Early View

Original Research Article

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Prevalence and determinants of smoke-free homes in 12 European countries: the

TackSHS Survey

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Summary

Background: Homes are one of the primary locations where people are exposed to second-hand smoke (SHS) in Europe. We describe the prevalence and identify the main determinants of having home-smoking restrictions in 12 European countries.

Methods: Cross-sectional survey in 12 European countries conducted in 2017-2018 (TackSHS Project). Approximately 1,000 participants representing the general population aged ≥15 years of each country were interviewed face-to-face. Individual and country-level characteristics were explored through adjusted prevalence ratios (PR) obtained from multilevel Poisson models with random effects.

Results: Among 11,734 participants, 70.2% (95%CI: 69.4-71.0%) had smoke-free homes and 17.5% (95%CI: 16.8-18.2%) had partial home-smoking restrictions in place. Prevalence of smoke-free homes ranged from 44.4% in Greece to 84.5% in England. Having a smoke-free home was significantly inversely associated with current (PR=0.60) or former (PR=0.95) smoking and living in a household with one (PR=0.70) and two or more (PR=0.58) people who smoke. It was also significantly associated with being ≥65 years old (PR=1.05), being female (PR=1.07), having a high educational level (PR=1.09), and living with children (PR=1.09). Having a smoke-free home was associated with living in Northern Europe, while partial home-smoking restrictions were more likely among respondents from Eastern Europe and countries with lower per capita gross domestic product.

Conclusions: The prevalence of smoke-free homes in Europe is relatively high, but with large variability across countries. European countries with a lower prevalence of smoke-free homes should implement tailored interventions targeting identified determinants and incorporate the success of other countries.

Key words: smoke-free homes; home-smoking restriction; smoke-free rules; smoking; involuntary smoking; secondhand smoke; tobacco smoke pollution; passive smoking; tobacco; Europe; TackSHS Project.

Take home message

About 70% of population from 12 European countries lived in smoke-free homes in 2017-2018.

Prevalence of smoke-free homes ranged from 44% in Greece to 85% in England.

Comprehensive policies are necessary to accelerate smoke-free homes adoption in Europe.

Introduction

Exposure to second-hand smoke (SHS) poses a significant public health threat, contributing to the development of severe conditions such as ischemic heart disease, stroke, lung cancer and nasal irritation. Exposure to SHS is also associated with an increased risk of type 2 diabetes, and the current evidence is suggestive about the SHS links to the development of breast cancer, asthma and chronic obstructive pulmonary disease [1]. In 2019, SHS exposure was responsible for approximately 690,000 deaths among women and 610,000 deaths among men globally [2]. In Europe alone, it has been estimated that approximately 24,000 adult deaths could be prevented yearly if SHS exposure at home were eliminated [3].

Children are particularly susceptible to SHS, because their lungs and airways are still developing, and they have faster breathing rates compared to adults. It has been estimated that about 40% of children are exposed to SHS globally [4]. In some countries of the World Health Organization (WHO) European Region, such as the Federation of Bosnia and Herzegovina, Croatia, and Serbia, up to 60% of youth are exposed to SHS at home [5]. Among children, SHS exposure is associated with acute respiratory infections, exacerbated asthma, otitis media, and sudden infant death syndrome [6]. In the European Union (EU) in 2017, 35,633 DALYs were attributed to home SHS exposure among children [6].

While exposure to SHS in most public places can be addressed by smoke-free regulations promoted by the WHO Framework Convention on Tobacco Control [7], private homes remain a major place where exposure to SHS occurs. This is particularly the case for adults who do not smoke, women, and children [8]. However, introduction

of smoke-free regulations in public places has helped shift societal norms around smoking in enclosed indoor spaces and has had a positive impact on the introduction of voluntary smoking restrictions in homes and improved health outcomes [9-12].

Monitoring the prevalence and determinants of smoke-free homes across European countries is of importance to better tailor actions to reduce exposure to SHS at home, and ultimately tackle its burden. Unfortunately, multi-country standardised tobacco surveillance system in Europe, such as the Eurobarometer, no longer collects data on smoking rules at homes [13]. Some other studies that collect these data focus on a specific population, for example, people who smoke [14], or are conducted only in a small number of European countries (for example, the Global Adult Tobacco Survey in Kazakhstan, Romania, or Ukraine) [15]. Some European countries monitor the prevalence of smoke-free homes at a national level; however, these studies apply different methodologies and the comparisons between countries is either impossible or challenging. Therefore, the TackSHS survey was conducted to improve the understanding of exposure to SHS in Europe using common standardised questionnaire in all the considered countries [16].

In this study, we have evaluated the prevalence of different types of home-smoking restrictions (complete, partial, or none) and identified individual and country-level factors associated with complete or partial home-smoking restrictions vs. having no restrictions in 12 European countries.

Methods

This is a cross-sectional observational study. The data were obtained from a survey conducted as part of the TackSHS project (2017-2018), in 12 European countries: Bulgaria, England, France, Germany, Greece, Ireland, Italy, Latvia, Poland, Portugal, Romania, and Spain [16]. These countries incorporate geographical, legislative, and cultural diversity across Europe, and cover approximately 80% of the whole EU-28 population at the time of the survey.

In total, the survey included 11,902 respondents. In each country, approximately 1,000 adult (defined as 15 years and older) respondents participated in the study. Sampling strategies applied ensured that the samples were representative of the country's general population in terms of age, sex, habitat (geographic area and/or size of municipality), and, in some countries, socio-economic characteristics [17].

The TackSHS survey questionnaire was developed by the Mario Negri Institute team from questionnaires used in previous national and European surveys, it was reviewed by the project expert group and is available upon request [10,18]. Trained interviewers conducted a face-to-face, computer-assisted personal interview in each country [17].

Variables

The dependent variable of this study was the self-reported smoking restrictions in participants' homes. All participants were asked: "At your home, where can people (including anyone living in the household and guests) smoke?" with the response options: (1) everywhere, (2) in some specific indoor areas (e.g., in the kitchen, in the bathroom), (3) nowhere inside. The respondents who mentioned that smoking is allowed everywhere were regarded as having "no restrictions" at their home, those who allowed smoking in some areas as having a "partial restriction" and those who

answered that smoking occurs "nowhere inside" as having a "complete restriction", in other words, having a "smoke-free home". Those participants with missing data on this variable (n=168) were excluded from the analyses.

The independent variables studied were participant age (four categories: <25, 25-44, 45-64, ≥65 years), sex (female or male), smoking status (never, former, and current smoking) [17], educational level (low, medium, and high) [17], presence of minors (14 years old and younger) at the household (yes/no) and number of people who smoke in the household (none, one, two or more). The missing data for individual independent variables (3 responses for educational level and 1 for number of people who smoke in the household) were excluded from analyses. Moreover, we analysed the country level independent variables such as geographical area (Northern, Western, Southern, and Eastern Europe) as defined by the United Nations M49 Standard [19], gross domestic product (GDP) per capita (≤€25.000 and >€25.000) according to the World Bank [20] and country score in the 2016 Tobacco Control Scale (TCS, <50, 50-55, and >55) [21].

Statistical analysis

We have calculated weighted prevalence as well as 95% confidence intervals (CI) of self-reported voluntary home-smoking restrictions (complete, partial, and no restrictions) overall, by country, and by individual-level variables. Furthermore, we performed a multivariate Poisson regression analysis with robust variance to estimate the prevalence ratios (PR) and their 95%CI for having complete and partial restrictions vs. having no smoking restrictions by individual independent variables. Finally, we fitted multilevel Poisson models with random effects to account for both individual

and country-level independent variables. PR and their 95%CI for complete vs. no restrictions. and partial vs. no restrictions were calculated.

Statistical weights were used to generate representative estimates of the general population of each country (*individual weights*). To calculate results for the entire sample, *country weights* were applied that combined individual weights with an additional weighting factor, with each country contributing in proportion to its population aged 15 years or over, as obtained by 2017 Eurostat [22]. Analyses were performed with IBM SPSS Statistics (Version 27), and Figure 1 was created with MapChart.

Ethical considerations

The TackSHS project obtained the approval from the Clinical Research Ethics Committee of the Bellvitge University Hospital (PR341/15). The TackSHS survey was approved by the local Ethics Committee in each participating country [17]. The survey protocol was registered with ClinicalTrials.gov (ID: NCT02928536). All participants received detailed information about the study through the information sheet and provided their consent to participate. This research followed and endorsed the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidance for reporting observational research [23].

Results

In total, 11,734 participants (98.6% of the total sample) responded to the question regarding voluntary smoking rules in their home and were included in the current analysis. Participants characteristics in each country are presented in the Supplementary Table 1. The overall prevalence of smoke-free homes among the 12

countries was 70.2% (95% CI: 69.4-71.0%), 17.5% (95% CI: 16.8-18.2%) reported having partial home-smoking restrictions and 12.3% (95% CI: 11.7-12.9%; Table 1) reported having no restrictions in place. The prevalence of smoke-free homes ranged from 44.4% (95% CI: 41.4-47.5%) in Greece to 84.5% (95% CI: 82.2-86.7%) in England (Figure 1). The prevalence of homes with partial home-smoking restrictions was the highest in Romania (35.4%, 95% CI: 32.5-38.4) and the lowest in England (8.4%, 95% CI: 6.8-10.2). Homes lacking any smoking restrictions were most prevalent in Greece (23.0%, 95% CI: 20.5-25.7) and least prevalent in Latvia (3.1%, 95% CI: 2.2-4.3; Supplementary Table 2).

Among people who currently smoke, the prevalence of smoke-free homes was 37.3%, ranging from 25.0% in Spain to 54.8% in Latvia. Among those who do not smoke currently (former and never smoking combined), 81.7% reported having a smoke-free home with the lowest prevalence in Greece (51.4%) and the highest in England (92.9%). The prevalence of smoke-free homes in households where only people who do not smoke live was 87.3%, ranging from 60.1% in Greece to 96.4% in Portugal. Amongst households where at least one person who smokes lives, 43.1% reported having a smoke-free home, with the lowest prevalence in Spain (26.5%) and highest in England (60.5%; Supplementary Table 3).

Table 2 presents the PRs for having a home with complete or partial smoking restrictions versus lacking any restrictions in place. Statistically significant direct associations with reporting a smoke-free home were found for respondents aged 65 and older compared to those aged 25 or younger (PR=1.05; 95% CI: 1.01-1.10); women (PR=1.07; 95% CI: 1.04-1.10); respondents with high educational level (PR=1.09; 95%

CI: 1.06-1.12) and those living with children of 14 years old and younger (PR=1.09; 95% CI: 1.05-1.12). Having a smoke-free home was inversely related to smoking status among those who currently (PR=0.60; 95% CI: 0.57-0.64) and formerly (PR=0.95; 95% CI: 0.93-0.98) smoke. Having a smoke-free home was also inversely related to the number of household members who smoke (*p for trend <0.001*). Regarding country-level characteristics, a smoke-free home was significantly more likely to be reported in Northern European countries (Table 2).

Individual factors for having partial home-smoking restrictions were similar for those of smoke-free homes. Living in Eastern compared to Northern Europe (PR=1.22; 95% CI: 1.05-1.42) was associated with having partial restrictions. In addition, homes with partial smoking restrictions were less likely among respondents from countries with a GDP >25,000€ (PR=0.85; 95% CI: 0.78-0.92). The results of multivariate analysis including only individual-level characteristics (Supplementary Table 4) revealed findings similar to the multilevel analysis (Table 2), although the strength of the association was slightly attenuated when controlling for country-level characteristics.

Discussion

This study shows that smoke-free homes are increasingly the norm across Europe with an overall prevalence of 70.2% in 2017-2018. This suggests a considerable increase from the last available data from 2010, when the reported prevalence was 62.2% [10]. We found large variability between the countries surveyed, with the prevalence of smoke-free homes ranging from 44.4% in Greece to 84.5% in England and being generally higher in Northern Europe. We found that smoke-free homes were significantly more likely reported by older participants, women, participants with high

educational level, and those living with children. Conversely, being a person who currently smokes or who smoked in the past and living in a household with people who smoke was significantly associated with not having a smoke-free home.

In 2010, a survey using the same methodology as the current one evaluated home-smoking restrictions in 18 European countries, with 11 of the 12 countries included in the current study (all except Germany) [10]. Overall, the prevalence of smoke-free homes reported in 2010 was lower; considering the prevalence for the 11 countries common for both surveys, it increased from approximately 58% in 2010 to about 67% in 2017-2018. The increase in the prevalence of smoke free-homes in European countries is likely to occur due to the expansion of smoke-free policies in public places, particularly at workplaces and the hospitality sector, and consequent decrease of both SHS exposure at home and the social acceptability of smoking [24-26]. Nevertheless, these results suggest an annual increase of nearly 1% in the prevalence of smoke-free homes, indicating it would take another 30 years to achieve smoke-free homes in all European homes at this rate. Therefore, accelerating progress in tobacco control – particularly strengthening and expanding smoke-free legislation in workplaces, public places and certain private settings, such as motor vehicles, as well as introducing various endgame strategies – is of utmost importance for extending smoke-free homes in Europe [25].

A survey conducted in 2016 in six European countries collected data on home-smoking restrictions among adults who smoke [14]. In that study, the overall prevalence of a smoke-free home was 26.5%, more than 10% lower than among respondents who smoke in the current survey (37.3%, Supplementary Table 3). In five out of six

countries included in both surveys (Germany, Greece, Poland, Romania and Spain), the prevalence of a smoke-free home was higher in 2018 [14]. These results highlight an overall lower adoption of smoke-free homes in households of those who smoke compared to the general public.

The current study, in line with previous research, showed that having a smoke-free home is less prevalent among people who smoke or have smoked in the past, and among those living with people who smoke [18, 27-29]. A systematic review on barriers to smoke-free home adoption identified that nicotine addiction was a barrier to both creating and maintaining a smoke-free home [28]. Moreover, lack of awareness about SHS health risks, denial of risk messages, and perceived benefits of smoking were other obstacles detected in creating a smoke-free home [28].

Other determinants of smoke-free homes were identified in the current study. Female respondents were more likely to report smoke-free rules in their household; this contrasts with some other country-specific studies that did not detect gender differences in smoke-free home adoption [18,30-31]. However, previous research suggests that while women may be more likely to promote smoke-free homes, they may experience a lack of agency in changing male home-smoking behaviours [28], which has prompted calls for the development of father-inclusive, family-wide interventions [32]. Regarding age and smoke-free home adoption, there is inconsistent evidence from previous studies. Some studies report older age to be associated with smoke-free homes [18], that is consistent with our findings, while others find them to be more likely adopted by middle age and younger participants [27, 30-31]. These differences could be also related to the stage of the cigarette epidemic in different

countries (and hence the age of the majority of those who currently smoke or smoked in the past) [33]. Socio-economic status is an important predictor of health behaviours, and our study confirms that smoke-free homes are more likely to be adopted by populations with higher socio-economic status [18,27-31]. These findings emphasize a need for interventions promoting smoke-free homes to be tailored to vulnerable populations and for structural policies addressing social determinants to decrease existing inequalities in SHS burden [4].

In our study participants from Northern European countries (England, Ireland, and Latvia) were more likely to have smoke-free homes. While a previous 2010 survey demonstrated that participants from the countries with strongly implemented tobacco control measures (higher TCS scores) were more likely to report smoke-free homes [10], our current study showed no significant association. Use of TCS has potential limitations as there is low variance across the countries that have achieved a high overall tobacco control and a general lack of information regarding legislation enforcement [34]. Our results suggest that tobacco control policies (proxied through the TCS) and economic conditions (proxied through GDP per capita) of the studied countries are not significantly related to the adoption of smoke-free homes, while the geographical region is. This may reflect that adoption of smoke-free homes and shifting societal norms around smoking at home could be more related to overall regional differences such as tobacco-free country ambitions or health literacy [35-36].

In the current study, about 13% of respondents who live in households where no one smokes allow visitors to smoke indoors of their homes. These results may indicate a lack of awareness about the risks of smoking and SHS exposure at home among the

general population [28], including those who do not smoke. There is evidence of the effectiveness of mass media campaigns for the general population in promoting smoke-free home adoption and decreasing the health burden of SHS exposure among children [37-38]. It is important to implement successful campaigns that lead all household members to recognise the risks of smoking in the home and to actively choose to make their private spaces smoke-free, contributing to a healthier, smoke-free future for generations to come [4,26]. Smoke-free homes not only create a healthier home environment, but also set a positive example for young generations and encourage healthy behaviours [5,26].

In our study, a smoke-free home was defined as a one where smoking is not allowed in indoor areas. Those households where smoking is only allowed in outdoor areas, such as balconies, were considered as smoke-free homes; and, therefore, a more restrictive definition would probably detect lower prevalence of smoke-free homes in Europe. Contrasting our results with other surveys is challenged by different questions asked when assessing the prevalence of smoke-free homes. Some studies ask about either smoking occurs in homes [31] or specifically about existing smoking rules [30] and if guests are allowed to smoke [18]; some questions specifically focus on indoor areas [14], while others do not specify explicitly indoor or outdoor areas. Asking these different questions to the same respondents would likely provide different estimates of the prevalence of smoke-free homes. Therefore, more cooperation in defining standard questions to evaluate smoke-free homes is necessary. Pan-European surveys, such as the Eurobarometer, should systematically use the same questions about home-smoking rules and home smoking behaviour, including frequency and clear definition of current home smoking, across different survey waves [39].

The current study has some limitations. Firstly, we used self-reported data in face-to-face interviews about smoking behaviour; therefore, the prevalence of smoke-free homes might be overestimated due to a social-desirability response bias. However, when the status of smoke-free homes is measured using environmental biomarkers, such as airborne nicotine, the validity of reporting home-smoking restrictions has been high [40]. Also, this study focused exclusively on conventional cigarette smoking. Future research should investigate the rules regarding the use of electronic cigarettes and other emerging tobacco or nicotine products. Other limitations include those inherent to the cross-sectional study design, which does not allow the study of causal associations. Nevertheless, the study has several strengths such as including participants from 12 countries, the representativeness of the adult population in each country and the homogeneity of the methodology used that allows a reliable comparison across countries. Moreover, we applied complex weighting procedure that allowed us to obtain both, country-specific and overall 12-country, estimates representative of the combined population of the countries studied. Finally, the current study provides pan-European results that were not collected in other recent European surveys. Even though the TackSHS survey was conducted in 2018, to the best of our knowledge, this is the latest pan-European survey providing comparable smoke-free homes data among multiple countries.

Conclusions and recommendations

The prevalence of smoke-free homes in Europe is high, but there is considerable variability among the countries surveyed. The results of this study spotlight the countries where urgent actions are needed to promote the adoption of smoke-free

homes. We have also identified important determinants to better target policies and interventions aimed at promoting smoke-free homes, especially to reach the most vulnerable groups: people with lower socio-economic status, those living with children, and with people who smoke.

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Support statement

Conflict of interest: All authors declare to have no conflict of interest.

Disclaimer: This paper reflects only the authors' views, and the European Commission is not responsible for any use that may be made of the information it contains.

Authors' contributions

EF, SG, JBS, SS and MJL conceptualized the survey proposal and acquired the financial support for the project. EF, SG and AL developed the study methodology. All authors conceptualised the manuscript. EF, SG, AL, MF and OT conducted the investigation and project administration tasks. AL curated the data and OT conducted the data analysis. YC, CS and AL supported statistical analysis. CS accessed the data and verified the data analyses. OT and CS have directly accessed and verified the underlying data reported. EF, SG, JBS, ROD, SS and MJL supervised the research process and manuscript preparation. OT prepared the original draft and all authors reviewed and edited multiple versions of the manuscript. All authors reviewed the manuscript and agreed on its submission.

Data sharing statement

Data collected for the study, including individual participant data and a data dictionary defining each field in the set, could be made available to others upon presentation of research proposal and its approval by the TackSHS Project Board. Research proposals from the tobacco industry and its allies are not accepted. Proposals should be directed to the corresponding author. A data access agreement will be signed prior data sharing.

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Table 1. Prevalence (%) and 95% confidence interval (CI) of homes with complete, partial and no home smoking restrictions by participants' characteristics (N=11,734; TackSHS Survey, 2017-2018)

	N	Complete restrictions			Partial restrictions			No restrictions		
		N	%	95% CI	n	%	95% CI	n	%	95% CI
All	11,734	7,968	70.2	69.4 - 71.0	2,394	17.5	16.8 - 18.2	1,372	12.3	11.7 - 12.9
Age (years)										
<25	1,427	928	68.7	66.3 - 71.0	332	19.4	17.5 - 21.5	167	11.9	10.3 - 13.6
25–44	4,034	2,709	70.3	68.9 - 71.8	856	17.3	16.1 - 18.5	469	12.4	11.4 - 13.4
45–64	4,269	2,783	66.6	65.1 - 68.0	936	19.8	18.6 - 21.1	550	13.6	12.6 - 14.7
≥65	2,004	1,548	77.6	75.8 - 79.3	270	12.2	10.9 - 13.6	186	10.2	9.0 - 11.5
Sex										
Female	6,185	4,316	72.3	71.2 - 73.4	1,290	17.8	16.8 - 18.7	579	9.9	9.2 - 10.7
Male	5,549	3,652	67.9	66.6 - 69.1	1,104	17.2	16.3 - 18.2	793	14.9	14.0 - 15.9
Smoking status										
Never	6,391	5,233	83.7	82.8 - 84.6	795	10.8	10.0 - 11.5	363	5.5	5.0 - 6.1
Former	2,025	1,467	74.8	72.8 - 76.7	366	15.9	14.3 - 17.6	192	9.3	8.1 - 10.7
Current	3,318	1,268	37.3	35.6 - 39.1	1,233	33.5	31.8 - 35.1	817	29.2	27.6 - 30.8
Minors (<15 years) in the household										
Yes	3,632	2,600	72.1	70.7 - 73.6	768	19.2	17.9 - 20.5	264	8.7	7.8 - 9.6
No	8,102	5,368	69.3	68.3 - 70.3	1,626	16.7	15.9 - 17.5	1,108	14.0	13.2 - 14.8

	N	n	%	95% CI	n	%	95% CI	n	%	95% CI
Number of people who smoke in the household*										
None	6,748	5,847	87.3	86.5 - 88.1	618	8.6	8.0 - 9.3	283	4.1	3.6 - 4.5
One	3,172	1,516	48.3	46.4 - 50.1	1002	27.6	26.0 - 29.2	654	24.1	22.6 - 25.8
Two or more	1,813	605	34.6	32.4 - 36.9	773	38.1	35.8 - 40.4	435	27.3	25.3 - 29.5
Educational level**										
Low	4,416	2,955	69.7	68.3 - 71.0	859	16.5	15.4 - 17.6	602	13.8	12.9 - 14.9
Medium	4,127	2,748	69.4	68.0 - 70.8	877	17.3	16.1 - 18.4	502	13.3	12.3 - 14.4
High	3,188	2,262	72.0	70.4 - 73.6	658	19.4	18.0 - 20.9	268	8.6	7.6 – 9.6

Absolute prevalence (N and n) is presented using raw numbers.

Prevalence rates (% and 95% CIs) were calculated using weights, combining country weights and individual weights with an additional weighting factor, with each country contributing in proportion to its population aged 15 years or over (from Eurostat) [22].

*1 participant from Bulgaria did not report number of people who smoke in the households (n=11,733 for this variable).

**3 participants from Romania did not report their level of education (n=11,731 for this variable).

Table 2. Prevalence ratios (PR) and 95% confidence interval (CI) of having complete or partial home-smoking restrictions compared to not having any smoking restrictions at home according to selected individual and country-level characteristics (TackSHS Survey, 2017-2018).

	Complete vs. no restrictions				Partial vs. no restrictions			
	N	%	PR	95% CI	N	%	PR	95% CI
All	9,337*	85.1			3,766	58.7		
Age (years)								
<25	1,095	85.3		1.00	499	62.0		1.00
25–44	3,177	85.1	0.99	0.95 - 1.03	1,325	58.3	0.92	0.81 - 1.04
45–64	3,332	83.1	0.98	0.94 - 1.02	1,486	59.3	0.95	0.84 - 1.07
≥65	1,733	88.4	**1.05**	**1.01 - 1.10**	456	54.6	0.89	0.77 - 1.04
p for trend			*0.053*				*0.311*	
Sex								
Male	4,444	82.0		1.00	1,897	53.6		1.00
Female	4,893	87.9	**1.07**	**1.04 - 1.10**	1,869	64.1	**1.20**	**1.11 - 1.30**
Smoking status								
Never	5,594	93.8		1.00	1,158	66.0		1.00
Former	1,659	88.9	**0.95**	**0.93 - 0.98**	558	63.0	0.96	0.85 - 1.08
Current	2,084	56.1	**0.60**	**0.57 - 0.64**	2,050	53.4	**0.83**	**0.76 - 0.90**
Minors (<15 years) in the household								
No	6,475	83.2		1.00	2,734	54.4		1.00
Yes	2,862	89.3	**1.09**	**1.05 - 1.12**	1,032	68.9	**1.25**	**1.15 - 1.37**
Number of people who smoke in the household**								
None	6,129	95.6		1.00	901	67.9		1.00
One	2,170	66.7	**0.70**	**0.67 - 0.73**	1,656	53.3	**0.80**	**0.73 - 0.88**
Two or more	1,038	55.8	**0.58**	**0.54 - 0.63**	1,208	58,2	**0.86**	**0.77 - 0.95**
p for trend			*<0.001*				*0.005*	
Educational level								
Low	3,557	83.4		1.00	1,461	54.3		1.00
Medium	3,250	83.9	1.02	0.99 - 1.06	1,379	56.4	1.03	0.93 - 1.14
High	2,530	89.4	**1.09**	**1.06 - 1.12**	926	69.4	**1.28**	**1.16 - 1.41**
p for trend			*<0.001*				*<0.001*	
Geographic area***								
Northern Europe	2,532	92.1		1.00	553	55.3		1.00
Western Europe	1,713	83.6	**0.90**	**0.88 - 0.93**	606	52.5	0.97	0.84 - 1.12
Southern Europe	3,121	83.6	**0.90**	**0.88 - 0.93**	1,511	61.2	1.10	0.96 - 1.26
Eastern Europe	1,971	84.2	**0.91**	**0.87 - 0.95**	1,096	66.9	**1.22**	**1.05 - 1.42**
Country GDP per capita								
≤25,000€	4,267	83.3		1.00	2,123	66.0		1.00
>25,000€	5,070	85.5	1.02	0.99 - 1.06	1,643	56.0	**0.85**	**0.78 - 0.92**

TCS score

Less than 50	3,098	84.6		1.00	1,472	56.3		1.00
50-55	3,056	84.8	1.00	0.97 - 1.04	1,138	60.6	1.04	0.93 - 1.15
More than 55	3,183	85.7	1.01	0.99 - 1.04	1,156	58.1	1.00	0.90 - 1.10
p for trend				*0.331*				*0.823*

GDP: Gross domestic product, TCS: Tobacco Control Scale.

Absolute numbers (N and n) are presented using raw numbers.

Prevalence (%), prevalence ratios (PR) and the corresponding 95% CIs were calculated using weights, combining country weights and individual weights with an additional weighting factor, with each country contributing in proportion to its population aged 15 years or over (from Eurostat) [22].

PR were estimated using multilevel Poisson regression models with random effects after adjustment for age, sex, and educational level. Figures in bold type are significant at 0.05.

*3 subjects did not report information on educational level were excluded from the analysis.

**1 subject from Bulgaria did not report the number of people who smoke at home and was excluded from the analysis for partial vs. no restrictions.

***Countries were categorised by geographic area according to the classification by the United Nations into Northern (England, Ireland, and Latvia), Western (France and Germany), Southern (Italy, Greece, Portugal, and Spain), and Eastern regions (Bulgaria, Poland, and Romania) [19].

Figure 1. Prevalence (%) of smoke-free homes in 12 European countries (N=11,734; TackSHS Survey, 2017-2018).
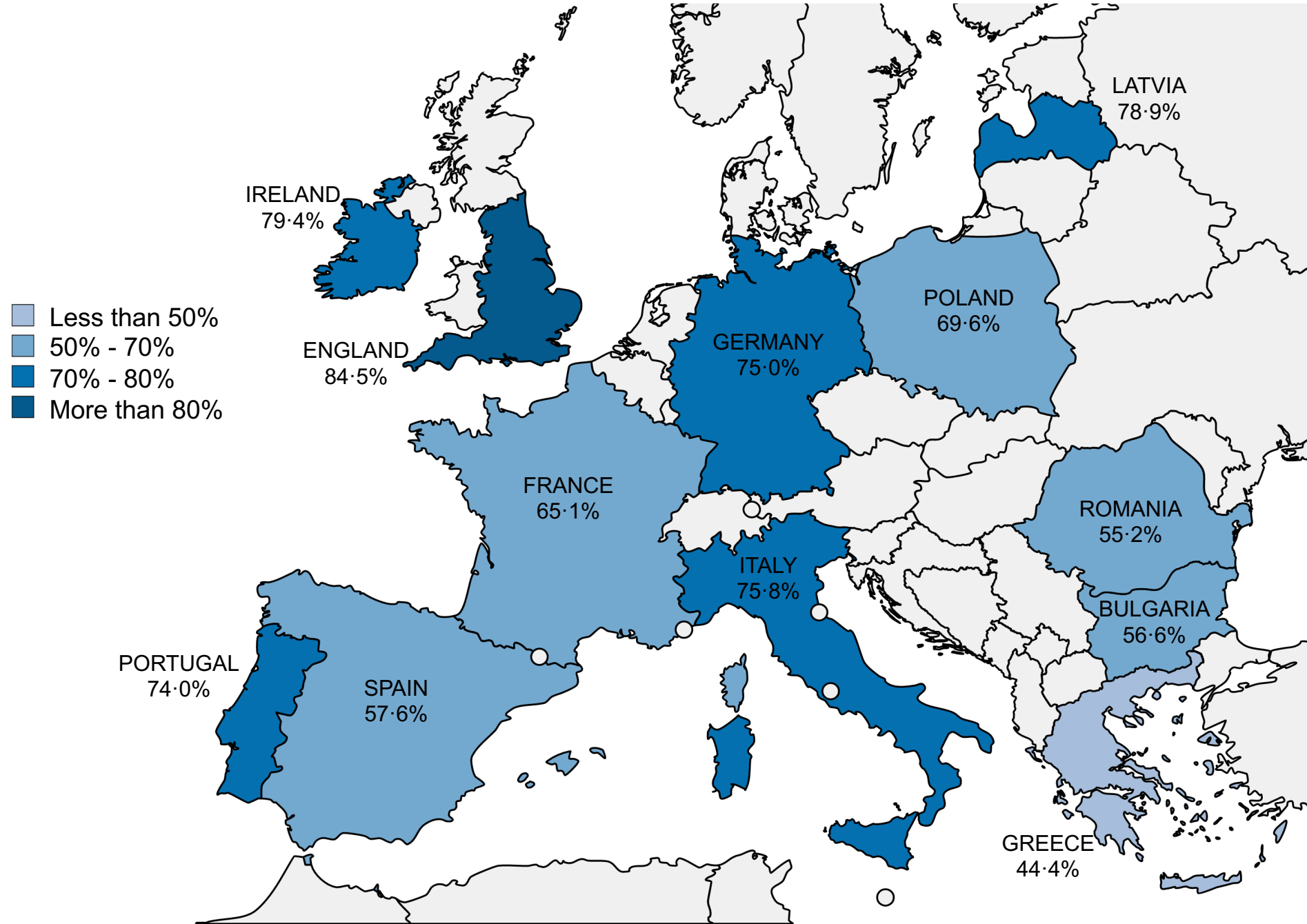
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LATVIA
78·9%

IRELAND
79·4%

ENGLAND
84·5%

GERMANY
75·0%

POLAND
69·6%

FRANCE
65·1%

ROMANIA
55·2%

ITALY
75·8%

BULGARIA
56·6%

PORTUGAL
74·0%

SPAIN
57·6%

GREECE
44·4%

Legend:
- Less than 50%
- 50% - 70%
- 70% - 80%
- More than 80%

Supplementary material: Prevalence and determinants of smoke-free homes in 12 European countries: the TackSHS Survey

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Supplementary Table 1. Study respondents' characteristics in 12 European countries (N=11,734; TackSHS Survey, 2017-2018).

		Sex				Age								Level of education*						Smoking status					
		Female		<25		25–44		45–64		≥65		Low		Medium		High		Current		Former		Never			
	Total	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%		
All	**11,734**	**6,185**	**52.3**	**1,427**	**13.0**	**4,034**	**33.8**	**4,269**	**34.6**	**2,004**	**18.6**	**4,416**	**38.6**	**4,127**	**35.9**	**3,188**	**25.5**	**3,318**	**26.0**	**2025**	**16.5**	**6391**	**57.5**		
BG	1,027	537	52.0	112	9.1	402	35.2	347	36.6	166	19.1	403	39.7	305	29.8	319	30.5	393	37.8	160	16.2	474	46.0		
FR	1,000	525	52.5	147	14.7	308	30.8	398	39.8	147	14.7	386	38.6	346	34.6	268	26.8	315	31.5	204	20.4	481	48.1		
DE	1,027	558	50.7	101	13.6	282	28.8	374	33.9	270	23.7	384	35.3	440	42.4	203	22.3	236	23.0	130	12.8	661	64.2		
EL	999	500	50.1	160	16.1	460	46.0	379	37.9	0	0.0	442	44.2	452	45.2	105	10.6	338	33.8	254	25.5	407	40.7		
IE	913	464	51.2	75	10.5	328	39.4	356	32.5	154	17.6	292	33.5	320	34.7	301	31.8	175	20.1	145	15.3	593	64.6		
IT	1,045	541	52.2	125	11.4	248	30.5	415	32.7	257	25.4	464	41.4	381	38.7	200	19.9	182	19.1	138	11.3	725	69.6		
LV	992	478	52.7	154	12.8	328	37.2	375	36.4	135	13.6	322	30.5	333	33.7	337	35.8	287	28.2	166	16.3	539	55.5		
PL	707	434	54.6	51	14.6	236	38.5	238	31.3	182	15.6	297	49.7	269	32.9	141	17.4	138	23.9	109	13.6	460	62.5		
PT	1,000	529	52.9	125	12.5	326	32.6	320	32.0	229	22.9	333	33.3	275	27.5	392	39.2	368	36.8	147	14.7	485	48.5		
RO	1,011	551	51.6	150	13.0	345	34.4	366	32.3	150	20.3	360	39.8	304	27.8	344	32.4	348	34.1	178	18.7	485	47.2		
ES	1,019	522	51.4	105	11.4	358	34.5	336	32.3	220	21.8	353	31.9	383	33.1	283	35.0	337	32.0	192	20.5	490	47.5		
EN	994	546	54.9	122	12.3	413	41.5	365	36.7	94	9.5	380	38.2	319	32.1	295	29.7	201	20.2	202	20.3	591	59.5		

Absolute numbers (n) are presented using raw numbers, individual weights applied for prevalence (%) for all countries analysed together and both, individual and country weights, applied for prevalence (%) per country.

Countries: Bulgaria (BG), France (FR), Germany (DE), Greece (EL), Ireland (IE), Italy (Italy), Latvia (LV), Poland (PL), Portugal (PT), Romania (RO), Spain (ES), England (EN).

*3 participants from Romania did not report their level of education (n=11,731 for this variable).

Supplementary Table 2. Prevalence (%) and 95% confidence intervals (CI) of homes with complete, partial and no smoking restrictions by country (N=11,734; TackSHS Survey, 2017-2018).

	N	Complete restrictions			Partial restrictions			No restrictions		
		n	%	95% CI	n	%	95% CI	n	%	95% CI
All	**11,734**	**7,968**	**70.2**	**69.4 - 71.0**	**2,394**	**17.5**	**16.8 - 18.2**	**1,372**	**12.3**	**11.7 - 12.9**
Bulgaria	1,027	579	**56.6**	53.5 - 59.6	306	**29.5**	26.8 - 32.3	142	**13.9**	11.9 - 16.1
France	1,000	651	**65.1**	62.1 - 68.0	180	**18.0**	15.7 - 20.5	169	**16.9**	14.7 - 19.3
Germany	1,027	770	**75.0**	72.2 - 77.5	134	**13.4**	11.4 - 15.5	123	**11.6**	9.7 - 13.7
Greece	999	444	**44.4**	41.4 - 47.5	325	**32.6**	29.7 - 35.5	230	**23.0**	20.5 - 25.7
Ireland	913	726	**79.4**	76.6 - 81.9	102	**11.4**	9.4 - 13.5	85	**9.2**	7.5 - 11.2
Italy	1,045	786	**75.8**	73.1 - 78.3	149	**13.4**	11.4 - 15.5	110	**10.8**	9.0 - 12.8
Latvia	992	780	**78.9**	76.3 - 81.4	182	**18.0**	15.7 - 20.4	30	**3.1**	2.2 - 4.3
Poland	707	525	**69.6**	66.2 - 73.0	98	**17.4**	14.8 - 20.4	84	**13.0**	10.7 - 15.6
Portugal	1,000	740	**74.0**	71.2 - 76.6	188	**18.8**	16.5 - 21.3	72	**7.2**	5.7 - 8.9
Romania	1,011	545	**55.2**	52.2 - 58.3	367	**35.4**	32.5 - 38.4	99	**9.4**	7.7 - 11.3
Spain	1,019	582	**57.6**	54.5 - 60.6	280	**27.5**	24.8 - 30.3	157	**14.9**	12.8 - 17.2
England	994	840	**84.5**	82.2 - 86.7	83	**8.4**	6.8 - 10.2	71	**7.1**	5.7 - 8.9

CI: confidence interval.

Absolute numbers (N and n) are presented using raw numbers. Relative prevalence (% and 95% CIs) were calculated using country weights.

Supplementary Table 3. Prevalence (%) and 95% confidence intervals (CI) of smoke-free homes according to the respondents smoking status and presence of people who smoke at home (N=11734; TackSHS Survey, 2017-2018).

| | N | Current smoking | | | | | | People who smoke in the household* | | | | | |
| | | Yes | | | No | | | Yes | | | No | | |
		n	%	95% CI	n	%	95% CI	n	%	95% CI	n	%	95% CI
All Countries	**11,734***	**3318**	**37.3**	**35.6-39.1**	**8416**	**81.7**	**80.9-82.5**	**4985**	**43.1**	**41.7-44.6**	**6748**	**87.3**	**86.5-88.1**
Bulgaria	1,027	393	31.6	27.0-36.2	634	71.7	68.1-75.1	575	33.5	29.8-37.5	451	85.0	81.5-88.0
France	1,000	315	35.9	30.7-41.3	685	78.5	75.3-81.5	458	44.1	39.6-48.7	542	82.8	79.5-85.8
Germany	1,027	236	38.7	32.5-44.9	791	85.8	83.3-88.1	324	47.8	42.7-53.2	703	88.4	85.9-90.7
Greece	999	338	30.8	26.0-35.8	661	51.4	47.6-55.2	543	31.3	27.5-35.3	456	60.1	55.5-64.5
Ireland	913	175	51.1	43.6-58.0	738	86.5	83.8-88.7	300	54.8	49.1-60.2	613	91.9	89.5-93.9
Italy	1,045	182	43.6	36.8-50.4	863	83.4	80.8-85.8	320	49.8	44.5-55.2	725	87.7	85.2-90.0
Latvia	992	287	54.8	49.0-60.6	705	88.4	85.9-90.6	428	58.4	53.7-63.1	564	94.0	91.9-95.8
Poland	707	138	34.6	27.9-42.1	569	80.6	77.1-83.7	207	33.3	27.9-39.2	500	91.1	88.3-93.6
Portugal	1,000	368	47.6	42.5-52.7	632	89.4	86.8-91.6	498	51.4	47.0-55.8	502	96.4	94.5-97.8
Romania	1,011	348	32.8	28.0-37.8	663	66.9	63.2-70.4	532	36.9	32.9-41.0	479	75.8	71.7-79.4
Spain	1,019	337	25.0	20.4-29.7	682	73.0	69.6-76.2	486	26.5	22.5-30.7	533	82.3	78.9-85.2
England	994	201	51.2	44.4-58.1	793	92.9	91.0-94.6	314	60.5	55.0-65.8	680	95.6	93.8-96.9

CI: confidence interval.

Absolute numbers (N and n) are presented using raw numbers. Relative prevalence (% and 95% CIs) for all countries together were calculated using individual weights and per country prevalence using country weights.

* 1 participant from Bulgaria did not report the number of people who smoke at home and was excluded from the analysis.

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Supplementary Table 4. Prevalence Ratios (PR) and 95% CI of having complete or partial home-smoking restrictions compared to no restrictions at home by country and according to selected individual characteristics (TackSHS Survey, 2017-2018).

		Complete vs. no restrictions			Partial vs. no restrictions			
	N	%	PR	95% CI	N	%	PR	95% CI
All Countries	9,337*	85.1			3,766	58.7		
Bulgaria	721	80.2	**0.94**	**0.89 - 0.99**	448	67.8	1.14	1.00 - 1.30
France	820	79.4	**0.93**	**0.89 - 0.98**	349	51.6	0.87	0.75 - 1.01
Germany	893	86.6	1.01	0.97 - 1.06	257	53.5	0.90	0.76 - 1.06
Greece	674	65.9	**0.79**	**0.74 - 0.84**	555	58.6	1.00	0.88 - 1.14
Ireland	811	89.6	**1.05**	**1.01 - 1.10**	187	55.2	0.96	0.81 - 1.14
Italy	896	87.6	1.03	0.98 - 1.07	259	55.4	0.96	0.82 - 1.12
Latvia	810	96.2	**1.13**	**1.09 - 1.17**	212	85.3	**1.47**	**1.29 - 1.67**
Poland	609	84.3	1.00		182	57.4	1.00	
Portugal	812	91.1	**1.06**	**1.02 - 1.10**	260	72.3	**1.19**	**1.03 - 1.36**
Romania	641	85.4	1.00	0.95 - 1.05	466	78.9	**1.32**	**1.16 - 1.49**
Spain	739	79.4	**0.93**	**0.88 - 0.98**	437	64.9	1.06	0.93 - 1.21
England	911	92.2	**1.09**	**1.04 - 1.13**	154	53.9	0.90	0.75 - 1.09
Age (years)								
<25	1,095	85.3	1.00		499	62.0	1.00	
25–44	3,177	85.1	0.98	0.95 - 1.01	1,325	58.3	**0.92**	**0.86 - 0.99**
45–64	3,332	83.1	0.98	0.95 - 1.00	1,486	59.3	0.95	0.88 - 1.02
≥65	1,733	88.4	**1.07**	**1.04 - 1.10**	456	54.6	0.92	0.83 - 1.01
p for trend			*<0.001*				*0.226*	
Sex								
Male	4,444	82.0	1.00		1,897	53.6	1.00	
Female	4,893	87.9	**1.07**	**1.05 - 1.08**	1,869	64.1	**1.19**	**1.13 - 1.24**

	N	%	PR	95% CI	n	%	PR	95% CI
Smoking status								
Never	5,594	93.8	1.00		1,158	66.0	1.00	
Former	1,659	88.9	**0.95**	**0.93 - 0.97**	558	63.0	0.97	0.90 - 1.05
Current	2,084	56.1	**0.66**	**0.64 - 0.69**	2,050	53.4	**0.91**	**0.86 - 0.96**
Minors (<15 years) in the household								
No	6,475	83.2	1.00		2,734	54.4	1.00	
Yes	2,862	89.3	**1.12**	**1.10 - 1.14**	1,032	68.9	**1.22**	**1.16 - 1.29**
Number of persons who smoke in the household**								
None	6,129	95.6	1.00		901	67.9	1.00	
One	2,170	66.7	**0.75**	**0.73 - 0.77**	1,656	53.3	**0.90**	**0.85 - 0.95**
Two or more	1,038	55.8	**0.61**	**0.58 - 0.64**	1,208	58.2	**0.92**	**0.87 - 0.98**
p for trend			*<0.001*				*0.020*	
Educational level								
Low	3,557	83.4	1.00		1,461	54.3	1.00	
Medium	3,250	83.9	**1.04**	**1.02 - 1.06**	1,379	56.4	1.06	1.00 - 1.12
High	2,530	89.4	**1.10**	**1.08 - 1.12**	926	69.4	**1.22**	**1.15 - 1.29**
p for trend			*<0.001*				*<0.001*	

* 3 participants from Romania did not report information on educational level were excluded from the analysis.

** 1 participant from Bulgaria did not report the number of people who smoke at home and was excluded from the analysis for partial vs. no restrictions.

Absolute numbers (N and n) are presented using raw numbers. Relative prevalence (% and 95%) CIs were calculated using weights, combining country weights and individual weights with an additional weighting factor, with each country contributing in proportion to its population aged 15 years or over (from Eurostat) [1].

PR were estimated using multivariate Poisson regression models with robust variance after adjustment for age, sex and educational level. Estimates were weighted for statistical weights that consider country specific adult population. Figures in bold type are statistically significant at 0.05.

References

1. European Commission. Eurostat. Database. Accessed December 19, 2023. https://ec.europa.eu/eurostat/data/database