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Smoking cessation among adolescents in Europe: The role of school policy and programmes



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ARTICLE INFO	ABSTRACT		
A R T I C L E I N F O Keywords: Smoking cessation Quitting Adolescents School Policy Education programme	Introduction: European estimates of adolescent smoking cessation are lacking and studies on the role of schools in quit behaviour are scarce. We aimed to describe smoking cessation attempts and success among adolescents in Europe and explored the association with school policy and programmes. Methods: We used cross-sectional data from the 2013 and 2016–2017 surveys of the European SILNE and SILNE-R projects. We included 4,509 12–19-year-old current or ex-smokers in 67 secondary schools in seven countries (Belgium, Germany, Finland, Ireland, Italy, the Netherlands, and Portugal). School staff reported strength of smoke-free school policies (SFSPs), proportion of grades in which anti-tobacco education was offered, and whether the school offered any form of cessation support programme. Multilevel logistic regression analysis determined school-level variation and the association of school-level and individual-level variables with self-reported and self-defined quit attempts and quit success. Results: Over three quarters (77.3%) of students reported a quit attempt and half of them (50.1%) reported quit success. Prevalence rates of quit success and quit attempts, showed relatively small variations between schools within countries. Associations of smoke-free school policy, tobacco educational programmes and cessation programmes with quit attempts and quit success could not be demonstrated with statistical significance. Quit attempts and quit success that adolescence is an important time to encourage quitting and to support quit attempts. We did not find evidence for a contribution of school policies and programmes to quit behaviour of adolescent smokers.		

1. Introduction

Most tobacco control efforts targeting adolescents aim at preventing smoking initiation (Backinger et al., 2003), such as bans on sales to minors and tobacco advertising (Nagler and Viswanath, 2013). However, some adolescents still start smoking and in 2015, one in five European 15–16 year-olds had smoked in the last 30 days (Kraus and Nociar, 2016), and 35.3% of 15-year-old daily smokers were addicted to nicotine (Coban et al., 2019). As the period of tobacco use lengthens,

addiction gets stronger, and risk of continuing smoking and developing tobacco-related diseases increase (Burns, 2003; Van Miert et al., 2011). Therefore, it is of great importance that adolescents who do start smoking quit as soon as possible.

Smoking cessation among adolescents has previously been defined by self-reported measures of abstinence of smoking over a given period or self-identifying as being quit (Haug et al., 2014; Jeong et al., 2020; Towns et al., 2017). Jeong et al. (2020) found that in 2015–2017, 86.9% of 12–18 year old smokers in South Korea had ever attempted to quit

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smoking, and 54.8% of them had succeeded. The prevalence of ever having attempted to quit was lower (61%) in a 2011–2012 cohort of Swiss vocational school students with a mean age of 18 years (Haug et al., 2014). In the US, most studies were conducted in the 1990's and found similar results. Burt and Peterson (1998) found that 60% of established adolescent smokers attempted to quit in the past 12 months, of whom 21% were still abstaining at the time of the survey. Sargent et al. (1998) found that 46.3% of adolescent occasional smokers, and around 10% of daily smokers had quit smoking after three years' follow-up. To our knowledge, there are no recent studies on the prevalence of smoking cessation attempts and success among adolescents in the wider European setting.

The school may contribute to successful smoking cessation among adolescents. Schools may 1) keep school premises smoke-free (i.e. smoke-free school policies, or SFSPs), 2) educate students on the harms of smoking and 3) provide cessation support. Reviews show that SFSPSs may reduce smoking prevalence and initiation (Galanti et al., 2014; Schreuders et al., 2017). To our knowledge no previous studies determined the association between SFSPs and smoking cessation. Schreuders et al. (2017) suggested that SFSPs may increase quitting by creating an environment in which adolescents' perceived behavioural control is stronger. However, it may have no impact on cessation or even decrease quitting, if smokers relocate to places outside the school premises and thereby strengthen smoking-related social groups (Schreuders et al., 2017).

Although many RCTs have demonstrated the efficacy of educational programmes in smoking initiation (Thomas et al., 2015), few studies have assessed effects on smoking cessation. RCTs have also studied impact of offering school-based cessation support (Fanshawe et al., 2017; Joffe et al., 2009; Krishnan-Sarin et al., 2013), but results are mixed. Little is known about the extent to which school programmes may support quitting in real-world applications. A recent observational study from South Korea found that students who had attended the smoking cessation programme at their school were more likely to have attempted to quit, but not to be more successful at quitting (Jeong et al., 2020).

This study aimed to describe smoking cessation attempts and their success rate among adolescent current and ex-smokers in Europe and to explore cross-sectional associations with school policies and programmes. The specific objectives were to quantify the prevalence of quit attempts and of successful quit attempts, to assess the variation at the school-level, and to assess the association of schools' policies and programmes (i.e. SFSPs, anti-tobacco education and smoking cessation programmes) with quit attempts and quit success. We used data of 4,509 adolescent current and ex-smokers from seven EU cities.

2. Methods

2.1. Study design

Cross-sectional surveys were carried out in 2013 and 2016–2017, respectively in the Smoking Inequalities – Learning from Natural Experiments (SILNE) project and its sequel the SILNE-Realist (SILNE-R) project. The SILNE project aimed to provide evidence on how to reduce socioeconomic inequalities in smoking by exploring variations in tobacco control policies between six countries in Europe. The SILNE-R project aimed to further understand tobacco control policy impact by applying a realist approach that focussed on mechanisms through which policy may or may not affect youth smoking.

In total, 67 secondary schools were included in seven cities in seven countries: Namur (Belgium), Tampere (Finland), Hanover (Germany), Dublin (Ireland), Latina (Italy), Amersfoort (the Netherlands), and Coimbra (Portugal). Ireland only participated in 2016–2017. 38 schools participated twice, in both surveys. In each country, the selected city's characteristics such as income and employment rates were close to the national average. Schools were selected from a local register, in which

two grades covering the ages 14–16 were included in the study. All students in the two selected grades in each school were invited to participate.

Both students and schools staff completed questionnaires. Questionnaires were self-administered using paper-and-pencil questionnaires. Students filled in the questionnaire in the classroom under surveillance of a research member and/or a teacher.

For more information on the study design, including ethical approval and informed consent in each country, and design of the questionnaires please see Lorant et al. (2015). The questionnaires have been previously used in several recent publications (Grard et al., 2019; Mélard et al., 2020; Schreuders et al., 2019b, 2020)

2.2. Study population

Data from participants in the 2013 and 2016–2017 surveys were merged in the current study to achieve sufficient numbers for analysis.

2.2.1. Students

The student population consisted of 28,937 secondary school students, of whom 23,788 participated in the survey (response rate 82.2%). Age ranged from 12 to 19. Only the 5,003 current or ex-smokers were selected for this study (see prevalence of current smoking and exsmoking in Supplementary Table 1). Current or ex-smoking was defined in two steps. First, participants were asked whether they had ever smoked, even just a few puffs (yes/no). Second, those answering 'yes', were asked 'Have you ever tried to quit smoking cigarettes?', with response options 'I have never smoked', 'I have only smoked a few times', 'I have never tried to quit smoking'. Adolescents who never smoked (either according to the first or second question), or only smoked a few times were excluded from this study.

2.2.2. School staff

590 school staff members completed a questionnaire on school characteristics (i.e. 9 per school on average). Staff members with missing values on specific variables were excluded for the construction of these variables, leading to a population of 525 staff members for smoke-free school policy, 590 for educational programmes, and 552 for cessation programmes.

2.3. Measurements

2.3.1. Dependent variables

Smoking cessation attempts were measured with the question: 'Have you ever tried to quit smoking cigarettes?'. 'Quit attempts' was coded 1 if answered with 'I have tried to quit at least once' or 'I have successfully quit smoking' and was coded 0 if the student indicated to have 'never tried to quit smoking'. 'Quit success' was coded 1 if answered with 'I have successfully quit smoking' and was coded 0 for 'I have tried to quit at least once'. The number of quit attempts and the timing of quit attempts and quit success were not measured in our surveys. Quit attempts and quit success were self-reported. Moreover, the question on quitting did not specify what was considered a quit attempt or being quit. Therefore these measures need to be interpreted as self-reported and self-defined.

2.3.2. School variables

School staff members reported whether or not the school had a policy prohibiting students to smoke cigarettes in school, on school grounds and at off-campus events (yes = 1, no = 0). The sum of these three items was calculated for each individual staff member. Individual scores were then aggregated to averages at the school-level. The latter were categorised into tertiles of SFSP representing 'weak', 'intermediate' and 'strong' policy. This is a measures the comprehensiveness or strength of SFSPs, which is one of the dimensions as identified in a review by

Galanti et al. (2014).

Staff members reported for each school grade whether the school offered education on tobacco (yes/no). The number of 'yes' responses was converted to the percentage out of the maximum number of grades in the secondary school system of the country. These percentages were aggregated to averages at the school-level. The latter were categorised into education offered in 'less than 33%', '33%-66%' and 'more than 66% of grades', to illustrate the intensity of anti-tobacco educational programmes. We were unable to measure what educational programmes entailed and for how many hours the students were taught about the risks of tobacco use.

Staff members reported whether the school offered programmes to help students quit smoking such as group sessions, self-help materials, and individual counselling by a nurse (yes/no). The school was considered to offer quit smoking programmes if the percentage of staff members answering 'yes' was \geq 50% (i.e., the majority). We could not measure what kind of help was offered to quit and whether students knew how to get this support.

Each school-level variable was year-specific (2013 or 2016–17), and the value of the school variable was linked to the students according to their year of participation.

2.3.3. Individual variables

We measured age (in years) and gender (male vs. female). To define academic performance, students marked how their grades were over the past year, choosing from 5 country-specific options which were categorised into 'high', 'medium', and 'low'. To approximate for how many years the participant had been smoking, we calculated the years since smoking initiation by subtracting reported age at smoking initiation (in years) from current age.

Alcohol use and physical activity we included in this study due to the interrelationships between alcohol, sports and smoking (Lisha and Sussman, 2010), and because they were found to be predictors of cessation behaviour (Haug et al., 2014). Physical activity was measured in time per day, and converted into <7 h/week or ≥7 h/week, based on the WHO's recommendation for moderate to vigorous physical activity for adolescents (World Health Organization, 2010). Alcohol use was dichotomised into having used alcohol 'once a month or less' (including non-drinkers) or 'more than once a month' in the last 12 months.

Students reported whether each of their parents and stepparents (as appropriate) smoked, which was dichotomised into 'none' and 'one or more smoking parents'. Students also reported whether 'none', 'some', 'most' or 'all' of their friends were smokers.

2.4. Statistical analysis

Out of the 5,003 current or ex-smokers, we excluded 494 participants who had missing data on any of the individual-level variables included in the current study; age (N = 12), gender (N = 20), years since initiation (N = 27), academic performance (N = 116), alcohol use (N = 171), and smoking behaviour of friends (N = 184). This resulted in a total adolescent study population of 4,509 for the analysis of quit attempts. For the analysis of quit success, only those who reported 'I have tried to quit at least once' or 'I have successfully quit smoking' were included (N = 3,487).

Prevalence rates of smoking cessation attempts and success were determined in the total population and according to categories of the individual-level variables. Prevalence rates were also presented as aggregates at the school-level. The distribution of prevalence rates across schools in 2016–17 and the corresponding median and interquartile range (IQR) at school-level were determined. Descriptive analyses were conducted in SPSS V.26.

We assessed the associations of individual and school variables with quit attempts and quit success. We used multilevel logistic regression analysis, because of the levelled structure of the data with students nested in schools. We were unable to additionally distinguish country as a level, due to the insufficient number of countries. All regression analyses were carried out in Stata/IC V.15.1, using the xtlogit command.

Quit attempts and quit success were analysed according to the same steps: we first analysed all school-level and individual-level variables in separate univariate models. Next, the model with basic adjustment (Model 1) included all school-level variables (school smoke-free policy, education programme, and cessation programme) and basic participantcharacteristics age, gender, country and survey year. The fully adjusted model (Model 2) additionally adjusted for other confounders: academic performance, years since smoking initiation, physical activity, alcohol use, parents' smoking and friends' smoking. Smoking behaviour of friends may act partly as a mediator in the association between schoollevel variables and outcomes, as friends are mostly in the same schools and are therefore influenced by the same school-level variables. We therefore present a model not controlled for friends' smoking behaviour as a sensitivity analysis.

We derived the intraclass correlation coefficient (ICC) from the xtlogit command output for an empty model (i.e. a without independent variables), a model that included country, year, age and gender, and Model 2. ICC is calculated by dividing the variance of the random effect by the total variance, and is presented as the percentage variance in the outcome that is attributable to the school-level.

3. Results

Table 1 presents the individual-level characteristics of the study population and the prevalence of quit attempts and quit success. The majority of the sample had initiated smoking less than one year ago (58.3%). More than three quarters (77.3%) had attempted to quit and half of them (50.1%) were successful. The vast majority (91.5%) of participants who had no smoking friends had attempted to quit (91.5%) and were successful (88.0%), unlike participants whose friends were all smokers (62.0% and 20.7%, respectively). Supplementary Table 2 presents the characteristics stratified by quit attempt and quit success status.

Fig. 1 presents quit attempt and quit success rates per school. The quit attempt rate ranged from 42.9% to 100%, with an IQR of 10.4, and the quit success rate ranged from 21.4% to 90.0%, with an IQR of 23.1 (see Supplementary Table 3). Variation between schools in quit attempt rates was relatively small in Portugal and Finland, and large in Germany and Ireland. Table 2 shows that 47.8% of schools offer tobacco education in less than a third of the grades, and 83.4% of school report to offer cessation support.

In Table 3, the results for quit attempts are presented. Overall, in all three models (univariate, basic adjustment and full adjustment) we found no evidence for associations between school-level variables and quit attempts. The fully adjusted model (Model 2) showed no significant association of SFSPs (OR strong vs. weak SFSP:1.12, 95%CI: 0.86-1.44), education programmes (OR > 66% of grades vs. < 33%:0.98, 95% CI:0.76-1.26), and cessation programmes (OR:1.14, 95%CI:0.91-1.43) with quit attempts. Odds of attempting to quit were lower when adolescents had smoking parents, smoking friends, and used alcohol at least monthly. Adolescents who had initiated smoking longer ago had higher odds of attempting to quit. There was some variation in quit attempts at the school-level (ICC empty model:2.42%), but this was for the largest part explained by country, year, age and gender variations between schools (ICC:0.67% in the model with basic adjustment (Model 1)).

Table 4 presents the multi-level logistic regression analysis for quit success. Overall, in all three models (univariate, basic adjustment and full adjustment) we found no evidence for associations between school-level variables and quit success. In the fully adjusted model (Model 2), all associations between school-level variables and quit success were non-significant (OR strong vs. weak SFSP: 0.85, 95%CI: 0.63-1.14; OR education in >66% of grades vs. < 33%: 0.86, 95%CI 0.64–1.16; OR cessation programme yes vs. no: 1.19, 95%CI:0.89–1.59). Adolescents had lower odds of successfully quitting if they had initiated smoking

Table 1

Description of the study population and prevalence of quit attempts, in percentages.

	Sample description (%)	Quit attempts (%)	Quit success (%)
N individuals (%)	4,509 (100%)	3,487 (77.3%)	1,747
	, , ,		(50.1%)
Survey year			
2013	54.2	76.6	48.8
2016-2017	45.8	78.2	51.6
Country			
Belgium	21.4	76.5	37.5
Finland	12.2	82.9	54.4
Germany	8.4	79.0	60.8
Ireland	4.5	74.0	69.5
Italy	24.2	74.1	41.5
The Netherlands	11.3	71.8	51.2
Portugal	17.9	82.5	61.7
Age (in years)			
12–14	16.4	80.1	58.0
15	35.6	77.5	54.5
16	29.8	76.2	46.2
17-19	18.2	76.2	40.3
Gender			
Female	48.9	78.2	46.4
Male	51.1	76.5	53.7
Years since smoking			
initiation			
Less than 1 year	58.3	76.8	60.1
1 vear	16.8	78.2	40.0
2 years	10.7	78.1	32.4
3 or more years	14.2	78.0	34.9
Academic performance			
High	29.4	78.4	55.6
Medium	43.2	77.8	50.9
Low	27.4	75.5	42.7
Physical activity	_,		
<7 h/week	56.5	76.8	47.5
>7 h/week	43.5	78.9	53.5
Alcohol use			
Less than once a	55.2	82.1	62.4
month			
Once a month or more	44.8	71.5	32.7
Smoking behaviour of	1110	/ 110	020
parents			
No parents smoke	44 9	79.5	57.6
One or more parents	55.1	75.6	43.7
smoke	0011	/010	1017
Friends who are smokers			
None of them	89	91.5	88.0
Some of them	38.8	82.2	67.2
Most of them	42.6	73.5	28.5
All of them	9.7	62.0	20.7
in or men	2.1	02.0	20.7

longer ago, had lower academic performance (compared with higher), used alcohol at least monthly, and if their parents or friends were smokers. There was substantial variation in quit success at the school-level (ICC empty model:9.44%), which was for a large part attribut-able country, year, age and gender variations between schools (Model 1: ICC:2.94%), and further attributable to variables in the fully adjusted model (Model 2: ICC:0.79%).

Supplementary Table 4 shows that, when not controlled for friends' smoking behaviour, all associations are similar to those found in the main analysis. Friends' smoking therefore did not seem to have a strong mediating or confounding effect.

4. Discussion

4.1. Key findings

Over three quarters of adolescent current or ex-smokers reported ever having attempted to quit smoking, and half of them reported to have successfully quit. We were unable to demonstrate associations between school-level policies and programmes and quit attempts or success. Quit attempts and quit success were inversely associated with alcohol use, parental smoking, proportion of smoking friends.

4.2. Evaluation of potential limitations

This cross-sectional study cannot draw conclusions on causal relationships. Associations may be confounded by variables that were not taken into account. At the school-level, the tobacco retail environment or the social norm regarding smoking may act as confounders that overestimate or conceal relationships. We therefore cannot firmly conclude that school policies and programmes were not associated with quit attempts and success. As the timing of quit attempts and success were not measured we cannot determine the timing of quitting relative to programme delivery.

In the methods section we highlighted some limitations in the measurement of quit-outcomes. As quit attempts and quit success were selfreported, recall bias may have occurred, especially among longer-term smokers who may not recall having attempted to quit in the past. Moreover, the lack of a definition of quitting in the question implies that the estimated prevalences depend on adolescents' interpretations. Given the often-irregular pattern of smoking among adolescents, the difference between quitting and a hiatus in smoking may not be clear. If the threshold for both definitions are low, this may have caused an overestimation of quit attempts and success rates. In some schools we found a 100% quit attempt rate, which may be a reflection of desirability bias or due to the low number of smokers in those schools.

The methods section we explained that the questionnaire lacks certain details on the school variables. Such details would have allowed a better classification of the comprehensiveness of education and cessation programmes, and perhaps revealed associations that we have now missed due to misclassification.

We found differences between the seven European cities in the rates of quit attempts/success and the variation between schools. Results might be generalisable to other cities in the same countries, especially in the smaller more homogeneous countries (e.g. Netherlands, Ireland). However, we cannot generalise to the wider European region as the sample of countries is relatively small and we lack data on Eastern Europe.

4.3. Interpretation of results

4.3.1. Quit attempt and quit success rates

Over three quarters of our study population attempted to quit smoking and half of them succeeded. These results are similar to percentages of 86.9% and 54.8% among South Korean adolescents. Qualitative research found that adolescent smokers are motivated to quit in the not too distant future (Schreuders et al., 2018)), and this motivation may be driven by societal de-normalisation of smoking, health consequences, and to prevent more severe addiction (O'Loughlin et al., 2009; Schreuders et al., 2018). However, as discussed above, quit attempt and quit success rates among adolescents may be lower than measured due to bias. Moreover, adolescents may still relapse despite temporary success, as O'Loughlin et al. (2009) found that only 19% of adolescent smokers who tried to quit had actually stopped smoking for at least one year.

4.3.2. Role of the school

Even though we found some variation at the school-level in the likelihood of quit attempts and success, these were not attributable to school policies and programmes. Previous studies on SFSPs did find associations with smoking initiation or smoking prevalence among adolescents (Galanti et al., 2014). Elements of the implementation and enforcement of SFSPs may affect smoking initiation, but not cessation. Many schools have designated smoking areas for students either on or just outside the school premises (Schreuders et al., 2017), and not all



Fig. 1. The distribution of A. quit attempts and B. quit success over schools in the 2016–17 survey data, grouped by country. Each bar is one school.

Table 2
Description of school variables and quit attempts and quit success rates at the
school-level. Number of schools = 67 . Number of individuals = 4.509 .

	Sample description (%)	Quit attempts (%)	Quit success (%)
Tobacco policy			
Weak	32.8	74.6	46.8
Intermediate	31.3	76.7	50.5
Strong	35.8	80.5	57.8
Tobacco education			
<33% of grades	47.8	77.1	51.8
33 – 66% of grades	34.3	78.2	49.0
>66% of grades	17.9	76.4	48.7
Cessation			
programmes			
No	16.4	78.8	59.4
Yes	83.4	77.1	49.6

staff enforces SFSPs (Schreuders et al., 2019c). Even if the school premises are truly smoke-free, students may find places to smoke away from the school, which allows smoking continuation and may even reinforce smoking as a way of social bonding (Schreuders et al., 2019a).

We did not detect an association between school tobacco education programmes and smoking cessation. In previous intervention studies, educational programmes are often found effective in reducing smoking, although sometimes to only a modest extent (Thomas et al., 2015). Studies show that this partly depends on the content of the offered curriculum. For example, curricula focussed on social competences were more often found to be effective (Thomas et al., 2015). We were unable to unravel what the tobacco education curricula entailed in the included schools. Besides content, RCTs tend to carefully design interventions and support schools in effectively implementing them, while the schools included in the current study may not have had the time and resources to implement intensive curricula.

We did not find an association between school cessation programmes and smoking cessation. Even though the majority of schools reported to have a cessation programme, these do not seem effective. Previous studies have found that smoking cessation support in schools can be effective (Jeong et al., 2020; Joffe et al., 2009) and that it may be more effective than in clinical settings (Towns et al., 2017). However, as for education programmes, in real-world practice, schools may not have had the time and resources to carefully adopt and implement an effective school-based cessation programme.

4.3.3. Individual-level determinants

Adolescents in our sample who smoke for a longer period of time were more likely to attempt quitting, but less likely to succeed than adolescent who had initiated less than a year ago. This may in part be explained by nicotine dependence, as stronger addiction is a motivator to attempt quitting, but also hinders success (O'Loughlin et al., 2009). Adolescents perceive cessation as more difficult if they smoke longer (O'Loughlin et al., 2009). Adolescents who recently started smoking may also appear more successful at quitting, because their smoking pattern is more irregular and they may be more inclined to report having quit smoking after not having smoked for a few days (O'Loughlin et al., 2009).

We found strong inverse associations between alcohol use and quit attempts and success. Smoking and alcohol use are strongly linked and youth smoking often take place mostly in party settings (Bailey et al., 2012; Huang et al., 2014; Nichter et al., 2010). Maintaining this lifestyle may make it much more difficult to quit smoking (Kelly and Barker, 2016). Alcohol use and smoking may however also have shared underlying risk factors that were not taken into account in this analysis (Viner et al., 2012).

Table 3

Multi-level regression analysis with quit attempts as the dependent variable.

		Odds ratio (OR) with 95% confidence interval (95% CI)		
		Univariate ^a	Model 1 ^b Basic adjustment	Model 2 ^c Full adjustment
School-level variables				
Tobacco policy	Weak	Ref.	Ref.	Ref.
	Intermediate	1.16 (0.93-1.45)	1.04 (0.84-1.28)	0.98 (0.79-1.21)
	Strong	1.41 (1.15–1.74)	1.26 (0.98-1.63)	1.12 (0.86-1.44)
Tobacco education	<33% of grades	Ref.	Ref.	Ref.
	33–66% of grades	1.17 (0.95-1.45)	1.07 (0.87-1.31)	1.14 (0.93-1.41)
	>66% of grades	1.06 (0.83-1.36)	0.88 (0.68-1.13)	0.98 (0.76-1.26)
Cessation programmes	No	Ref.	Ref.	Ref.
	Yes	1.24 (1.00–1.52)	1.11 (0.88–1.40)	1.14 (0.91–1.43)
Country and survey year				
Country	Belgium	Ref.	Ref.	Ref.
2	Ireland	0.90 (0.61-1.34)	0.75 (0.49-1.15)	0.66 (0.43-1.01)
	Finland	1.50(1.12 - 2.01)	1.28(0.87 - 1.88)	1.12(0.76 - 1.66)
	Germany	1.15(0.84 - 1.58)	1.06(0.76-1.47)	0.99(0.71 - 1.39)
	Italy	0.87 (0.69-1.10)	0.83 (0.67-1.11)	0.81 (0.63-1.05)
	Netherlands	0.79 (0.59-1.05)	0.78 (0.60-1.04)	0.68 (0.51-0.90)
	Portugal	1.47 (1.11–1.94)	1.44 (1.11-1.85)	1.17 (0.90-1.51)
Survey year	2013	Ref.	Ref.	Ref.
	2016-2017	1.04 (0.88–1.23)	1.06 (0.89–1.27)	1.04 (0.87–1.25)
Individual-level variables				
Age (in years)	<14	Ref	Bef	Bef
rige (in years)	15	0.84 (0.68 - 1.05)	0.83(0.67-1.03)	0.88(0.70-1.10)
	16	0.78(0.63-0.98)	0.00(0.07 - 1.00) 0.78(0.62-0.98)	0.89(0.70-1.13)
	>17	0.75(0.59-0.97)	0.74(0.52-0.96)	0.87(0.65-1.15)
Gender	Female	Bef	Bef	Ref
Schuch	Male	0.91(0.78 - 1.05)	0.91(0.79 - 1.06)	0.87(0.74 - 1.01)
Years since initiation	<1	Ref		Ref
	1	1.08(0.89 - 1.31)		1.31(1.07 - 1.61)
	2	1.06(0.84 - 1.34)		1.32 (1.03–1.70)
	->3	1.07(0.97 - 1.32)		1.45(1.15-1.82)
Academic performance	 High	Ref.		Ref.
·····	Medium	0.98(0.82 - 1.16)		1.03(0.86 - 1.23)
	Low	0.81(0.67 - 0.98)		0.88(0.71 - 1.07)
Physical activity	<7 h/week	Ref.		Ref.
- <u>j</u>	>7 h/week	1.09(0.95 - 1.27)		1.13(0.97 - 1.32)
Alcohol use	< once a month	Ref.		Ref.
	> once a month	0.55(0.48 - 0.63)		0.65 (0.56-0.76)
Parents' smoking	No parents smoke	Ref.		Ref.
0	>1 parents smoke	0.80 (0.69-0.92)		0.85 (0.74-1.00)
Friends' smoking	None of them	Ref.		Ref.
0	Some of them	0.42 (0.29-0.62)		0.46 (0.32-0.67)
	Most of them	0.26 (0.18-0.37)		0.30 (0.21-0.44)
	All of them	0.15 (0.10-0.23)		0.18(0.12 - 0.28)
Intraclass correlation coefficient (ICC; in%)		2.42 ^d	0.67 ^e	0.24 ^f

^a Unadjusted, crude, model for each independent variable.

^b Model 1 included: tobacco policy, tobacco education, cessation programmes, country, year of survey, age and gender.

^c Model 2: Model 1 + years since smoking initiation, academic performance, physical activity, alcohol use, parents' smoking and friends' smoking.

^d Intraclass correlation coefficient (ICC) from empty model (i.e. without independent variables).

^e ICC from a model that included country, year, age and gender as independent variables.

^f ICC from model 2.

The inverse associations of friends' and parents' smoking behaviour with quit attempts and success underscore the difficulty of quitting smoking in a pro-smoking social environment. This has been demonstrated for adults, who are less likely to quit when their partner still smokes and does not support quitting (Park et al., 2004). Living in a social environment with many smokers creates opportunity and cues to smoke, and reduces motivation to quit. Among adolescents it may be particularly important not to run the risk of losing friends by quitting a shared behaviour. This may also mean that, with the decreasing smoking trend, it may become easier for adolescents to quit.

4.4. Implications

Support to adolescents undertaking quit attempts is needed to achieve sustainable smoking cessation at a young age. This may be achieved through behavioural therapy (Simon et al., 2015) and incentives to quit (Krishnan-Sarin et al., 2013). There is insufficient evidence that nicotine replacement therapy and other pharmacotherapy are effective and safe for adolescents (Myung and Park, 2019; Towns et al., 2017).

Our data suggest that schools currently play a minor role in encouraging and supporting quit attempts. The effectiveness of SFSPs may be improved by wider smoke-free areas around the school and stricter rules on leaving the school grounds (Schreuders et al., 2017). Interventions in schools may need to include elements such as group sessions or incentives (Joffe et al., 2009; Krishnan-Sarin et al., 2013). Some staff members in our sample were unaware of the school's policies and programmes, which may reflect that the school does not sufficiently communicate about school rules and services. Clear communication and awareness among both students and staff may help in providing effective support in the school environment. Schools may require national financial and organisational support to effectively implement school policies and programmes. More observational studies, with more

Table 4

Multi-level regression analysis with quit success as the dependent variable.

		Odds ratio (OR) with 95% confidence interval (95% CI)		
		Univariate ^a	Model 1 ^b Basic adjustment	Model 2 ^c Full adjustment
School-level variables				
Tobacco policy	Weak	Ref.	Ref.	Ref.
	Intermediate	1.25 (0.93-1.69)	1.09 (0.83–1.43)	0.95 (0.73-1.24)
	Strong	1.28 (0.97-1.68)	1.06 (0.77-1.45)	0.85 (0.63-1.14)
Tobacco education	<33% of grades	Ref.	Ref.	Ref.
	33–66% of grades	0.69 (0.54-0.89)	0.70 (0.56-0.88)	0.81 (0.64-1.01)
	>66% of grades	0.76 (0.56-1.02)	0.72 (0.53-0.97)	0.86 (0.64-1.16)
Cessation programmes	No	Ref.	Ref.	Ref.
	Yes	0.85 (0.66–1.11)	1.09 (0.81–1.47)	1.19 (0.89–1.59)
Country and survey year				
Country	Belgium	Ref.	Ref.	Ref.
5	Ireland	3.81 (2.29-6.34)	3.99(2.34 - 6.80)	2.83(1.69 - 4.75)
	Finland	1.97(1.45 - 2.75)	1.74 (1.13-2.67)	1.63(1.06 - 2.52)
	Germany	2.81(1.97 - 4.00)	2.12(1.44 - 3.13)	1.80(1.21 - 2.68)
	Italy	1.24(0.92 - 1.67)	1.22(0.90-1.66)	1.07(0.78 - 1.46)
	Netherlands	1.92(1.29 - 2.87)	1.77(1.20-2.61)	1.44(1.00-2.07)
	Portugal	2.46(1.76 - 3.44)	3.06 (2.20-4.26)	2.06(1.52 - 2.79)
Survey year	2013	Ref.	Ref.	Bef.
	2016-2017	0.90 (0.74-1.09)	1.05 (0.85–1.29)	0.93 (0.75–1.14)
Individual-level variables				
Age (in years)	<14	Ref	Bef	Ref
rige (in years)	15	0.82(0.67-1.01)	0.81(0.66 - 1.00)	1.06(0.83-1.34)
	16	0.56(0.45-0.70)	0.54(0.43-0.68)	1.00(0.00 - 1.01) 1.00(0.77 - 1.30)
	>17	0.41 (0.31 - 0.52)	0.38(0.29-0.49)	1.00(0.77 - 1.36)
Gender	Female	Ref	Bef	Ref
Gender	Male	1.30(1.12-1.50)	1.35(1.17-1.56)	1 43 (1 21 - 1 70)
Years since initiation	<1	Ref	1.00 (1.17 1.00)	Ref
Teurs since minution	1	0.42(0.35-0.52)		0.56(0.45-0.70)
	2	0.31(0.24-0.40)		0.42 (0.31 - 0.55)
	>3	0.34(0.27-0.42)		0.45(0.35-0.58)
Academic performance	High	Ref		Ref. (0.00 0.00)
ricudeline performance	Medium	0.80(0.68-0.95)		0.88(0.72 - 1.06)
	Low	0.54 (0.45 - 0.66)		0.63(0.50-0.79)
Physical activity	<7 h/week	Bef		Bef
i hysical activity	>7 h/week	1.20(1.04 - 1.39)		1 12 (0.95 - 1.33)
Alcohol use	\leq once a month	Ref		Ref
Theohor use	\geq once a month	0.27 (0.23 - 0.32)		0.38(0.32-0.45)
Parents' smoking	No parents smoke	Ref.		Ref.
	>1 parents smoke	0.59(0.51 - 0.68)		0.69(0.59 - 0.82)
Friends' smoking	None of them	Ref.		Ref.
	Some of them	0.28(0.20-0.39)		0.31(0.22 - 0.43)
	Most of them	0.06(0.04-0.08)		0.08(0.06-0.11)
	All of them	0.04(0.02-0.06)		0.06(0.04-0.10)
Intraclass correlation coefficient (ICC; in%)		9.44 ^d	2.94 ^e	0.79f

fICC from model 2.

^a Unadjusted, crude, model for each independent variable.

^b Model 1 included: tobacco policy, tobacco education, cessation programmes, country, year of survey, age and gender.

^c Model 2: Model 1 + years since smoking initiation, academic performance, physical activity, alcohol use, parents' smoking and friends' smoking.

^d Intraclass correlation coefficient (ICC) from empty model (i.e. without independent variables).

^e ICC from a model that included country, year, age and gender as independent variables.

detailed measurements, are needed to monitor adolescent smoking cessation and the impact of real-world actions that schools undertake to discourage smoking.

Our results suggest that cessation support may need to be specifically targeted towards clusters of adolescents among whom smoking and drinking are common, who perform poorly in school, and who are from homes where smoking is prevalent. Identifying these students may need to be part of a strategy to effectively help adolescent smokers to quit smoking.

4.5. Conclusions

In our European sample, more than three quarters of adolescents tried to quit smoking, and half reported to be successful. This underscores that adolescence is an important time to encourage and support quit attempts. Our results imply that school policies and programmes currently play a minor role in encouraging and supporting adolescents to quits smoking, while more effective actions in the school setting may contribute to smoking cessation among adolescents in the future.

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Contributors

MAGK and AEK conceived this paper and designed the methodology.

AEJM performed the statistical analyses. AEJM and MAGK drafted the manuscript. AEJM, AEK, VL, JA, AR, LC and MAGK contributed to the interpretation of the findings and the writing of the final manuscript. All authors contributed to and have approved the final manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugalcdep.2021.10 8945.

References

- Backinger, C., Fagan, P., Matthews, E., Grana, R., 2003. Adolescent and young adult tobacco prevention and cessation: current status and future directions. Tob. Control 12 (Suppl. 4), iv46–iv53.
- Bailey, S.R., Jeffery, C.J., Hammer, S.A., Bryson, S.W., Killen, D.T., Ammerman, S., Robinson, T.N., Killen, J.D., 2012. Assessing teen smoking patterns: the weekend phenomenon. Drug Alcohol Depend. 120 (1–3), 242–245.
- Burns, D.M., 2003. Tobacco-related Diseases, Seminars in Oncology Nursing. Elsevier, pp. 244–249.
- Burt, R.D., Peterson, A.V.J., 1998. Smoking cessation among high school seniors. Prev. Med. 27 (3), 319–327.
- Coban, F., Kunst, A., Van Stralen, M., Richter, M., Rathmann, K., Perelman, J., Alves, J., Federico, B., Rimpelä, A., Lorant, V., 2019. Nicotine dependence among adolescents in the European Union: how many and who are affected? J. Public Health 41 (3), 447–455.
- Fanshawe, T.R., Halliwell, W., Lindson, N., Aveyard, P., Livingstone-Banks, J., Hartmann-Boyce, J., 2017. Tobacco cessation interventions for young people. Cochrane Database Syst. Rev. (11).
- Galanti, M.R., Coppo, A., Jonsson, E., Bremberg, S., Faggiano, F., 2014. Anti-tobacco policy in schools: upcoming preventive strategy or prevention myth? A review of 31 studies. Tob. Control 23 (4), 295–301.
- Grard, A., Schreuders, M., Alves, J., Kinnunen, J.M., Richter, M., Federico, B., Kunst, A., Clancy, L., Lorant, V., 2019. Smoking beliefs across genders, a comparative analysis of seven European countries. BMC Public Health 19 (1), 1–12.
- Haug, S., Schaub, M.P., Schmid, H., 2014. Predictors of adolescent smoking cessation and smoking reduction. Patient Educ. Couns. 95 (3), 378–383.
- Huang, G.C., Soto, D., Fujimoto, K., Valente, T.W., 2014. The interplay of friendship networks and social networking sites: longitudinal analysis of selection and influence effects on adolescent smoking and alcohol use. Am. J. Public Health 104 (8), e51–e59.
- Jeong, W., Kim, Y.K., Joo, J.H., Jang, S.-I., Park, E.-C., 2020. The association of smoking exposure at home with attempts to quit smoking and cessation success: a survey of South Korean adolescents who smoke. Int. J. Environ. Res. Public Health 17 (11), 4129.
- Joffe, A., McNeely, C., Colantuoni, E., An, M.-W., Wang, W., Scharfstein, D., 2009. Evaluation of school-based smoking-cessation interventions for self-described adolescent smokers. Pediatrics 124 (2), e187–e194.
- Kelly, M.P., Barker, M., 2016. Why is changing health-related behaviour so difficult? Public Health 136, 109–116.

- Kraus, L., Nociar, A., 2016. ESPAD Report 2015: Results from the European School Survey Project on Alcohol and Other Drugs. European Monitoring Centre for Drugs and Drug Addiction.
- Krishnan-Sarin, S., Cavallo, D.A., Cooney, J.L., Schepis, T.S., Kong, G., Liss, T.B., Liss, A. K., McMahon, T.J., Nich, C., Babuscio, T., 2013. An exploratory randomized controlled trial of a novel high-school-based smoking cessation intervention for adolescent smokers using abstinence–contingent incentives and cognitive behavioral therapy. Drug Alcohol Depend. 132 (1–2), 346–351.
- Lisha, N.E., Sussman, S., 2010. Relationship of high school and college sports participation with alcohol, tobacco, and illicit drug use: a review. Addict. Behav. 35 (5), 399–407.
- Lorant, V., Soto, V.E., Alves, J., Federico, B., Kinnunen, J., Kuipers, M., Moor, I., Perelman, J., Richter, M., Rimpelä, A., 2015. Smoking in school-aged adolescents: design of a social network survey in six European countries. BMC Res. Notes 8 (1), 91.
- Mélard, N., Grard, A., Robert, P.-O., Kuipers, M.A., Schreuders, M., Rimpelä, A.H., Leão, T., Hoffmann, L., Richter, M., Kunst, A.E., 2020. School tobacco policies and adolescent smoking in six European cities in 2013 and 2016: a school-level longitudinal study. Prev. Med. 138, 106142.
- Myung, S.-K., Park, J.-Y., 2019. Efficacy of pharmacotherapy for smoking cessation in adolescent smokers: a meta-analysis of randomized controlled trials. Nicotine Tob. Res. 21 (11), 1473–1479.
- Nagler, R.H., Viswanath, K., 2013. Implementation and research priorities for FCTC Articles 13 and 16: tobacco advertising, promotion, and sponsorship and sales to and by minors. Nicotine Tob. Res. 15 (4), 832–846.
- Nichter, M., Nichter, M., Carkoglu, A., Lloyd-Richardson, E., Network, T.E.R., 2010. Smoking and drinking among college students: "It's a package deal". Drug Alcohol Depend. 106 (1), 16–20.
- O'Loughlin, J., Gervais, A., Dugas, E., Meshefedjian, G., 2009. Milestones in the process of cessation among novice adolescent smokers. Am. J. Public Health 99 (3), 499–504.
- Park, E.-W., Tudiver, F., Schultz, J.K., Campbell, T., 2004. Does enhancing partner support and interaction improve smoking cessation? A meta-analysis. Ann. Fam. Med. 2 (2), 170–174.
- Sargent, J.D., Mott, L.A., Stevens, M., 1998. Predictors of smoking cessation in adolescents. Arch. Pediatr. Adolesc. Med. 152 (4), 388–393.
- Schreuders, M., Nuyts, P.A., van den Putte, B., Kunst, A.E., 2017. Understanding the impact of school tobacco policies on adolescent smoking behaviour: a realist review. Soc. Sci. Med. 183, 19–27.
- Schreuders, M., Krooneman, N.T., Van den Putte, B., Kunst, A.E., 2018. Boy smokers' rationalisations for engaging in potentially fatal behaviour: in-depth interviews in the Netherlands. Int. J. Environ. Res. Public Health 15 (4), 767.
- Schreuders, M., Klompmaker, L., van den Putte, B., Kunst, A.E., 2019a. Adolescent smoking in secondary schools that have implemented smoke-free policies: in-depth exploration of shared smoking patterns. Int. J. Environ. Res. Public Health 16 (12), 2100.
- Schreuders, M., Kuipers, M.A., Mlinarić, M., Grard, A., Linnansaari, A., Rimpela, A., Richter, M., Perelman, J., Lorant, V., van den Putte, B., 2019b. The association between smoke-free school policies and adolescents' anti-smoking beliefs: moderation by family smoking norms. Drug Alcohol Depend. 204, 107521.
- Schreuders, M., Linnansaari, A., Lindfors, P., van den Putte, B., Kunst, A.E., 2019c. Why Staff at European Schools Abstain from Enforcing Smoke-free Policies on Persistent Violators. Health Promotion International.
- Schreuders, M., van den Putte, B., Mlinarić, M., Mélard, N., Perelman, J., Richter, M., Rimpela, A., Kuipers, M.A., Lorant, V., Kunst, A.E., 2020. The association between smoke-free school policies and adolescents' perceived antismoking norms: moderation by school connectedness. Nicotine Tob. Res. 22 (11), 1964–1972.

Simon, P., Kong, G., Cavallo, D.A., Krishnan-Sarin, S., 2015. Update of adolescent smoking cessation interventions: 2009–2014. Curr. Addict. Rep. 2 (1), 15–23.

- Thomas, R.E., McLellan, J., Perera, R., 2015. Effectiveness of school-based smoking prevention curricula: systematic review and meta-analysis. BMJ Open 5 (3).
- Towns, S., DiFranza, J.R., Jayasuriya, G., Marshall, T., Shah, S., 2017. Smoking Cessation in Adolescents: targeted approaches that work. Paediatr. Respir. Rev. 22, 11–22.
- Van Miert, E., Sardella, A., Bernard, A., 2011. Biomarkers of early respiratory effects in smoking adolescents. Eur. Respir. J. 38 (6), 1287–1293.

Viner, R.M., Ozer, E.M., Denny, S., Marmot, M., Resnick, M., Fatusi, A., Currie, C., 2012. Adolescence and the social determinants of health. Lancet 379 (9826), 1641–1652.

World Health Organization, 2010. Global Recommendations on Physical Activity for Health. World Health Organization.