	Ref
1 smoking parent	2.34 (2.04 to 2.67)	1.98 (1.70 to 2.29)	1.34 (1.01 to 1.77)	1.28 (0.95 to 1.72)
≥2 smoking (step)parents	3.78 (3.25 to 4.39)	2.97 (2.50 to 3.52)	1.40 (1.04 to 1.87)	1.34 (0.96 to 1.86)
School level				
Per cent Smokers at school	1.98 (1.87 to 2.10)	1.64 (1.53 to 1.77)	1.33 (1.09 to 1.62)	1.29 (1.06 to 1.58)

*Univariate analyses were not controlled for any confounding factors.
 †Multivariate analyses were controlled for all variables included in the table.

lower odds of smoking on the school premises, though these associations could not be demonstrated with statistical significance.

Table 5 presents the association between school policies and smoking within socioeconomic subgroups of students. The

associations between school smoking policies and daily smoking were very similar in students with low and high academic achievement and students with low and high parental educational level. For smoking on the school premises, associations tended to be somewhat stronger in students of low academic

Table 4 The association between school smoking policy and daily smoking and smoking on school premises

	OR with 95% CI				
	Model 1	Model 2	Model 3	Model 4	Model 5
Daily smoking (N=10 325)					
Student perceived policy	1.05 (0.87 to 1.26)	1.05 (0.88 to 1.25)	1.06 (0.91 to 1.23)	1.11 (0.96 to 1.27)	1.04 (0.98 to 1.10)
Staff reported total policy	1.30 (0.99 to 1.70)	1.29 (1.00 to 1.67)	1.26 (1.00 to 1.58)	1.31 (1.05 to 1.62)	1.04 (0.93 to 1.16)
Regulations*	0.91 (0.76 to 1.09)	0.91 (0.76 to 1.09)	0.92 (0.79 to 1.07)	0.96 (0.83 to 1.10)	0.98 (0.92 to 1.06)
Communication*	1.15 (1.00 to 1.31)	1.14 (1.00 to 1.30)	1.13 (1.01 to 1.27)	1.13 (1.01 to 1.25)	1.03 (0.97 to 1.09)
Sanctions*	1.28 (1.00 to 1.63)	1.28 (1.01 to 1.62)	1.24 (1.00 to 1.53)	1.26 (1.04 to 1.54)	1.04 (0.93 to 1.15)
Smoking on school premises (N=1461)					
Student perceived policy	0.91 (0.79 to 1.05)	0.91 (0.79 to 1.05)	0.91 (0.79 to 1.04)	0.91 (0.79 to 1.05)	0.89 (0.78 to 1.02)
Staff reported total policy	0.85 (0.62 to 1.16)	0.85 (0.63 to 1.18)	0.84 (0.62 to 1.15)	0.85 (0.62 to 1.16)	0.71 (0.53 to 0.96)
Regulations*	0.86 (0.70 to 1.05)	0.86 (0.70 to 1.05)	0.86 (0.70 to 1.05)	0.86 (0.70 to 1.06)	0.92 (0.77 to 1.11)
Communication*	1.00 (0.86 to 1.18)	1.01 (0.86 to 1.19)	1.00 (0.85 to 1.17)	1.00 (0.85 to 1.18)	0.91 (0.77 to 1.06)
Sanctions*	0.95 (0.73 to 1.24)	0.96 (0.73 to 1.26)	0.95 (0.73 to 1.23)	0.94 (0.72 to 1.23)	0.79 (0.60 to 1.03)

Model 1: Age, gender and ethnicity.
 Model 2:+parental educational level.
 Model 3:+smoking rules at home, smoking parents.
 Model 4:+academic achievement.
 Model 5:+% smokers at school.
 *The three subscales regulations, communication and sanctions were modelled simultaneously.

Table 5 The association between school smoking policy and smoking outcomes, stratified by academic achievement of the student and parental educational level

	OR with 95% CI*			OR with 95% CI*		
	Low academic achievement	High academic achievement	p Value interaction	Low parental educational level	High parental educational level	p Value interaction
Daily smoking	N=5969	N=4091		N=4879	N=4172	
Student perceived policy	1.03 (0.96 to 1.09)	1.03 (0.96 to 1.11)	0.927	1.05 (0.99 to 1.12)	1.00 (0.93 to 1.07)	0.116
Staff reported total policy	1.05 (0.93 to 1.19)	0.95 (0.79 to 1.13)	0.254	1.03 (0.90 to 1.18)	0.96 (0.82 to 1.12)	0.446
Regulations†	0.98 (0.91 to 1.06)	0.97 (0.87 to 1.08)	0.892	0.99 (0.90 to 1.08)	0.93 (0.83 to 1.03)	0.294
Communication†	1.04 (0.97 to 1.11)	0.96 (0.87 to 1.06)	0.156	1.02 (0.95 to 1.10)	1.02 (0.93 to 1.10)	0.866
Sanctions†	1.08 (0.96 to 1.20)	1.03 (0.88 to 1.22)	0.621	1.05 (0.93 to 1.18)	1.02 (0.89 to 1.17)	0.687
Smoking on school premises	N=952	N=445		N=871	N=413	
Student perceived policy	0.90 (0.79 to 1.03)	0.86 (0.72 to 1.01)	0.511	0.89 (0.77 to 1.02)	0.92 (0.79 to 1.08)	0.571
Staff reported total policy	0.69 (0.50 to 0.95)	0.80 (0.51 to 1.20)	0.580	0.71 (0.50 to 0.99)	0.80 (0.54 to 1.19)	0.543
Regulations†	0.92 (0.76 to 1.12)	0.95 (0.73 to 1.23)	0.829	0.88 (0.71 to 1.09)	0.90 (0.70 to 1.14)	0.887
Communication†	0.88 (0.75 to 1.05)	0.97 (0.77 to 1.22)	0.450	0.91 (0.76 to 1.09)	0.98 (0.79 to 1.22)	0.482
Sanctions†	0.79 (0.61 to 1.04)	0.76 (0.51 to 1.12)	0.796	0.84 (0.63 to 1.13)	0.88 (0.61 to 1.25)	0.781

*Controlled for age, gender, ethnicity, smoking rules at home, smoking parents and smoking prevalence at school.

†The three subscales regulations, communication and sanctions were modelled simultaneously.

achievement and low parental education. For example, adolescents with low academic achievement tended to show a stronger association between staff reported total policy and smoking on school premises (OR=0.69, 95% CI 0.50 to 0.95) than adolescents with high academic achievement (OR=0.80, 95% CI 0.51 to 1.20, p for interaction=0.580). However, we did not find any significant interactions.

DISCUSSION

Key findings

School smoking policies were not associated with daily smoking among students. However, in schools where staff reported stronger smoking policies, students were less likely to report smoking on the school premises. Specific components of staff reported policy, as well as student perceived policy, also showed negative associations with smoking on the school premises, although these associations could not be demonstrated with statistical significance. For smoking on the school premises, associations were somewhat stronger in students with lower academic achievement and students with lower educated parents. However, we could not demonstrate these educational inequalities with statistical significance.

Evaluation of potential limitations

Owing to the cross-sectional nature of the data, we were not able to assess the causality and the direction of possible causal associations between school smoking policies, smoking behaviours and control variables. It is unlikely that individual students influence the school's smoking policy. However, we identified student academic achievement and the school smoking prevalence as potential mediators. According to our results, both academic achievement and school smoking prevalence did not mediate the association between school smoking policies and smoking. We found mostly positive associations with daily smoking before control for school smoking prevalence while we would expect inverse associations. Furthermore,

associations between school policies and smoking on the school premises did not change when adding academic achievement and became even stronger after control for school smoking prevalence.

In this study, we derived data on daily smoking and smoking on school premises from self-completed questionnaires. When using self-reported data, smoking behaviour may be under-reported due to socially desirable answering of questions.^{41 42} Under-reporting of smoking may be associated with stronger school smoking policies because the social norm in these schools may be not to smoke. If this is true, associations between policies and smoking may be overestimated.

Even though we included 50 schools from six countries, the number of schools remains a limitation to the possible inclusion of school-level confounders other than smoking prevalence. Potential school-level confounders include health education programmes in schools,²⁷ school type (ie, the educational tracks in a school)²⁴ and socioeconomic indicators of the school (eg, area-level information on household income).⁴³

In the school questionnaire, we measured multiple aspects of school smoking policies. This is an advantage over some studies that used less extensive policy measurements. Yet we were not able to capture some other potentially important details, such as the explicit statement of the purpose and goals of policies,¹⁰ the perceived adherence to smoking rules^{23 44} and students' perceived clarity of rules.^{13 45} If smoking policies were possibly measured in more detail, we may have found stronger associations with daily smoking and smoking on school premises.

Interpretation of results

Our finding that schools with stronger smoking policies had less smoking on the school premises is consistent with previous studies.^{13 22 45 46} This finding implies that smokers in schools with strong policies may smoke fewer cigarettes, and that non-smokers may be exposed to less smoking at school. Exposure to smoking at school may encourage smoking initiation.⁴⁷ A school

with many students smoking near the school may also create a smoking-approving environment. This suggests that enacting strong school smoking policies may help prevent smoking initiation in the longer term.⁴⁸

Daily smoking was not associated with school smoking policies. Similarly, several previous studies did not find an association either between smoking and school smoking policies.^{10 19 25 27 28} It is possible that policies may only affect smoking behaviour under certain conditions that were not measured in the current study. One study suggested that students may need to perceive that there is a clear set of smoking rules,²¹ whereas another study pointed out that schools may need to have a smoke-free zone in order for other smoking rules to have an effect.¹⁸

Our results suggest that school smoking policies are effective in lower and higher socioeconomic groups. However, we did find some associations that tended to be stronger in students with lower academic achievement and in students with lower educated parents. 'Equity positive' effects⁵ have previously only been observed for policies at the national level, such as policies on tax/price raises and on age of sales restrictions on tobacco products.⁵ For other types of tobacco control policies (such as smoke-free policies and tobacco advertisement bans), some studies found 'equity negative' effects,^{5 49} while most studies concluded that both high and low SES groups seem to benefit from policies equally ('equity neutral').⁵

The influence of school smoking policies on adolescent smoking is weak compared to the strong influence of peer and parental smoking behaviours. Our results support the findings of many previous studies on the effects of peers and parents on adolescent smoking.^{50–52} This suggests that besides school policies, the prevention of smoking in adolescents may benefit from school programmes with a focus on social influences and social competences. Some school programmes that focus on social influences may be effective in reducing smoking initiation.⁵³

CONCLUSIONS

Our findings suggest that school smoking policies have no significant effect on daily smoking among students, but may reduce the prevalence of smoking on the school premises. This reduction might decrease students' exposure to smoking in school settings and reduce the possibility that students might start experimenting with smoking at school. Thus, these findings support other studies⁸ that suggest that school policies may contribute to reducing adolescent smoking prevalence rates. Moreover, our findings suggest that both higher and lower socioeconomic groups would benefit from school smoking policies.

Author affiliations

¹Department of Public Health, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands

²Institute of Health and Society, Université Catholique de Louvain, Brussels, Belgium

³Medical Faculty, Institute of Medical Sociology (IMS), Martin Luther University Halle-Wittenberg, Halle (Saale), Germany

⁴School of Health Sciences, University of Tampere, Tampere, Finland

⁵Department of Adolescent Psychiatry, Pitkänmiemi Hospital, Nokia, Tampere University Hospital, Tampere, Finland

⁶National School of Public Health, University of Lisbon, Lisbon, Portugal

⁷Department of Human Sciences, Society and Health, University of Cassino and Southern Lazio, Cassino, Italy

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Contributors MAGK and AEK conceived and designed the study. VES prepared the data. MAGK and RdK conducted the statistical analyses, interpreted the data and drafted the manuscript. VES, IM and BF contributed to the data collection. VES, MR, IM, AHR, JP, BF, AEK and VL contributed to the interpretation of the data and critically revised the manuscript for important intellectual content. VL initiated and conceptualised the survey. All authors have read and approved of the final manuscript.

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