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ORIGINAL ARTICLE

Does the pattern of educational inequalities in smoking in Western Europe depend on the choice of survey?

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Abstract
Objectives Smoking rates vary according to socioeconomic group. We investigated whether patterns of educational inequalities in smoking prevalence differ across three major European surveys.
Methods Data on smoking came from National Health Interview Surveys (NHIS), the European Community Household Panel (ECHP) and the Eurobarometer (EB). We calculated prevalence ratios by education. We controlled for sex, country, data source and age. We used likelihood ratio tests to determine whether inequalities in each country differed between surveys and whether the association of education and smoking across countries was the same in different surveys.
Results Smoking prevalence tended to be lower in the ECHP than in both other surveys, and was highest in the EB. The pattern of inequalities in smoking also differed between surveys. Statistically significant differences between surveys were found mainly in Southern Europe, where EB-based prevalence ratios often deviated from those in the other two surveys.
Conclusions Relative inequalities in smoking prevalence depend on the survey used. Our results suggest that the NHIS and the ECHP are more reliable sources of information on educational inequalities in smoking than the EB.

Keywords Smoking · Socioeconomic inequalities · Western Europe · International comparison

For the Euro-GBD-SE Consortium.

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Introduction

Smoking continues to be the largest cause of mortality and morbidity in the European Union, and accurate estimates of overall prevalence and information on the risk of smoking by socioeconomic group are necessary for effective targeting of tobacco control policies and interventions (European Commission Health and Consumer Protection Directorate General 2012; WHO 2012). While several studies have described smoking prevalence and patterns of socioeconomic inequalities in smoking in European countries (Schaap et al. 2008, 2009; Huisman et al. 2005a, b; Cavelaars et al. 2000; Bogdanovica et al. 2011; Giskes et al. 2005), these studies usually applied single European data sources. For example, using National Health Interview Surveys (NHIS), Schaap et al. (2009) investigated socioeconomic inequalities in ever-smokers according to four educational levels, but only for the female part of the population. Data from the 5th wave of the European

Community Household Panel (ECHP) were also analyzed in this context. Smoking prevalence ratios were calculated for several indicators of socioeconomic position, including education split into three different levels (Schaap et al. 2008). Huisman et al. (2005a, b) used odds ratios and two levels of education for their analyses. In one study they focused on adolescents and young adults, while concentrating on an overall, non-country-specific analysis in the other. Bogdanovica et al. (2011) used tobacco use information from the 2006 Eurobarometer survey (EB wave 66.2). However, the authors only analyzed the correspondence of overall prevalence between the EB and national surveys, without looking at inequalities in smoking. Each of the studies took a different analytical approach, rendering a direct comparison of the results difficult.

Even though several analyses were carried out using different data sources, we still do not know whether previous estimates are accurate, since no study compared the levels of smoking prevalence and smoking inequality patterns according to educational level between different surveys. We therefore investigated whether patterns of smoking prevalence and patterns of smoking inequalities by educational level differed across three major European surveys. Educational level was chosen as the indicator of socioeconomic status (SES) for the analyses in this paper.

Methods

Description of surveys

For the comparability of smoking prevalence levels between countries, it was important to evaluate data that were collected around the same time. Therefore, our analyses used data on smoking prevalence from three widely used surveys which were all conducted around the year 2000: a collection of NHIS, the ECHP and the EB. The countries included and further information on the data sources are presented in Table 1. The NHIS were nationally representative surveys from 13 countries, usually provided by national statistical offices, with the exception of Finland, for which the data came from the Finbalt Health Monitor, and Belgian data coming from the Scientific Institute of Public Health. The surveys, which entailed cross-sectional country-specific information, were collected and harmonized as part of the Eurothine project (Eurothine 2007). The sample size was always above 10,000 respondents, except in Germany, where the national sample included just above 7,000 individuals. Non-response was highest in The Netherlands and Belgium, at about 40 %, and lowest in Spain and Italy (about 15 %).

The ECHP is a social survey which was administered in the member states of the European Union between 1994 and 2001. We used the seventh wave (2000) for our analyses. The ECHP used a uniform random sampling design and common questionnaires for all 15 countries included in the survey. National households were the target population of the panel survey. Data were collected by national statistical offices and other research centers, and harmonized by Eurostat, the statistical information office of the European Commission (Eurostat 2012). The national sample sizes varied from approximately 4,000 (Denmark) to 14,500 respondents (Italy). Non-response in the first wave, among the countries included in our analysis, was highest in Ireland (44 %) and lowest in Italy at 9 %. The attrition rate up to wave seven is also presented in Table 1, in parentheses next the non-response information (Huisman et al. 2005b).

The EB was our third source of smoking information. We chose the EB 58.2, which was collected in 2002 and included 15 countries. The fieldwork was carried out by the European Opinion Research Group, on behalf of the European Commission. A multi-stage sampling design was used, and all member states received uniform instructions. The EB aims to have a sample size of 1,000 completed interviews (Eurobarometer 2002).

Other international surveys did not include questions on smoking or it was not measured in the way needed for this analysis. Although it contained appropriate smoking information, we chose not to include the Survey of Health, Aging, and Retirement in Europe (SHARE 2011), as it only studies respondents who are 50 years old or older, whereas our analyses include all those 25 and above.

Some countries were excluded from the analyses because information on smoking was incomparable or unavailable. We also excluded countries for which smoking information was missing for more than 20 % of the respondents and countries which were only represented by one suitable survey, thus not allowing for a comparison. For these reasons, Ireland, France and Switzerland were excluded from the NHIS collection. Sweden, United Kingdom, The Netherlands, Luxembourg, France and Germany were excluded from the ECHP. Luxembourg and France were excluded from the EB. Further country-specific information about the different surveys can be found in Table 1. Throughout the analysis countries are ordered by European region: North, West and South. It would have been highly informative to also compare smoking prevalence rates and inequalities in Central and Eastern European countries. However, this information was only available in the NHISs for the time around the year 2000.

Measures of smoking

In all cases, smoking status was self-reported and referred to general smoking including all common tobacco products

Table 1 Overview of information on the different surveys used [National Health Interview Surveys (NHIS), European Community Household Panel (ECHP), Eurobarometer (EB)] and the countries included in the analysis (for the comparison a country had to be included in at least two of the three surveys)

Country	Survey name	Year	Sample size (percentage men)	Non-response/ attrition rate (%)[a]	Age range	Proportion with high education	
						Men	Women
National Health Interview Surveys (NHIS)							
Finland	Finbalt Health Monitor	1994/1996/1998/ 2000/2002/2004	20,371 (46.43)	28.0–35.0	16–64	0.72	0.78
Sweden	Swedish Survey of Living Conditions	2000/2001	11,484 (48.65)	23.9/22.2	16–84	0.77	0.77
Denmark	Danish Health and Morbidity Survey (DHMS/SUSY)	2000	16,690 (49.06)	25.8	16–98	0.79	0.72
England	Health Survey for England (HSE)	2001	15,767 (44.60)	33.0	16–100	0.65	0.60
Ireland	Excluded, more than 20 % missing						
The Netherlands	General social survey (POLS)	2003/2004	15,803 (48.54)	41.7/38.7	16–85	0.70	0.56
Belgium	Health Interview Survey	1997/2001	18,481 (48.48)	41.5/38.6	16–99	0.59	0.54
France	Excluded, more than 20 % missing						
Germany	German National Health Examination and Interview Survey	1998	7,124 (48.43)	38.6	17–79	0.55	0.50
Switzerland	Excluded, not available in the other sources						
Spain	National Health Survey	2001	20,748 (48.43)	15.0	16–75+	0.34	0.26
Italy	Health and health care utilization/Multipurpose Family Survey	1999/2000	118,245 (48.16)	13.4/18.3	16–105	0.37	0.33
Portugal	National Health Survey	1998/1999	40,917 (47.26)	n.a.	16–103	0.14	0.13
European Community Household Panel (ECHP)							
Finland	ECHP Wave 7	2000	5,614 (49.18)	27 (31.31)	17–91	0.69	0.68
Sweden	Excluded, more than 20 % missing						
Denmark	ECHP Wave 7	2000	3,833 (48.73)	38 (35.07)	16–91	0.80	0.70
UK	Excluded, non-comparable coding of smoking variable						
Ireland	ECHP Wave 7	2000	4,528 (48.76)	44 (54.28)	17–91	0.47	0.46
The Netherlands	Excluded, no information on smoking						
Belgium	ECHP Wave 7	2000	4,713 (46.57)	16 (29.76)	17–91	0.65	0.61
Luxemburg	Excluded, no information on smoking						
France	Excluded, no information on smoking						
Germany	Excluded, no information on smoking						
Austria	ECHP Wave 7	2000	5,801 (48.39)	30 (22)	15–91	0.82	0.60
Spain	ECHP Wave 7	2000	12,317 (48.07)	33 (31.16)	16–91	0.36	0.31
Italy	ECHP Wave 7	2000	14,585 (48.67)	9 (17.73)	17–91	0.41	0.37
Portugal	ECHP Wave 7	2000	11,054 (47.31)	11 (4.88)	17–91	0.20	0.19
Greece	ECHP Wave 7	2000	9,437 (47.90)	10 (24.46)	17–91	0.47	0.38
Eurobarometer (EB)							
Finland	EB 58.2	2002	1,024 (42.68)	n.a.	15–92	0.67	0.74
Sweden	EB 58.2	2002	1,000 (46.90)	n.a.	15–95	0.72	0.77

Table 1 continued

Country	Survey name	Year	Sample size (percentage men)	Non-response/ attrition rate (%)[a]	Age range	Proportion with high education	
						Men	Women
Denmark	EB 58.2	2002	1,000 (49.60)	n.a.	15–92	0.85	0.82
UK	EB 58.2	2002	1,312 (36.51)	n.a.	15–91	0.70	0.61
Ireland	EB 58.2	2002	1,013 (48.47)	n.a.	15–94	0.60	0.67
The Netherlands	EB 58.2	2002	1,035 (48.31)	n.a.	15–87	0.74	0.63
Belgium	EB 58.2	2002	1,110 (47.66)	n.a.	15–93	0.66	0.64
Luxemburg	Excluded, not available in the other sources						
France	Excluded, not available in the other sources						
Germany	EB 58.2	2002	2,042 (47.50)	n.a.	15–90	0.77	0.71
Austria	EB 58.2	2002	1,023 (40.27)	n.a.	15–90	0.89	0.80
Spain	EB 58.2	2002	1,000 (48.50)	n.a.	15–89	0.54	0.42
Italy	EB 58.2	2002	1,027 (48.39)	n.a.	15–93	0.61	0.53
Portugal	EB 58.2	2002	1,002 (45.81)	n.a.	15–88	0.21	0.18
Greece	EB 58.2	2002	1,003 (49.95)	n.a.	15–88	0.62	0.38

[a] Attrition since first wave in the ECHP

(cigarettes, pipe, and cigars). In the NHIS the respondents were classified as current regular smokers, current occasional smokers, ex-smokers or never-smokers. In the case of Sweden, England, Germany and Italy, the survey did not include a distinction between regular and occasional smokers, but only asked about smoking in general. Hence, we cannot rule out the possibility that some respondents who might have been occasional smokers counted themselves as regular smokers or as non-smokers. Country-specific questions are listed in Table 3 of the Electronic Supplementary Material. In the ECHP the respondents were asked whether they smoked daily/smoked occasionally/did not smoke but used to smoke daily/did not smoke but used to smoke occasionally/never smoked. In the EB subjects were asked to indicate if they smoked regularly or occasionally, given that they had indicated earlier that they smoked packed cigarettes, their own rolled cigarettes, or pipe/cigars. In separate questions they were also asked if they used to smoke but had stopped, and whether they had never smoked. No distinction was made between those smoking cigarettes, a pipe or cigars.

We ran separate analyses for the group of current smokers and for the group of ever-smokers, the latter definition of smoking prevalence often being used when looking beyond current smokers only, and summarizing all individuals who ever chose to take up smoking, including current and former smokers. We defined current smokers as "current regular smokers" in the NHIS, as "current daily smokers" in the ECHP, and as "regular smokers" in the EB. Ever-smokers were defined as "current regular smokers" or "ex-smokers" in the NHIS, either as "current daily smokers" or "former daily smokers" in the ECHP, and either as "smoking regularly" or "used to smoke but had now stopped" in the EB. Occasional smokers were not counted as current or ever-smokers, since they tend to be different from regular smokers in terms of socioeconomic status and smoking-related health outcomes (Lindstrom and Ostergren 2001).

Measure of educational attainment

To ensure comparability between surveys, the measure of educational attainment was standardized across the surveys to express high and low final educational attainment. In the NHIS and the ECHP, educational attainment was constructed in the same way, i.e., on the basis of the International Standard Classification of Education (ISCED). We defined high education as upper secondary education or higher (ISCED levels 3, 4, 5 and 6), and low education as lower secondary education or less (ISCED levels 0, 1, and 2).

In the EB, the respondents had to indicate how old they were when they ended their full-time education. In order to

arrive at a comparable classification of education, we recoded this information on the basis of typical graduation ages at different ISCED levels across Europe as presented by the OECD (OECD Education at a Glance 2002). In this way we were able to assign individuals to the most likely corresponding educational level. In a final step, we reclassified the ISCED levels into low (ISCED levels 0, 1, and 2) vs. high (ISCED levels 3, 4, 5 and 6) educational attainment, in order to match those in the other two surveys. Table 1 includes the proportions of those with a high education across the three surveys. We see that the EB results in a slightly higher proportion (up to 20 % more) of individuals with a high level of education in Ireland, Germany, Spain, Italy and Greece among men; and in Ireland, Germany, Austria, Spain and Italy among women. The NHIS and the ECHP exhibit similar education distributions.

Statistical analyses

We first determined whether the smoking information in the three different surveys resulted in significantly different overall levels of prevalence of current smokers and ever-smokers for each country. Secondly, we analyzed whether patterns of educational inequalities in smoking differed between the data sources, within and across countries.

We calculated age-standardized overall smoking prevalence rates using the direct method based on the 1995 European Standard Population (Ahmad et al. 2001) and applied regression analysis for further calculations.

In all regression analyses we calculated prevalence ratios (PRs) of the two outcome variables—current smokers and ever-smokers—by means of generalized linear regression models for the binomial family and a log link function. Since smoking is a non-rare event, we chose to use PRs rather than calculating odds ratios (ORs), as ORs are likely to be too high for events which occur relatively often (Barros and Hirakata 2003; Skov et al. 1998; Eikemo et al. 2009; Viera 2008). The relative differences were expressed as prevalence ratios which represented the risk of being a current smoker or an ever-smoker. The analyses were always stratified by sex, and we controlled for educational level and age. Throughout the analysis we excluded respondents younger than 25 years of age, whose patterns of smoking might still have been unstable before this age, and in order for individuals to be old enough to have achieved their highest level of education. Depending on whether we calculated the PRs by data source and/or country or based on a pooled data set we stratified by or controlled for those two variables, respectively. For all calculations we used the statistical software package STATA, version 11.

To examine whether the sex-specific prevalence of smoking in each country differed between the surveys we calculated PRs of the two outcome variables, controlling for age, education and source, stratifying by country, and focused on the PRs by source and their significance (Table 2).

To calculate sex-specific and country-specific levels of educational inequalities in smoking between the surveys, we applied the same type of regression but now focused on the PR by low vs. high level of education, and additionally stratified by survey. In a further step, in order to establish whether levels differed significantly between surveys for each country, instead of stratifying by survey we included a two-way interaction of educational level and data source and used a likelihood ratio to compare these country-specific models to the models without the interaction term (Figs. 1, 2, 3, 4, significance indicated by asterisks).

Using the same likelihood ratio method, we also investigated whether the association of education and smoking across countries was the same in the different data sources. For both sexes separately, we pooled our data over all sources and countries and in a full model controlled for age, educational level, data source, and country, and the interactions of age and country, educational level and country, data source and country, and educational level and source. Additionally, we also included the interaction of education, country and source and compared both models, and used the likelihood ratio test to determine the statistical significance of this three-way interaction term (test results listed next to Figs. 1, 2, 3, 4).

Results

Overall prevalence of current smokers and ever-smokers

Country-specific smoking prevalence rates from the three different data sources are summarized in Table 2. In the first three columns, we display the age-standardized overall prevalence rates for current smokers and ever-smokers, respectively, stratified by sex, country and data source. In columns four through six we show the smoking prevalence ratios based on regression. Since the prevalence rates and the PRs were obtained with different methods, in some cases the results did not match perfectly, as in the case of female current smokers in Finland, where the prevalence rates were 19.2 % in the NHIS and 18.1 % in the ECHP, while the PR was 1.00.

For both men and women, there were significant differences (marked in bold) between the surveys, in both: the levels of prevalence of current and that of ever-smokers (Table 2). More specifically, the prevalence of current smokers and ever-smokers tended to be lower in the ECHP than in the other two surveys, and was highest in the EB. Among men, the highest current smoking prevalence rates

Table 2 Age-standardized overall prevalence (%) of current smokers and ever-smokers in the National Health Interview Surveys (NHIS), European Community Household Panel (ECHP) and the Eurobarometer (EB) in 13 European countries around the year 2000; smoking prevalence ratio and significance (in bold) of differences ($p < 0.05$) between surveys

Current smokers							Ever-smokers						
	Age-standardized overall prevalence (%)			Smoking PRs and their significance (significant differences in bold)				Age-standardized overall prevalence (%)			Smoking PRs and their significance (significant differences in bold)		
	National Health Interview Survey (NHIS)	European Community Household Panel (ECHP)	Eurobarometer (EB)	ECHP vs. NHIS	EB vs. NHIS	EB vs. ECHP		National Health Interview Survey (NHIS)	European Community Household Panel (ECHP)	Eurobarometer (EB)	ECHP vs. NHIS	EB vs. NHIS	EB vs. ECHP
Men							Men						
Finland	29.5	27.7	37.7	0.98	**1.30**	**1.33**	Finland	56.0	54.2	63.7	**0.93**	**1.09**	**1.17**
Sweden	17.8		14.9		0.82		Sweden	55.0		34.9		**0.69**	
Denmark	37.1	33.9	38.9	**0.92**	1.03	1.12	Denmark	64.6	58.8	62.2	**0.90**	**0.92**	1.03
England/UK	26.4		39.1		**1.44**		England/UK	63.5		63.5		0.97	
Ireland		27.8	32.1			**1.36**	Ireland		46.0	57.1			**1.30**
The Netherlands	29.0		33.7		**1.19**		The Netherlands	66.1		67.9		1.02	
Belgium	30.6	28.9	34.3	0.99	**1.16**	**1.17**	Belgium	66.0	53.2	61.9	**0.84**	0.94	**1.13**
Germany	29.2		38.0		**1.34**		Germany	60.8		64.1		1.05	
Austria		31.0	37.6			**1.33**	Austria		48.6	60.6			**1.31**
Spain	40.1	37.8	46.1	0.96	**1.17**	**1.21**	Spain	67.7	55.9	73.4	**0.84**	**1.07**	**1.27**
Italy	32.9	30.3	33.4	**0.93**	1.04	1.12	Italy	63.0	45.3	60.6	**0.71**	0.98	**1.37**
Portugal	32.9	30.4	36.8	0.98	1.13	**1.15**	Portugal	58.6	45.5	62.7	**0.82**	1.07	**1.30**
Greece		47.7	50.2			1.08	Greece		56.2	74.8			**1.34**
Women							Women						
Finland	19.2	18.1	26.4	1.00	**1.54**	**1.54**	Finland	35.8	31.9	44.1	0.94	**1.36**	**1.44**
Sweden	21.5		25.5		1.17		Sweden	49.1		50.6		1.04	
Denmark	33.4	33.1	29.4	1.00	0.94	0.94	Denmark	56.9	52.2	57.1	**0.95**	1.02	1.08
England/UK	25.3		33.7		**1.44**		England/UK	54.4		51.9		1.00	
Ireland		26.5	31.4			**1.24**	Ireland		38.3	48.2			**1.31**
The Netherlands	23.1		28.5		**1.32**		The Netherlands	55.9		56.7		1.01	
Belgium	21.1	20.6	22.9	1.03	1.11	1.07	Belgium	46.6	31.9	42.0	**0.71**	**0.89**	**1.25**
Germany	22.1		24.8		**1.19**		Germany	39.2		40.1		1.09	
Austria		19.5	26.1			**1.59**	Austria		28.4	38.7			**1.52**
Spain	24.2	19.4	28.7	**0.84**	**1.21**	**1.43**	Spain	34.6	24.1	39.8	**0.74**	**1.12**	**1.50**
Italy	19.1	15.8	29.7	**0.76**	**1.46**	**1.92**	Italy	32.6	19.5	42.7	**0.56**	**1.21**	**2.17**
Portugal	9.4	9.1	11.3	**0.75**	1.17	**1.56**	Portugal	14.7	11.4	20.4	**0.61**	**1.30**	**2.13**
Greece		20.8	30.7			**1.55**	Greece		21.7	40.9			**1.91**

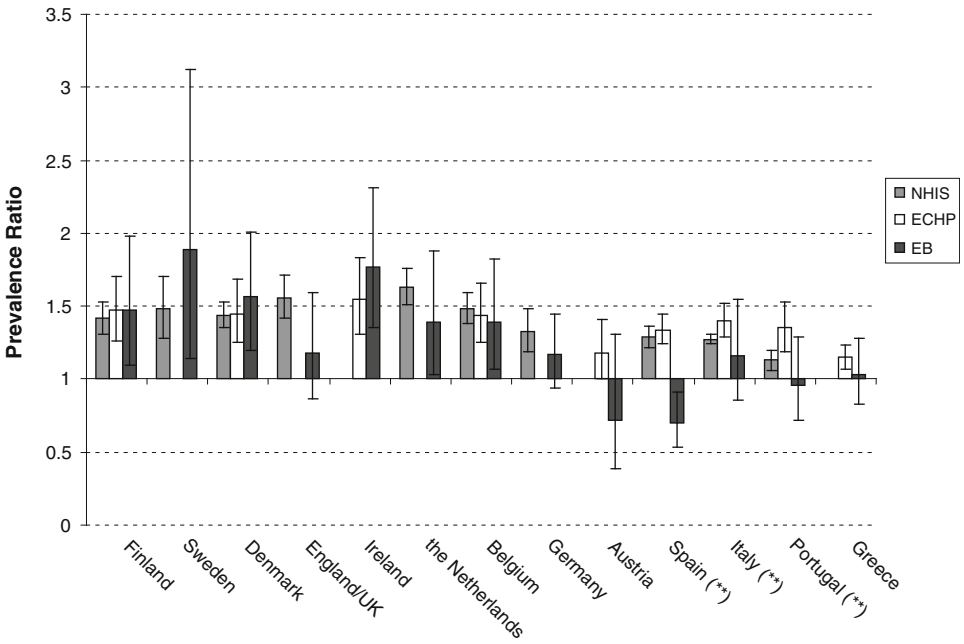

Fig. 1 Educational inequalities in male current smokers in 13 European countries around the year 2000 (ref = 1, high education), significance between the National Health Interview Surveys (NHIS), European Community Household Panel (ECHP) and the Eurobarometer (EB) per country is shown in *parentheses*, per country (*$p < 0.05$, **$p < 0.01$). Differences in inequality patterns between pairs of surveys, likelihood ratio p values: NHIS and ECHP: $p = 0.063$, EB and NHIS: $p = 0.098$, EB and ECHP: $p = 0.027$

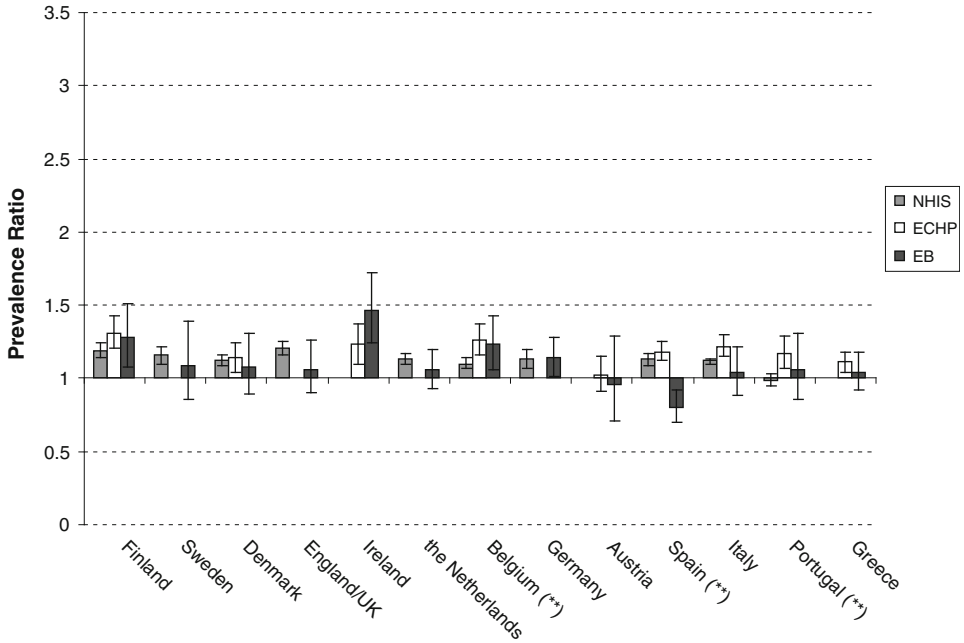

Fig. 2 Educational inequalities in male ever-smokers in 13 European countries around the year 2000 (ref = 1, high education), significance between the National Health Interview Surveys (NHIS), European Community Household Panel (ECHP) and the Eurobarometer (EB) per country is shown in *parentheses*, per country (*$p < 0.05$, **$p < 0.01$). Differences in inequality patterns between pairs of surveys, likelihood ratio p values: NHIS and ECHP, $p = 0.025$; EB and NHIS, $p = 0.115$; EB and ECHP, $p = 0.195$

were observed in Spain (38–46 %) and Greece (48 and 50 %). Sweden, on the other hand, had the lowest prevalence level, at 15 and 18 %. Among women, the levels of current smokers were lowest in Portugal (9–11 %) and highest in Denmark (29–33 %) and England (25 and 34 %).

Educational inequalities in smoking by current smokers and ever-smokers

Generally, educational inequalities in current smokers were larger than those in ever-smokers in all surveys, with both showing a similar pattern across all countries (Figs. 1, 2, 3, 4). Among males within the NHIS, inequalities were largest in Northern and Western Europe, with a PR of around 1.5 among current smokers. They were smallest in the countries of Southern Europe. In the ECHP, male current smokers in Northern and Western Europe had inequality levels that were very similar to those in the NHIS. In Southern European countries, the ECHP showed larger inequalities than the other two surveys. The EB exhibited the least pronounced inequality patterns and even showed reversed inequality gradients in Austria and Spain,

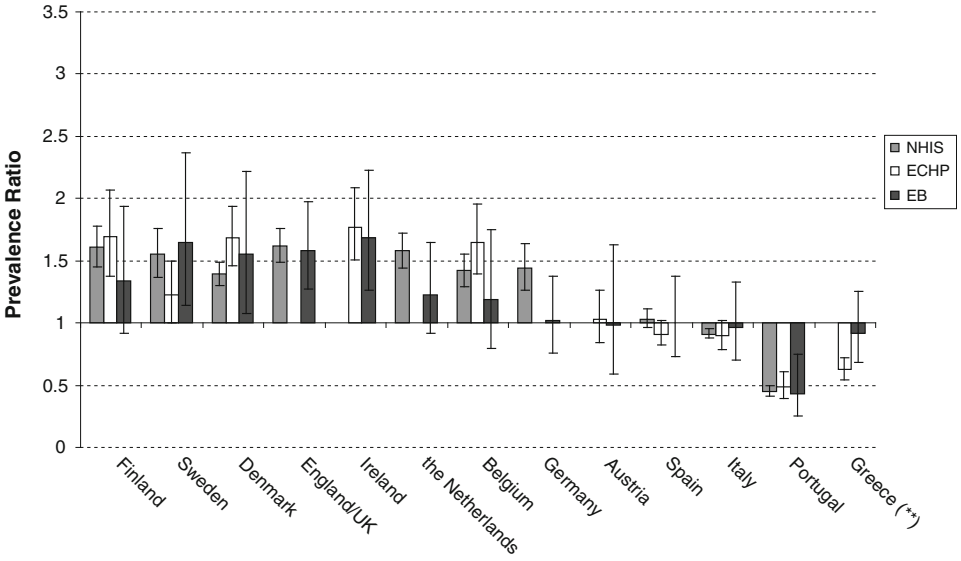

Fig. 3 Educational inequalities in female current smokers in 13 European countries around the year 2000 (ref = 1, high education), significance between the National Health Interview Surveys (NHIS), European Community Household Panel (ECHP) and the Eurobarometer (EB) per country is shown in *parentheses*, per country (*$p < 0.05$, **$p < 0.01$). Differences in inequality patterns between pairs of surveys, likelihood ratio p values: NHIS and ECHP, $p = 0.119$; EB and NHIS, $p = 0.364$; EB and ECHP, $p = 0.087$

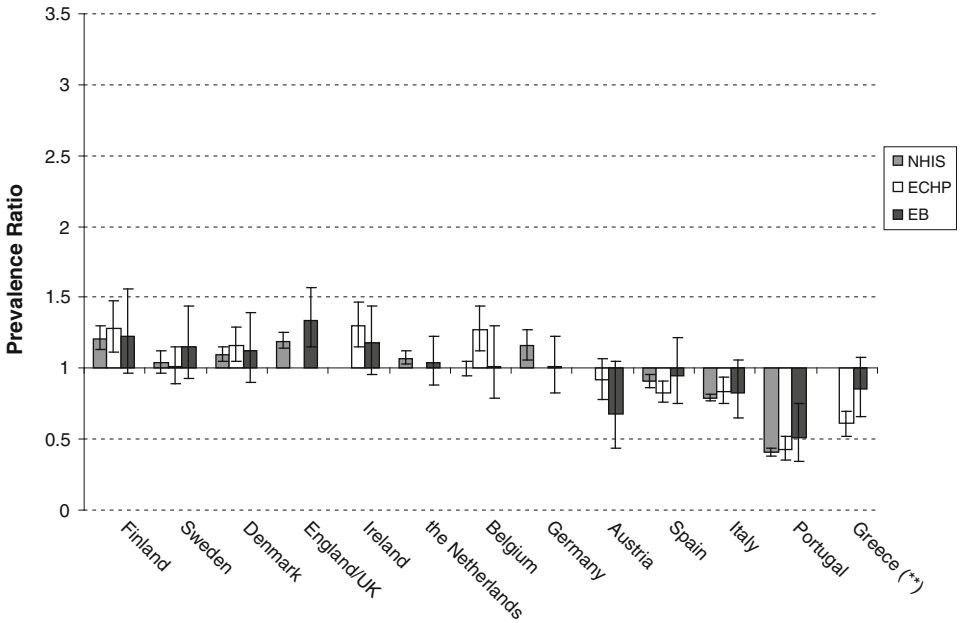

Fig. 4 Educational inequalities in female ever-smokers in 13 European countries around the year 2000 (ref = 1, high education), significance between the National Health Interview Surveys (NHIS), European Community Household Panel (ECHP) and the Eurobarometer (EB) per country is shown in parentheses, per country (*$p < 0.05$, **$p < 0.01$). Differences in inequality patterns between pairs of surveys, likelihood ratio p values: NHIS and ECHP, $p = 0.073$; EB and NHIS, $p = 0.650$; EB and ECHP, $p = 0.005$

i.e., individuals with a lower educational level had a lower risk of smoking than those with a higher education. In this survey there were no significant inequalities among current smokers in the UK, Germany, Austria, Italy, Portugal and Greece. Educational inequalities among male current smokers differed significantly between the data sources in Spain (EB and NHIS, EB and ECHP), Italy (NHIS and ECHP) and Portugal (EB and ECHP, NHIS and ECHP). Among ever-smokers there were no inequalities in the EB in Sweden, Denmark, England, The Netherlands, Austria, Italy, Portugal and Greece, and in the ECHP in Austria. There were significant differences between the sources in Belgium (NHIS and ECHP), Spain (EB and NHIS, EB and ECHP) and Portugal (NHIS and ECHP).

Women in Northern and Western Europe demonstrated a pattern of smoking inequalities that was very different from that of their counterparts in Southern Europe. Smoking women in Southern Europe had an inverse risk pattern. For ever-smoking women this was also the case in Austria. According to the EB inequalities were not significant among female current smokers in Finland, The Netherlands, Belgium, Germany, Austria, Spain, Italy and Greece. They were also not significant in the ECHP in Sweden, Austria, Spain, Italy, and in the NHIS in Spain. The pattern of educational inequalities among female current smokers differed significantly between the data sources in Greece (EB and ECHP). Among ever-smokers in the EB inequalities were only significant in England and

Portugal, only being non-significant in the ECHP in Sweden and Austria, and in the NHIS in Sweden and Belgium. Among ever-smokers there were also only significant differences between sources in Greece (EB and ECHP).

The likelihood ratio analysis of the regression models (p values listed next to Figs. 1, 2, 3, 4) based on the pooled data sets confirmed the differences in inequality levels found in the analyses above. We can see that the association of education and smoking across countries was not the same in all three data sources. For male current smokers, there were significant differences between the EB and ECHP ($p = 0.027$). For ever-smokers there were differences between the ECHP and the NHIS ($p = 0.025$). Among women there was a significant difference only among ever-smokers between the EB and the ECHP ($p = 0.005$).

Discussion

The prevalence of current smokers and ever-smokers differed significantly between the three sources. The percentages tended to be lower in the ECHP than in the other two surveys, and were highest in the EB. The pattern of educational inequalities in ever and current smoking also differed significantly between surveys. Statistically significant differences between surveys were found mainly in Spain, Portugal, Italy and Greece, where PRs based on the EB often deviated from those found in the other two surveys.

For our analysis we selected three widely used European data sources that include information on smoking behavior: two international surveys and a harmonized collection of NHIS. A relevant concern might be whether the questions used to ask about the respondents' smoking behavior were comparable between the surveys. As all used the same or very similar wording and categories to inquire about current regular/occasional smoking, former smoking and never smoking, we do not expect bias.

All responses were self-reported. However, this was not a major problem in our analysis, since we were comparing surveys which all included self-reported information. Furthermore, studies have concluded that self-reported estimates are quite accurate with only small socioeconomic differences in reporting bias (Patrick et al. 1994; Suadicani et al. 1994). We also excluded individuals below the age of 25 from our analyses and underreporting is usually expected at youngest ages. We are aware that there might be potential bias concerning the non-response or attrition rate since first wave in the ECHP, if smoking status and/or educational level were not distributed equally between those who responded and those who did not (Huisman et al. 2005b). No detailed information on the relationship between non-response and education could be found for the other surveys used. However, it was found that while non-response can cause a bias in the level of smoking prevalence, the association between smoking and socioeconomic status is not biased (Van Loon et al. 2003).

There is some evidence that smoking prevalence might be higher when collected face-to-face than in self-administered surveys (Christensen et al. 2014). The ECHP and EB were both collected face-to face, while the NHIS comprised both methods. We do not consider the latter a possible source of bias, since the prevalence levels of the NHIS usually lay between those of the other two surveys.

Education is a widely used indicator of SES. Unlike occupation or income, it has the advantage that it avoids the problem of health-related social mobility later in life, as it is normally completed before ill-health in mid-life starts (Siegrist and Marmot 2006). The main strength of using education as a measure of SES is that it is relatively easy to measure, obtains high response rates, and is a relevant indicator for everyone from younger adulthood on, regardless of working circumstances. Because it is a fundamental determinant of both occupation and income, education also lies at the heart of people's position in society (Lahelma 2001; Ross and Wu 1995). While the NHIS and the ECHP used the same variable to measure education, we had to construct a comparable variable for the EB which would be as similar as possible. Still, as our results show, in some countries this solution led to a proportion of those with high education that was higher than the proportions in the two other data sources, possibly pointing to some misclassification of educational level.

Neither can we rule out differences in our data sources due to sampling and survey methods. While the ECHP and the EB used the same methods and questions for all countries included in those surveys, our harmonized collection of NHIS might be more heterogeneous. Although the EB survey is the largest continuous and standardized source of smoking information, its relatively small sample size only allows for less detailed analyses of smoking prevalence in population subgroups. A study comparing smoking prevalence levels in the 2006 EB with prevalence from national surveys found discrepancies within countries and concluded that the EB's sample size was too small for reliable analyses by sex or educational level (Bogdanovica et al. 2011). More detailed analyses are likely to require sources with a larger sample size and with an educational variable that is more directly comparable to the education information available elsewhere; the minimal sample size recommended for an analysis by educational group being $N = 5.000$ (Schaap and Kunst 2009).

The different distribution of educational levels and its sample size make the EB a less reliable source and may explain why it is more often the prevalence ratios based on the EB that deviate from those found in the other two surveys.

In order to further assess which of the surveys might yield the most reliable estimates of smoking inequalities, we compared them to levels of inequality in lung cancer mortality. Estimates from other studies showed that in Spain and Italy in the early 2000s mortality from lung cancer was higher in men with a low educational level, supporting estimates of inequality in smoking based on the NHIS (Kulik et al. 2014). A country that has moved through the early stages of the smoking epidemic, as indicated by higher lung cancer mortality among those with a lower education based on past smoking patterns will have already passed through the earlier stage of having relatively many smokers with a higher educational level (Cavelaars et al. 2000).

While the authors are not aware of any analyses that have compared the extent of educational inequalities in current and ever-smoking across different surveys, the magnitude and the geographical patterns of inequalities do conform to other authors' single-survey studies of earlier waves of the ECHP or (older) sets of harmonized NHISs (Huisman et al. 2005a; Cavelaars et al. 2000). Bogdanovica et al. (2011) compared the smoking prevalence levels in the EB in 2006 with national prevalence survey data. However, they focused only on officially reported overall non-sex-specific prevalence levels, and did not study educational inequalities in particular.

Finally, it should be kept in mind that although we only present relative inequalities, absolute inequalities in smoking prevalence will also strongly depend on the survey used, since they depend on both the average prevalence and on relative inequalities.

Conclusion

Relative inequalities in prevalence of ever and current smoking depend on the survey used. Our results suggest that the NHIS and the ECHP are more reliable sources of information on educational inequalities in smoking than the EB. When undertaking comparative analyses of prevalence and inequalities of other risk factors, it should be taken into account that results might also differ depending on the data source.

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Conflict of interest The authors declare that they have no conflict of interest.

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