



Where do teens smoke? Smoking locations of adolescents in Europe in relation to smoking bans in bars, schools and homes



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ABSTRACT

This study aimed to assess where European adolescents smoke. Data of 2,140 13-19-year-olds from 55 secondary schools in seven European cities was analysed using multilevel logistic regression analyses. Adolescents most often reported regularly smoking in 'other public locations (e.g., streets and parks)' (69%) and friends' homes (50%). Adolescents were less likely to smoke in bars, at school or at home when exposed to strong smoking bans at these locations. Bans on smoking in bars or at home were associated with regular smoking in other public locations, suggesting that smoking may have displaced towards these locations.

1. Introduction

Young people in Europe are increasingly exposed to smoking bans in public spaces and the home environment (Joossens and Raw, 2017). In most countries, spaces in the public domain, such as government buildings, schools, hospitals and public transport, were the first to become smoke-free to protect citizens who enter these buildings from exposure to secondhand smoke (International Agency for, 2009). Later other areas followed to specifically protect employees, such as indoor workplaces and the hospitality industry (e.g., bars and restaurants) (International Agency for, 2009). In turn, national smoke-free policies have stimulated smokers to voluntarily adopt smoking bans in their own homes (Mons et al., 2013). Smoking bans in public spaces and the home environment have the potential to reduce the smoking prevalence and smoking uptake among adolescents, and prevent them from becoming established smokers (Feigl et al., 2015; Siegel et al., 2005; Song et al., 2015; Wakefield et al., 2000; Albers et al., 2008; Gorini et al., 2016).

Although the impact of smoking bans on reducing youth smoking has been demonstrated in a number of studies (Feigl et al., 2015; Siegel et al., 2005; Song et al., 2015; Wakefield et al., 2000; Albers et al., 2008; Gorini et al., 2016), it is unclear how smoking bans affect adolescents

who do continue to smoke, and in particular their smoking locations. There are two important issues that remain insufficiently addressed.

Firstly, there is limited evidence on the extent to which adolescents smoke less often in the locations where smoking bans have been implemented. While most studies have focused on reductions in smoking on the school premises under school smoking bans (Kuipers et al., 2016; Lovato et al., 2006; Watts et al., 2010), it is unknown whether adolescent smoking also occurs less often in other locations with smoking bans, such as bars and homes. We expect that the occurrence of smoking in bars and homes depends on the strength of smoking bans. Studies conducted among adults have shown that weak (or partial) smoking bans are less effective in reducing smoking in bars and at home than strong (or non-partial) smoking bans (Hennessy et al., 2014; Nagelhout et al., 2012). If the same were to apply to adolescents, they would continue to smoke in spaces with weak bans. This would be important knowledge given that the strength of public smoking bans varies between European countries (Joossens and Raw, 2017).

Secondly, in response to smoking bans, adolescent smoking may relocate from locations with strong smoking bans to places where smoking is allowed. A well recorded example of the relocation of smoking among adolescents is the displacement of smoking from the

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school premises to just outside the school premises (Schreuders et al., 2017). This may also apply to smoking bans at home: several studies have shown that these may not always reduce adolescent smoking rates (Emory et al., 2010), implying that adolescents continue to smoke, most likely in other locations where smoking is allowed, such as parks and streets, or at a friend's home. It is unknown whether a similar relocation process occurs in response to smoking bans in bars. Studies conducted among adults have shown that adults relocate their smoking outdoors once smoking is banned inside bars (Kennedy et al., 2012; López et al., 2012), but not to the home environment (Mons et al., 2013; Fong et al., 2006; Cheng et al., 2011; Hyland et al., 2007). Similar patterns in displacement cannot be assumed outright for adolescents, given main differences between adolescents and adults, for example in terms of daily activity spaces, the social meaning of smoking, and the extent of addiction to nicotine. It is, therefore, important to investigate how adolescents respond to strong smoking bans in bars, and other places, in order to assess the full impact of smoke-free legislation and to inform future policy.

In addition, the influence of smoking bans on smoking locations may vary by smoking frequency. Nondaily smokers mostly smoke in social settings (Rubinstein et al., 2014), and may easily abstain from smoking when prohibited (Rooke et al., 2013) due to limited nicotine dependence (Rubinstein et al., 2014; Shiffman et al., 2012). Daily smokers, on the other hand, may experience more difficulty with temporary abstinence. The continuation of smoking in spaces where smoking is prohibited and relocation of smoking to other spaces may, therefore, particularly be an issue among daily smokers.

The aims of this study were to: 1) determine in which public and private locations daily and nondaily adolescent smokers reported smoking regularly in seven European cities, 2) and assess the relationship between the strength of smoking bans (in bars, schools and homes) and smoking locations of daily and nondaily smokers. This study used data of 13-19-year-old smokers from 55 schools in seven European cities that vary in the strength of their smoke-free legislation.

2. Methods

2.1. Design and study population

Data was collected late 2016 to late 2017 as part of the European SILNE-R project (silne-r.ensp.org/). A paper-based survey on tobacco use was completed by 13,061 students in 55 secondary schools in seven medium-sized European cities: Namur (Belgium), Tampere (Finland), Hanover (Germany), Dublin (Ireland), Latina (Italy), Amersfoort (the Netherlands) and Coimbra (Portugal). These cities were chosen because they have a population size, income and employment rate comparable to the national average. In each school, students were included from two grades enrolling mostly 15-16-year-olds, which resulted in an age range of 12-19. Surveys were completed in the classroom, under surveillance of a research assistant and/or teacher. Ethical approval was obtained from institutional and/or national research ethics committees. More details on the survey can be found elsewhere (Lorant et al., 2015).

For the analysis, only current smokers were included. Current smokers were defined as students who had smoked a cigarette on at least one day in the past 30 days. Out of a total of 2259 current smokers, we excluded two individuals who were 12 years old, and individuals with missing information on age ($n = 5$), gender ($n = 5$), frequency of going out ($n = 9$), regular smoking in the six locations ($n = 50$) and home smoking ban ($n = 32$), and school smoking ban ($n = 16$), resulting in a study population of 2140 individuals (13-19 years old).

2.1.1. Measures

2.1.1.1. Dependent variables. The main dependent variables were regular smoking in six locations: in a bar or club, at home, on the school

premises, just outside the school premises, at friends' homes, and in other public locations (e.g., park, street, alley). Respondents were asked to choose one or more locations where they usually smoke cigarettes. For descriptive purposes, the average number of reported smoking locations was calculated.

2.1.1.2. Smoking ban variables. The three main independent variables measured the strength of smoking bans in three locations: in bars, on school premises, and at home. Strength was defined as the comprehensiveness of a smoking ban, i.e. whether smoking is completely, partially or not prohibited. We measured the strength of smoking bans in bars at the national level. We grouped cities together according to the score they obtained for the subscale included in the national Tobacco Control Scale (TCS) score, which quantifies the strength of implementation of smoke-free legislation in bars and restaurants in Europe: respondents from Dublin and Tampere were categorized as having 'strong' bans in bars, respondents from Amersfoort, Latina and Namur were categorized as 'medium', and respondents from Hanover and Coimbra were categorized as 'weak' (Joossens and Raw, 2017).

School staff members (i.e., janitors, teachers and those in management positions) filled out a questionnaire on the smoking rules at school ($n = 314$). To determine the strength of smoking bans at school, staff responses to eight questions were combined into a sum-score. Six questions asked whether smoking was prohibited for 1) staff and 2) students in three locations: a) in the school building, b) on the school premises, and c) at off-campus school-sponsored events. 0.5 points were earned for each 'yes'. Two questions addressed the presence of a smoking area for 1) students and 2) staff. 0.5 points were earned for each 'no'. Staff members who had missing values were excluded from calculating the school smoking ban strength ($n = 62$). Each school was assigned an aggregated mean score, ranging from zero to four. Adolescents were then divided into tertiles ('weak', 'medium' and 'strong' school smoking ban) based on the scores of their schools.

Participants indicated whether smoking was permitted in their home and were categorized into having a 'strong' ('no one is permitted to smoke in my home'), 'medium' ('smoking is permitted only in certain areas of my home'), or 'weak' smoking ban at home ('smoking is freely permitted in my home'). 'I don't know' responses were categorized as 'unknown'.

2.1.1.3. Individual-level independent variables. Demographics included age, gender, migration background (zero, one, or two parents born in a country other than the country of residence), and parental educational level. The educational level of parents was measured on country specific scales and categorized into 'low', 'middle', 'high' and 'don't know'. In general, 'low' corresponded to primary school and/or lower level of secondary school, 'middle' corresponded to completed secondary school and/or lower level of college, and 'high' corresponded to a college or university degree. Only the information of the parent with the highest educational level was used.

Other individual-level determinants included frequency of going out ('never', 'once a month', 'two to three times a month', 'once a week', and 'more than once a week') and smoking frequency. Smoking frequency distinguished 'daily smokers' (smoked on (almost) every day in the last 30 days), and 'nondaily smokers' (smoked less than daily). Smoking status of parents and friends were not included, as these variables are plausible mediators in the relationship between smoking bans and smoking locations of adolescents, thus correcting for them may result in over-adjustment.

2.1.2. Statistical analysis

Descriptive statistics of the study sample were determined, stratified by smoking frequency. We estimated associations between the strength of smoking bans and regular smoking in the different locations, stratified by smoking frequency. Due to the nested data structure (students within

schools), multilevel logistic regression analyses were conducted. The number of countries was insufficient to fit a three-level model, and we therefore included country not as a level, but as a covariate in the analysis. The covariate country was excluded from the model that included national smoking bans in bars as independent variable, since these two variables are highly correlated. Other covariates included age, gender, migrant background, parental education, and frequency of going out. Intraclass correlation coefficients (ICCs) were estimated to present the variance at the school-level for smoking in each of the six locations. In addition, we conducted post-hoc analyses among daily smokers to explore whether the associations differed according to socioeconomic status (SES) and age, by adding interaction terms between the strength of smoking bans and parental education and age, respectively. The analyses were conducted in Stata version 15 (StataCorp. Stata Statisti, 2017).

3. Results

Table 1 presents the characteristics of the study population. Overall, males and females were equally distributed. Most respondents were 15 years old, had no migrant background, had at least one parent with a high educational level, went out once a month or less, and had strong smoking bans at home (44.2%). Also, 17.3% of the respondents lived in a country with strong smoking bans in bars. 31.3% of daily smokers had strong smoking bans at home (vs. 51.4% of nondaily smokers), and 11.8% of daily smokers lived in a country with strong smoking bans in bars (vs. 20.5% of nondaily smokers).

Table 1 also presents the prevalence of smoking in each location. Adolescents most often smoked in public outdoor locations (69.3%), followed by friend’s homes (49.8%). Least often adolescents reported smoking on the school premises (28.9%) and at home (30.3%). On average, adolescents smoked in 2.58 out of 6 locations. Daily smokers smoked in 3.86 locations on average, while nondaily smokers smoked in 1.86 locations on average. Supplementary Table 1 shows that across cities similar patterns were observed: in most cities adolescents most often smoked in public outdoor locations, followed by friend’s homes. A noteworthy difference is that adolescents from Coimbra (Portugal), a city with a weak smoking ban, most often smoked in a bar or club (73.9%), while adolescents from Tampere (Finland), which had a much stronger ban, least often smoked in a bar or club (3.6%).

Table 2 presents the associations between the strength of smoking bans in bars and regular smoking in the different locations, for daily and nondaily smokers. Overall, there was little variance at the school-level for regular smoking in the different locations. Variance at the school-level, however, was high for regular smoking on the school premises (ICC = 22.94 for daily smokers; ICC = 32.13 for nondaily smokers) and regular smoking in bars/clubs (only for nondaily smokers, ICC = 16.86). Daily smokers who lived in cities with strong smoking bans in bars were less likely to regularly smoke in a bar or club (OR = 0.35, 95%CI = 0.18; 0.67) and on the school premises (OR = 0.32, 95%CI = 0.11; 0.93) compared to daily smokers exposed to weak smoking bans in bars. They were also more likely to regularly smoke at home (OR = 2.21, 95%CI = 1.22; 4.03) and in other public locations (OR = 3.84, 95%CI = 1.33; 11.03). Nondaily smokers who lived in cities with strong smoking bans in bars were less likely to regularly smoke on the school premises (OR = 0.25, 95%CI = 0.07; 0.86) and more likely to regularly smoke in other public locations (OR = 2.47, 95%CI = 1.53; 4.00) compared to nondaily smokers who lived in cities with weak smoking bans in bars.

Table 3 presents similar associations as in Table 2, but then for smoking bans at school. Smoking on the school premises was less prevalent when strong smoking bans were implemented, for daily smokers (OR = 0.44, 95%CI = 0.20; 0.96) as well as nondaily smokers (OR = 0.52, 95%CI = 0.27; 0.99). For medium-strength school smoking bans the association with smoking on school premises was weaker and non-significant, and daily smokers more often reported smoking just outside the school premises (OR = 1.92, 95%CI = 1.29; 2.84). Exposure

Table 1
Characteristics and smoking locations of the study population.

	Total	Daily smokers	Nondaily smokers
N	2140	771	1369
Male (%)	46.2	49.2	44.5
Age (%)			
14 or younger	18.5	13.4	21.4
15	37.6	33.9	39.7
16	28.4	30.9	27.0
17 or older	15.5	21.8	11.9
Migrant background (%)			
None	77.6	77.6	77.6
One parent	14.1	14.1	14.1
Two parents	8.3	8.3	8.3
Parental education (%)			
Low	13.8	17.1	11.9
Average	37.0	41.0	34.7
High	41.4	32.8	46.3
Don't know	7.8	9.1	7.1
Frequency of going out to bars/clubs (%)			
Never	24.1	17.6	27.8
Once a month or less	29.5	27.0	31.0
Two to three times a month	17.8	16.6	18.4
Once a week	14.8	18.3	12.9
More than once a week	13.8	20.5	10.0
Smoking bans in bars (%)			
Weak	19.9	18.4	20.7
Medium	62.8	69.8	58.9
Strong	17.3	11.8	20.5
Smoking bans at school premises (%)			
Weak	32.5	33.9	31.7
Medium	34.2	34.0	34.3
Strong	33.4	32.2	34.0
Smoking bans at home (%)			
Weak	11.7	16.6	9.0
Medium	37.9	47.2	32.6
Strong	44.2	31.3	51.4
Unknown	6.3	4.9	7.0
Respondents who regularly smoked (%)			
In a bar or club	40.4	55.9	31.6
At home	30.3	60.1	13.5
On the school premises	28.9	49.7	17.2
Just outside the school premises	39.3	65.2	24.8
At friends' homes	49.8	69.8	38.4
In other public outdoor locations	69.3	84.8	60.5
Average number of reported smoking locations	2.58	3.86	1.86

to strong school smoking bans was also associated with lower odds of regularly smoking in bars/clubs among daily smokers (OR = 0.59, 95% CI = 0.37; 0.94).

Table 4 presents similar associations as in Table 2, but then in relation to smoking bans at home. Both daily and nondaily smokers with strong smoking bans at home had lower odds of regularly smoking at home compared with respondents with weak smoking bans at home (OR = 0.26, 95%CI = 0.16; 0.43 for daily smokers; OR = 0.27, 95% CI = 0.16; 0.45 for nondaily smokers). Daily smokers with medium (OR = 2.28, 95%CI = 1.32; 3.94) and strong (OR = 1.81, 95%CI = 1.02; 3.23) smoking bans at home had higher odds of regularly smoking in other public locations compared with daily smokers with weak smoking bans at home.

Supplementary Table 2 presents the results of the post-hoc analyses of interaction between smoking bans and SES and age, respectively. The majority of ORs for interaction were <1, meaning that negative associations between the strength of smoking bans and smoking locations, found in the general population of daily smokers, were relatively strong among older and higher SES adolescents, respectively. Only a few interactions, however, were found to be statistically significant, indicating the power of this study may have been insufficient to demonstrate substantial differences with statistical significance.

Table 2
Prevalence (%) and odds ratios (OR)^a of regular smoking in the different locations according to the strength of smoking bans in bars.

	Strength of smoking bans in bars			Strength of smoking bans in bars		School-level ICC ^b (%)
	Weak	Medium	Strong	Medium	Strong	
Daily smokers	%	%	%	OR (95%CI)	OR (95%CI)	
In a bar/club	72.5	56.1	28.6	0.37 (0.22;0.62)	0.35 (0.18;0.67)	0.19
At home	51.4	62.1	61.5	1.97 (1.27;3.06)	2.21 (1.22;4.03)	<0.01
On the school premises	62.0	50.6	25.3	0.48 (0.19; 1.22)	0.32 (0.11;0.93)	22.94
Just outside the school premises	60.6	66.4	65.9	1.93 (1.07; 3.46)	1.61 (0.78; 3.30)	3.56
At friends' homes	71.1	71.4	59.3	0.97 (0.57; 1.66)	0.74 (0.38; 1.45)	0.21
In other public locations	73.2	86.4	93.4	2.07 (1.07;3.99)	3.84 (1.33;11.03)	4.39
Nondaily smokers	%	%	%	OR (95%CI)	OR (95%CI)	
In a bar/club	52.3	26.3	26.1	0.25 (0.12;0.55)	0.54 (0.24; 1.25)	16.86
At home	16.3	12.3	14.3	0.71 (0.45; 1.13)	0.99 (0.61; 1.60)	<0.01
On the school premises	28.3	17.5	5.0	0.76 (0.25; 2.28)	0.25 (0.07;0.86)	32.13
Just outside the school premises	26.9	26.1	18.9	1.13 (0.60; 2.12)	0.60 (0.30; 1.18)	11.97
At friends' homes	28.3	44.3	31.8	2.11 (1.20;3.72)	0.85 (0.45; 1.60)	9.01
In other public locations	43.1	64.3	67.1	2.28 (1.46;3.55)	2.47 (1.53;4.00)	3.92

^a All odds ratios were adjusted for smoking bans at home, smoking bans at school, age, gender, migrant background, parental education, and frequency of going out. Reference is weak smoking bans in bars.

^b ICC = Intraclass correlation coefficient.

Table 3
Prevalence (%) and odds ratios (OR)^a of regular smoking in the different locations according to the strength of smoking bans at school.

	Strength of smoking ban at school			Strength of smoking ban at school		School-level ICC ^b (%)
	Weak	Medium	Strong	Medium	Strong	
Daily smokers	%	%	%	OR (95%CI)	OR (95%CI)	
In a bar/club	59.8	58.8	48.8	0.90 (0.60; 1.35)	0.59 (0.37;0.94)	<0.01
At home	60.9	60.3	58.9	1.16 (0.78; 1.71)	1.08 (0.70; 1.67)	<0.01
On the school premises	57.9	50.0	40.7	0.54 (0.27; 1.07)	0.44 (0.20;0.96)	9.58
Just outside the school premises	60.5	69.5	65.7	1.92 (1.29;2.84)	1.38 (0.90; 2.14)	<0.01
At friends' homes	70.9	73.7	64.9	1.39 (0.91; 2.11)	0.80 (0.51; 1.26)	<0.01
In other public locations	85.8	84.4	84.3	1.01 (0.54; 1.87)	0.92 (0.46; 1.86)	2.96
Nondaily smokers	%	%	%	OR (95%CI)	OR (95%CI)	
In a bar/club	31.3	29.6	33.9	0.91 (0.59; 1.41)	0.69 (0.42; 1.16)	2.10
At home	14.3	13.9	12.4	0.77 (0.50; 1.18)	0.62 (0.38; 1.01)	<0.01
On the school premises	18.0	17.3	16.3	0.64 (0.36; 1.12)	0.52 (0.27;0.99)	3.85
Just outside the school premises	26.3	25.4	22.7	1.22 (0.80; 1.87)	0.84 (0.52; 1.35)	1.91
At friends' homes	47.9	34.5	33.5	0.92 (0.68; 1.25)	1.05 (0.74; 1.50)	<0.01
In other public locations	58.3	62.3	60.7	1.12 (0.77; 1.63)	1.32 (0.86; 2.02)	1.82

^a All odds ratios were adjusted for smoking bans at home, country, age, gender, migrant background, parental education, and frequency of going out. Reference is weak smoking ban at school.

^b ICC = Intraclass correlation coefficient.

Table 4
Prevalence (%) and odds ratios (OR)^a of regular smoking in the different locations according to the strength of smoking bans at home.

	Strength of smoking ban at home			Strength of smoking ban at home		School-level ICC ^b (%)
	Weak	Medium	Strong	Medium	Strong	
Daily smokers	%	%	%	OR (95%CI)	OR (95%CI)	
In a bar/club	56.3	56.0	56.8	1.07 (0.68; 1.71)	1.08 (0.65; 1.77)	<0.01
At home	73.4	67.0	44.4	0.67 (0.42; 1.06)	0.26 (0.16;0.43)	<0.01
On the school premises	53.1	49.7	50.2	1.00 (0.63; 1.59)	0.87 (0.53; 1.43)	9.58
Just outside the school premises	62.5	69.2	59.8	1.32 (0.85; 2.04)	0.89 (0.56; 1.41)	<0.01
At friends' homes	64.8	74.5	66.8	1.52 (0.98; 2.38)	1.12 (0.70; 1.79)	<0.01
In other public locations	77.3	87.6	83.4	2.28 (1.32;3.94)	1.81 (1.02;3.23)	2.96
Nondaily smokers	%	%	%	OR (95%CI)	OR (95%CI)	
In a bar/club	37.4	30.7	33.4	0.69 (0.42; 1.14)	0.65 (0.40; 1.05)	2.10
At home	22.8	19.5	7.8	0.74 (0.45; 1.22)	0.27 (0.16;0.45)	<0.01
On the school premises	18.7	15.5	18.8	0.88 (0.50; 1.56)	1.08 (0.63; 1.86)	3.85
Just outside the school premises	29.3	28.5	22.4	0.85 (0.53; 1.37)	0.81 (0.51; 1.28)	1.91
At friends' homes	41.5	39.2	38.4	0.96 (0.62; 1.49)	0.86 (0.57; 1.31)	<0.01
In other public locations	63.4	59.0	59.9	0.89 (0.57; 1.39)	0.94 (0.61; 1.44)	1.82

^a All odds ratios were adjusted for smoking bans at school, country, age, gender, migrant background, parental education, and frequency of going out. Reference is weak smoking ban at home.

^b ICC = Intraclass correlation coefficient.

4. Discussion

4.1. Key findings

European adolescents most often reported smoking at friends' homes and in outdoor public locations such as streets and parks. Daily smokers were less likely to smoke in places where smoking was banned. Smoking bans in bars and at home were associated with regular smoking in other public locations. Strong smoking bans on the school premises were not associated with higher odds of smoking elsewhere. Similar associations were found among nondaily smokers, but were less pronounced.

4.2. Limitations

A number of potential limitations of the current study need to be acknowledged. Firstly, the cross-sectional design limits our ability to draw firm conclusions on the extent to which smoking may have displaced towards other locations after the implementation of a smoking ban. Further studies, in particular longitudinal or repeated cross-sectional studies, are needed to assess how many adolescents relocate their smoking behaviour instead of quitting smoking, and to identify temporal patterns of relocation. Secondly, residual confounding may be present in this study since we measured the strength of smoke-free legislation on the country-level and were not able to account for unique (cultural) country-level confounders. In addition, potential school-level confounders have not been measured, such as the type of school (i.e., the educational tracks in a school) and physical environment of the school. Thirdly, the measurement of smoking locations lacked some precision. Respondents could not specify in the survey how often they smoked in a certain location, and we are therefore limited in identifying those locations where smoking most frequently occurs. Additionally, in the item that identified smoking 'on school premises' the Portuguese questionnaire more broadly referred to the 'area around the school'. This may have caused some overestimation of smoking on school premises in Portugal. Finally, we did not measure the enforcement of smoking bans, which may also influence where youth smoke.

4.3. Interpretation of the findings

There was limited evidence on the extent to which adolescents smoke less often in the locations where smoking bans have been implemented. Studies conducted among adults found that strong smoking bans in bars (Nagelhout et al., 2011; Thomson and Wilson, 2006; Weber et al., 2003) and homes (Hennessy et al., 2014) were associated with a reduced occurrence of smoking in those locations. Our study has now demonstrated similar associations among European adolescents. We also found that strong smoking bans at school were associated with a lower odds of smoking on the school premises, which confirms previous findings (Kuipers et al., 2016; Lovato et al., 2006).

For bars, however, we found that medium and strong smoking bans were equally associated with lower odds of smoking in bars/clubs, compared with weak smoking bans. A possible explanation for why we did not find a stronger association for strong smoking bans is that, in our survey, respondents may not have distinguished between smoking inside or just outside a bar/club, with the effect that they overestimated the prevalence of smoking inside bars/clubs in cities with strong smoking bans. For example, in Dublin, a city with strong smoking bans, 40.2% of respondents reported smoking in bars/clubs (Supplementary Table 1), while studies conducted among adults found that only 3–5% of smokers in Ireland smoke in bars (Fong et al., 2006; Nagelhout et al., 2011).

We found that adolescents who lived in cities with strong smoking bans in bars were more likely to regularly smoke in public outdoor locations. This result is in line with the hypothesis that smoking may displace from locations where smoking is banned to places where smoking is allowed. Previous studies conducted among adults found that banning smoking from bars resulted in the relocation of smoking to the

outdoor spaces around bars, such as terraces and outside the entrance (Kennedy et al., 2012; López et al., 2012). It is possible that this pattern of displacement also occurs among adolescent smokers, and even extends to streets and parks. We suggest that the social smoking practices that are closely related to visiting bars and clubs may be easily relocated outdoors, and therefore allow continuation of smoking in these social settings (Rooke et al., 2013).

Our finding that smoking among daily smokers is more prevalent in homes when bars are smoke-free contradicts previous studies which have suggested that smoking bans in bars do not result in more smoking in the home and actually result in more smoke-free rules at home (Mons et al., 2013; Cheng et al., 2011; Hyland et al., 2007; Lee et al., 2011). These previous studies, however, were conducted among adults and it is possible that adolescents display different smoking behaviours in response to smoking bans in bars. Further research is warranted to determine whether adolescents truly displace their smoking to the home environment.

We found higher reports of smoking just outside the school premises when smoking bans at school were of medium strength. We therefore provide additional support for the existing evidence for displacement of smoking to locations just outside the school premises (Schreuders et al., 2017). Because schools are eminently places where peers meet, the social smoking practices around schools may continue outside the regulated area of the school premises. However, no such relationship was observed with strong school bans. Though not reported, the schools with strong smoking bans in our sample may have restrictions that extend to just outside the school premises and/or rules that prohibit students from leaving the school premises during school hours, which may explain why we did not find an association.

We found some evidence that non-daily smokers may differ from daily smokers in their response to smoking bans. Among nondaily smokers, we found no association between 1) smoking bans in bars and smoking at home, 2) school smoking bans and smoking just outside the school premises, and 3) smoking bans at home and smoking in other public locations. A possible explanation is that nondaily smokers may be more likely to be 'social smokers' who only smoke in social settings (Rubinstein et al., 2014), and for whom it may not feel necessary to seek alternative places to smoke. Moreover, they do not need to maintain their smoking behaviour due to low or no nicotine dependence (Rubinstein et al., 2014; Shiffman et al., 2012).

4.4. Implications

This study is one of the few which has examined cross-national variations in the strength of smoking bans, their associations with adolescent smoking and locations where this occurs. The current study supports that the implementation of strong smoking bans in public spaces and the home environment remains important in preventing adolescents from smoking in those places. Smoking bans have the potential to reduce adolescent smoking rates by changing the smoking norms in public spaces and increasing the social unacceptability of smoking (Alesci et al., 2003; Hamilton et al., 2007; Satterlund et al., 2012). This change in norms, supported by mass media campaigns focussed on second-hand smoke prevention (King et al., 2003; Lewis et al., 2015), may stimulate parents to introduce voluntary smoking restrictions in their own homes (Mons et al., 2013; Borland et al., 2006).

Further research is necessary to confirm smoking displacement behaviour among adolescents. If adolescents indeed respond to the implementation of smoking bans by replacing smoking towards non-banned locations, the potential effects of smoking bans on their smoking behaviour are undermined. In order to prevent such displacement, schools may need to implement more comprehensive smoking bans, e.g. prohibiting any smoking by students on or around the school premises during school hours, or prohibiting leaving school premises during school hours (Schreuders et al., 2017). Similarly, bans on smoking at bars and clubs may need to be expanded to include areas around the bar

or club.

5. Conclusion

European adolescent smokers most often report smoking in public outdoor locations. Adolescents were less likely to report smoking in places with strong smoking bans. We found some evidence that smoking may have displaced from smoke-free bars towards other locations, especially to unregulated outdoor locations. If future research confirms smoking displacement among adolescents, smoking bans may need to cover a larger area such as the outdoor spaces around bars and school premises.

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Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.healthplace.2019.102213>.

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