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Exposure to car smoking among youth in seven cities across the European Union

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ABSTRACT

Background: In the United States and Canada, cars were found to be a major source of harmful secondhand smoke (SHS) exposure among youth. Little is known about the magnitude of this public health problem in European countries. We study SHS exposure in vehicles among adolescents across seven cities of the European Union (EU), with a particular focus on socioeconomic characteristics and smoking in adolescents' social environment.

Methods: Self-reported survey data on SHS exposure in cars during the past seven days was obtained from the 2016/17 cross-sectional SILNE-R study for 14- to 17 year old adolescents in seven EU cities (N = 10,481). We applied two multivariable logistic regression models with sociodemographic characteristics and mediating smoking-related factors.

Results: SHS exposure in cars varied widely across the seven EU cities: 6% in Tampere (Finland), 12% in Dublin (Ireland), 15% in Amersfoort (the Netherlands), 19% in Hanover (Germany), 23% in Coimbra (Portugal), 36% in Namur (Belgium) and 43% in Latina (Italy). Low paternal (OR 1.65, CI95% 1.38–1.98) and maternal (OR 1.40, CI95% 1.16–1.68) educational levels and parental migration (OR 1.37, CI95% 1.14–1.64) backgrounds were correlated with SHS exposure in cars. Other correlates were one's own or peer smoking and environmental family factors, such as having at least one parental smoker (OR 4.04, CI95% 3.49–4.68) and partial smoking bans at home.

Conclusions: In most of these seven cities, a considerable proportion of youth riding in cars, particularly those from disadvantaged and smoking-permissive backgrounds, is exposed to SHS in cars.

1. Background

Along with the home environment, cars can be major source of secondhand smoke (SHS) exposure among children and youth (King et al., 2012; Patel et al., 2018). Minors being frequently exposed to SHS in vehicles are more likely to be diagnosed with adverse health outcomes such as asthma, persistent wheezing, and decreased lung function (Patel et al., 2018; Raoof et al., 2015). In small enclosed spaces such as a car, passengers are exposed to airborne toxins with concentrations comparable to or even higher than those in smoking bars (Patel et al., 2018; Raoof et al., 2015; Rees and Connolly, 2006). However, atmospheric and biological markers of SHS concentration in vehicles can be mediated by air-conditioning status, extent of airflow, number and inches of windows open, and driving speed (Raoof et al., 2015). In addition to the toxic dimension of SHS in cars, there is also evidence that school students reporting exposure to SHS in vehicles are more likely to show future intention and aspiration to smoke (Patel et al., 2018).

In the early 2010s, approximately one fifth of US adolescents reported exposure to SHS in vehicles (Agaku et al., 2016; King et al., 2012; Patel et al., 2018). Studies found nonexistent smoke-free (SF) home rules, individual smoking status, tobacco use of household members, and having friends who smoke to all be associated with higher SHS car exposure (Agaku et al., 2016; King et al., 2012; Patel et al., 2018). Two Canadian studies found inequalities due to socioeconomic status (SES) in relation to adult and children SHS exposure (Azagba, 2015; Montreuil et al., 2017). One of the rare continental European studies available thus far included 2007/08 data on adult smokers' vehicle smoking rules from Germany (52% allow smoking in cars), France (59%), and the Netherlands (36%) and found young age,

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daily smoking and smoking rules at home to all be associated with permissive car smoking rules, but found no differences by education (Hitchman et al., 2012). Nevertheless, car smoking rules reported by adult smokers might directly correspond with adolescents' actual SHS exposure.

A Canadian study found that SF car legislation for vehicles carrying children was effective in reducing SHS exposure among minors (Nguyen, 2013). For instance, California's SF car legislation act (2007) banned smoking inside of cars when minors (age ≤17 years) are present. This policy led to a 37% reduction in the odds of being exposed to SHS in vehicles in the period between 2001 and 2011 (Patel et al., 2018). In Europe, there is significant variability in tobacco control policies across countries (Feliu et al., 2019). In 2018, SF car legislation was implemented only in Cyprus, Greece, the United Kingdom, France, the Republic of Ireland, and Italy. In countries without SF car legislation, such a policy is being increasingly debated, as illustrated by parliamentary debates in Finland, Germany, and the Netherlands.

Data on the magnitude of SHS exposure are known to support SF policy adoption (Mlinarić et al., 2018), yet little is known about the prevalence of SHS exposure in cars in European countries. There is an urgent need to describe the magnitude of this public health problem from the perspective of adolescents, since data reported by adults might be underreported due to social desirability bias. The main objectives of this study are to convey self-reported survey data of young people's SHS exposure in cars across European cities, investigate differences in the socioeconomic background of these adolescents, and examine the smoking behavior of their respective social environment.

2. Methods

Data were obtained from the 2016/17 cross-sectional SILNE-R (www.silne-r.ensp.org) study, which was performed in seven cities of the European Union (EU). SILNE-R is a school-based survey carried out in seven medium-sized cities located in Belgium (Namur), Finland (Tampere), Germany (Hanover), Ireland (Dublin), Netherlands (Amersfoort), Italy (Latina), and Portugal (Coimbra). A total of 55 secondary schools were included (six to twelve schools in each city). The participation rate was 80% (Namur: 85%; Tampere: 87%; Hanover: 66%; Dublin: 80%; Amersfoort: 87%; Latina: 79%; Coimbra: 76%). The total adolescent population consisted of 13,061 school students in two grades who were 13 to 17 years old. Adolescents were excluded from the analysis if they were aged 12, 13, or 18 years or older, as these age groups were unevenly distributed. The total response of 14-to 17 year-olds included 12,168 adolescents. The English version of the questionnaire is provided as a supplementary file (1)* .

2.1. Measures

The outcome measure is self-reported SHS exposure in cars during the past seven days, which was determined by asking respondents14 to -17 years of age the question, "During the past 7 days, on how many days did you ride in a car with someone who was smoking cigarettes?" Categorical response options included "do not know", "did not ride in a car in the last week", "0 days," "1 or 2 days," "3 or 4 days," "5 or 6 days," and "all 7 days." Adolescents who indicated a response higher than "0 days" were classified as being exposed to SHS in a car within the past 7 days (Agaku et al., 2016; Patel et al., 2018). Respondents who did not know (n = 403) or did not ride in cars (n = 388) were excluded. Data with missing information on any of the variables of interest were excluded (n = 1,687), which led to a final sample size of N = 10,481.

* Supplementary material can be found by accessing the online version of this paper at http://dx.doi.org and by entering doi: …

2.2. Analyses

We applied two multivariable logistic regression models yielding odds ratios (ORs) with 95% confidence intervals (CIs) and included factors commonly identified in the scientific literature as being associated with SHS exposure in cars (Agaku et al., 2016; Azagba, 2015; Hitchman et al., 2012; King et al., 2012; Patel et al., 2018). The ORs represent the odds of being exposed to SHS in cars on at least one day within the past week. In the first model we included the demographic characteristics of country, gender, age, migration status (parent born in another country), and parental education. In the second model, we added factors related to smoking in adolescents' social environment as mediators between demographic characteristics and SHS exposure. Mediators are smoking status (weekly, experimental, never), parental smoking (both smokers, at least one smoker, at least one ex-smoker, both never smokers), home smoking rules (complete ban, partial ban, permitted freely) and best friends (all, most, some, none) smoking (Kuipers et al., 2016b, a). Statistical analyses were performed with STATA 14.0.

3. Results

Table 1 displays that 22% of the final sample (n = 10,481) reported being exposed to SHS in cars. The prevalence of SHS car exposure varied widely across the 7 EU cities, ranging from 6% in Finland (Tampere), 12% in Ireland (Dublin), 15% in the Netherlands (Amersfoort), 19% in Germany (Hanover), 23% in Portugal (Coimbra), 36% in Belgium (Namur) to 43% in Italy (Latina). Fig. 1 shows that SHS exposure mostly takes place for 1 or 2 days. In Belgium (Namur), Portugal (Coimbra), and Italy (Latina), a considerably higher proportion of adolescents reported at least 3 days of exposure.

Occasional or weekly smokers and those who have friends who smoke were more likely to report SHS car exposure. We found no differences in SHS exposure by gender in both models. After adjustment for smoking-specific factors, the age gradient disappeared, but associations with migration background, paternal and maternal education remained significant. A migration background, with both parents having been born in another country (OR 1.37, CI95% 1.14–1.64), is associated with higher odds of being exposed than having parents without a migration background. Relative to the educational levels of high-SES parents, low paternal (OR 1.65, CI95% 1.38–1.98) and maternal (OR 1.40, CI95% 1.16–1.68) educational levels were associated with SHS car exposure. Approximately one third of adolescents have smoking parents (35%), which was associated with higher odds of being exposed to SHS in cars than having parents who had never smoked (e.g., one parental smoker: OR 4.04, CI95% 3.49–4.68). Partial and nonexistent home smoking bans were also found to be associated with adolescent SHS exposure in vehicles.

4. Discussion

We found large differences across the seven EU cities, with the lowest SHS exposure in Tampere (Finland) and the highest in Latina (Italy) and Namur (Belgium). We found a social gradient in SHS exposure with regard to educational background, and increased odds among smokers and respondents with a permissive family and peer smoking environment.

4.1. Limitations

A few limitations of this report must be mentioned. Our surveys were carried out in medium-sized cities and the prevalence measures of our sample therefore cannot be generalized at the national level of any given country. Adult smoking prevalence at the city-level would have been useful information but unfortunately was not available for the seven cities included in our study. While participation rates were high,

Table 1
ORs from multivariable logistic regression for SHS exposure in cars last week.

	Total pop.	Exposed to SHS in car	Odds ratios (ORs) (95% confidence interval)	
	(%)[1]	(%)[2]	Model 1[a]	Model 2[b]
Total (N)	10,481			
(%)	100	22.3		
Country (city)				
Tampere (Finland)	14.5	6.0	REF	REF
Namur (Belgium)	13.9	36.3	7.54 (5.90 to 9.63)***	6.23 (4.76 to 8.14)***
Hanover (Germany)	8.7	18.9	3.55 (2.70 to 4.68)***	3.01 (2.23 to 4.07)***
Dublin (Ireland)	16.6	12.4	2.10 (1.61 to 2.74)***	2.78 (2.08 to 3.71)***
Latina (Italy)	16.2	43.0	9.60 (7.54 to 12.2)***	8.52 (6.52 to 11.13)***
Amersfoort (Netherlands)	15.3	14.9	2.54 (1.96 to 3.29)***	3.39 (2.56 to 4.50)***
Coimbra (Portugal)	14.9	23.2	3.11 (2.40 to 4.05)***	3.83 (2.88 to 5.09)***
Gender				
Male	48.7	21.5	REF	REF
Female	51.3	23.1	1.06 (0.96 to 1.18)	1.03 (0.92 to 1.15)
Age				
14	30.0	19.6	REF	REF
15	42.8	20.1	1.05 (0.92 to 1.18)	0.93 (0.81 to 1.08)
16	21.0	27.5	1.53 (1.32 to 1.77)***	1.14 (0.96 to 1.35)
17	6.2	33.1	1.79 (1.45 to 2.20)***	1.06 (0.83 to 1.36)
Migration				
Domestic	76.4	22.0	REF	REF
1 migrant parent[3]	12.4	23.2	1.17 (1.01 to 1.36)*	1.15 (0.97 to 1.37)
2 migrant parents[4]	11.0	23.3	1.17 (0.99 to 1.37)	1.37 (1.14 to 1.64)**
Maternal education				
High	39.6	15.5	REF	REF
Middle	33.1	25.9	1.29 (1.13 to 1.47)***	1.12 (0.96 to 1.30)
Low	13.9	37.7	1.66 (1.41 to 1.96)***	1.40 (1.16 to 1.68)***
Unknown	13.4	17.6	1.24 (1.00 to 1.54)*	1.25 (0.98 to 1.59)
Paternal education				
High	35.7	13.8	REF	REF
Middle	29.9	24.9	1.52 (1.33 to 1.75)***	1.20 (1.03 to 1.41)*
Low	17.9	37.8	2.26 (1.93 to 2.65)***	1.65 (1.38 to 1.98)***
Unknown	16.4	19.0	1.47 (1.21 to 1.75)***	1.01 (0.81 to 1.27)
Parental smoking				
None	45.0	9.1		REF
Ex-smoker	19.6	12.5		1.20 (1.01 to 1.43)*
1 Smoker	23.1	38.3		4.04 (3.49 to 4.68)***
2 Smokers	12.3	56.2		7.12 (5.98 to 8.48)***
Smoking rules at home				
Complete ban	56.0	12.5		REF
Partial ban	38.6	30.3		1.77 (1.56 to 2.01)***
Permitted freely	5.4	66.4		4.21 (3.36 to 5.28)***
Smoking Friends				
None	42.1	10.5		REF
Some	42.5	24.2		1.62 (1.41 to 1.87)***
Most	13.4	47.2		2.39 (1.97 to 2.90)***
All	2.0	61.8		3.33 (2.30 to 4.83)***
Smoking Status				
Never	66.4	14.9		REF
Experimenter	22.7	28.5		1.34 (1.17 to 1.53)***
Weekly	10.9	54.1		2.26 (1.88 to 2.71)***

Note: ORs represent the odds of being exposed to SHS in cars on at least one day within the past week.
*** - $p < 0.001$, **- $p < 0.01$, * - $p < 0.05$.
[1] Percentages in columns.
[2] Percentage relative to nonexposed.
[3] One or both parents born in another country.
[4] One or both parents born in another country.
[a] Model 1: Controlled for demographic and socioeconomic characteristics of country, gender, age, migration status (parent born in another country), and parental education.
[b] Model 2: Model 1 + smoking factors at home, peer smoking, and smoking status.

approximately 20% of the adolescents did not participate due to missing parental consent or school absenteeism. In Germany and Italy, active parental consent was required, which resulted in a lower response rate compared to that in the cities with passive consent. One wave (n = 4 schools) of the German data collection had to be carried out in the last week of school before the summer holidays with above-average school absenteeism. Approximately 1,687 respondents with missing information were excluded, which could have influenced our results on the prevalence and determinants of SHS exposure in cars. Last, our study design is cross-sectional, and as such, the relationships

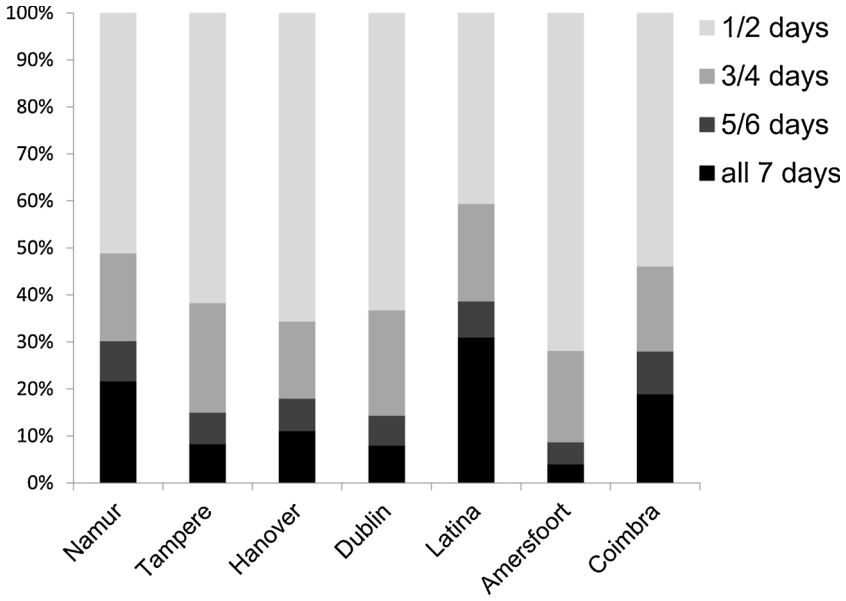

Fig. 1. Distribution of SHS exposure in cars during the last week among exposed adolescents in %.

observed should be interpreted with caution.

4.2. Interpretation

We found that even when controlling for smoking in adolescents' social environment, parental education was significantly associated with SHS exposure. The social gradient in SHS exposure corresponds with earlier Canadian studies on vehicle exposure (Azagba, 2015; Montreuil et al., 2017). Inequalities by SES can be explained by widely documented educational differences in adolescent and adult tobacco use (Bosdriesz et al., 2016; Kuipers et al., 2016a). Permissive family and peer smoking environments are strong factors as well (Agaku et al., 2016; Azagba, 2015; Hitchman et al., 2012), which means that SHS exposure in vehicles is part of a more generalized exposure to SHS. Legislation for SF cars may therefore be closely linked to efforts to reduce exposure at home.

Considerable differences were found between cities with regard to SHS exposure in cars. Exposure among Dutch (15%), Irish (12%), and Finnish (6%) youth was considerably lower than the exposure reported for the US (approx. 18–25%) in the early 2010s (Agaku et al., 2016; King et al., 2012; Patel et al., 2018). In contrast, Belgian (36%) and Italian (43%) adolescents reported considerably higher exposure. These differences may be explained by the respective legislative tobacco control context and varying degrees of smoking prevalence (Bosdriesz et al., 2016; Feliu et al., 2019). Nevertheless, according to 2014 Eurobarometer data, daily smoking of adults in Finland (12%), Germany (15%), the Netherlands (16%), Portugal (16%), Belgium (17%), and Italy (17%) does not differ extensively from the adolescent car exposure in our study. Additionally, the study of Feliu et al. (2019) found lower smoking prevalence and higher quitting ratios in Italy compared to Germany and Portugal, which does not correspond with the high SHS car exposure identified in the Italian city of Latina.

Cultural and infrastructural differences (such as the Netherlands being a traditional "biking nation") influence the preferred means of transport and may have influenced our findings. In a study on car smoking rules Dutch smokers (36%) were to be less permissive than German (52%) or French (59%) smokers (Hitchman et al., 2012), which helps explain the low exposure for Dutch youth. Contextual factors such as climate and date of adoption, mode of implementation (Mlinarić et al., 2018) and enforcement of existing SF legislation in public places may also explain the observed variation between countries.

It is notable that SHS exposure in Italy is higher compared to that in countries without legislation (Germany, the Netherlands, Portugal, Belgium) and Ireland (SF legislation implemented 2016), although Italian data collection (2017) took place a year after implementation (2016). The enforcement of this law is mostly performed by the local public order (e.g., police) authorities, with possibly low prioritization due to limited time and personnel resources (Mlinarić et al., 2018). Smoking fines in Italy depend on the age of children or the presence of pregnant women and range between 500€ and 5,000€, while in Ireland, smoking fines range between 100€ and 1,000€. The high SHS exposure in the Italian city of Latina may be an effect of weak enforcement strategies (Mlinarić et al., 2018), permissive smoking norms or even higher SHS car exposure prior to implementation (Martínez-Sánchez et al., 2014). Moreover, the general smoking prevalence in Italy is higher than that in Ireland or Finland, and quitting ratios in Italy are also considerably lower (Feliu et al., 2019). Studies evaluating SF car laws using time series or quasi-experimental data have provided evidence of their long-term effectiveness (Nguyen, 2013; Patel et al., 2018). Although we included countries with and without SF car legislation, differences between those countries must be interpreted with caution due to the relatively low number of cities included in this study and the cross-sectional design of our study.

SF car legislation for vehicles carrying minors is expected to be implemented soon in Nordic countries but is also being discussed in Germany and in the Netherlands. Recent research indicates that public support is generally high for SF policies pertaining to child protection (Fu et al., 2018; Kuijpers et al., 2018). In progressive tobacco control countries, such as New Zealand, 92% of people across all socio-demographic groups support SF car legislation if vehicles are carrying children (Li et al., 2016). This is also the case even in countries where smokers are an increased proportion of the population and may be more resistant, such as Germany and the Netherlands. Approximately 90% of Dutch adolescents are in favor of SF car legislation for vehicles carrying children (Schreuders et al., 2018). In Germany, 72% of adults and 67% of smokers support such an intervention (Boeckmann et al., 2018).

5. Conclusions

In most of the seven EU cities analyzed, a considerable proportion of youth riding in cars, particularly those from disadvantaged and smoking-permissive backgrounds, is exposed to SHS in cars. Given the evidence on the long-term effectiveness of SF car measures, the high level of public support in some countries, and the substantial exposure

to SHS in cars, policy-makers should consider nation-wide smoke-free car policies as a measure to reduce SHS exposure and related health inequalities among minors.

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Contributors

MM and MS conceptualized the study. MM and MS analyzed and interpreted the data with the support of UM and AEK. MM drafted the final manuscript. All authors contributed to the writing of the final manuscript version and approved the final manuscript.

Ethics

Ethical approval was granted through the ethical committee of the Medical Faculty of the Martin Luther University Halle-Wittenberg (2016-90 hm-bü), Germany, and obtained in all participating countries separately to comply with respective national standards. Belgium: REF 2012/09OCT/461 N° enregistrement belge B403201215182 – Comité d'éthique Hospitalo-Facultaire des Cliniques Universitaires Saint-Luc. Germany: Ethical approval MLU Halle-Wittenberg: 2016-90 hm-bü. Supervisory school authority Hanover: H 1 R b - 81402 - 55 – 2016. Supervisory school authority Lüneburg (Celle): LG 1 R.22 – 503000. Portugal: General Directorate for education, approval number 0338600002 on the 26th of July 2016. The Netherlands: Medical Research Involving Human Subjects Act (WMO): reference number W16_252 # 16.297, 11 August 2016. Ireland: Research Ethics Committee – Dublin Institute of Technology: Ethical Clearance Ref 15–105, 16th June 2016. Finland: Ethics Committee of the Tampere Region, Statement 29/2016. Italy: Ethical Committee "Lazio 2", protocol number 0068451/2016.

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Declaration of Competing Interest

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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.2019.107561.

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