

Effect of nationwide tobacco control policies on smoking cessation in high and low educated groups in 18 European countries

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ABSTRACT

Background: Recently a scale was introduced to quantify the implementation of tobacco control policies at country level. Our study used this scale to examine the potential impact of these policies on quit ratios in European countries. Special attention was given to smoking cessation among lower educational groups.

Methods: Cross-sectional data were derived from national health surveys from 18 European countries. In the analyses we distinguished between country, sex, two age groups (25–39 and 40–59 years) and educational level. Age-standardised quit ratios were calculated as total former-smokers divided by total ever-smokers. In regression analyses we explored the correlation between national quit ratios and the national score on the Tobacco Control Scale (TCS).

Results: Quit ratios were especially high (>45%) in Sweden, England, The Netherlands, Belgium and France and relatively low (<30%) in Lithuania and Latvia. Higher educated smokers were more likely to have quit smoking than lower educated smokers in all age-sex groups in all countries. National score on the tobacco control scale was positively associated with quit ratios in all age-sex groups. The association of quit ratios with score on TCS did not show consistent differences between high and low education. Of all tobacco control policies of which the TCS is constructed, price policies showed the strongest association with quit ratios, followed by an advertising ban.

Conclusion: Countries with more developed tobacco control policies have higher quit ratios than countries with less developed tobacco control policies. High and low educated smokers benefit about equally from the nationwide tobacco control policies.

In the past decade many countries have implemented more or less comprehensive tobacco control policies. Tobacco control policies include, among others, taxes on tobacco products, bans or restrictions on smoking in public places and advertising bans. Recently, Joossens and Raw developed the Tobacco Control Scale (TCS) to quantify the efforts in the field of tobacco control at country level in Europe.¹ According to TCS large variations exist between countries.

An important question is whether these variations in tobacco control policies between countries are correlated with differences in smoking behaviour. Different types of studies (trials, time-series analyses and cross-sectional studies) showed an effect of individual tobacco control measures, mostly within countries or regions, on smoking

behaviour.^{2–6} The International Tobacco Control (ITC) Policy Evaluation Project studied the effect of nationwide tobacco control policies on smoking behaviour in an international study comparing the United States, Canada, Australia and the United Kingdom.⁷ The TCS created the opportunity to also compare European countries on their efforts to reduce smoking rates and the association of these efforts with smoking prevalence in national populations.

Socioeconomic inequalities in smoking have widened and persisted in the last decades.⁸ Tobacco policies need to tackle these inequalities by achieving reductions of smoking prevalence rates among lower socioeconomic groups. Nevertheless, it is generally acknowledged that, mainly, higher socioeconomic groups have benefited from early tobacco control policies, such as written information campaigns and health publicity.^{9–10} On the other hand, lower socioeconomic groups seem to be more responsive to price policies than smokers in a higher socioeconomic position.^{9–11–12} It is therefore uncertain whether the impact of nationwide tobacco control policies differs between high and low socioeconomic groups.

The impact of nationwide tobacco control policies on smoking behaviour should preferably be examined in a longitudinal study design, wherein information about smoking behaviour and its determinants before and after the implementation of a policy is measured. For the evaluation of national tobacco control programmes, this longitudinal design is preferably applied to several countries in order to be able to compare “intervention” countries (where a specific intervention is implemented during the study period) to “control” countries (where the intervention is not yet widely implemented). Unfortunately, comparative longitudinal data on smoking are available only for the ITC study referred to above. As a result, in-depth comparison between European countries with different tobacco control policies is not yet possible with the available data. Alternative approaches are needed to obtain first evidence on the potential effect of national policies on smoking in European countries. In this paper, we apply a comparative approach based on cross-sectional data.

The aim of this study was to examine the extent to which tobacco control policies are correlated with smoking cessation. Special attention was given to smoking cessation among lower educa-

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tional groups. The analysis consisted of two steps. First, we assessed the national levels and educational inequalities in smoking cessation ratios in 18 European countries. Second, we explored the relation of the cessation ratios by educational level with national tobacco control policies as measured by the score on the TCS. We used data from 18 countries from all European regions. For the first time, this international overview of smoking inequalities included data from eastern European and Baltic countries.

METHODS

The Tobacco Control Scale allocated a score to each country based on the level of implementation of different tobacco control policies as it was in 2004–5. The scale is based on six policies that were described by the World Bank as being most important and effective. A group of experts allocated points to each policy according to its potential impact on national smoking rates. The maximum possible score on TCS is 100. The scale includes the following policies (maximum points): price (30 points), public place bans (22 points), public information campaign spending (15 points), advertising bans (13 points), health warnings (10 points) and treatment (10 points).¹ Table 1 shows the national scores on the TCS. Countries are ranked by their score on the TCS in 2005. Ireland has the highest score of 74 out of 100 points. Latvia has the least developed tobacco control policy with a score of 29 points.

National health surveys

Micro-level data from national health interview surveys of 18 European countries were obtained and analysed. Most surveys were conducted in or after the year 2000, except the German and Portuguese surveys, which were conducted in 1998–9. Sample sizes were above 4500 for all surveys, except those from Estonia, Czech Republic, Slovakia and Latvia. Non-response percentages ranged from about 15% in Italy and Spain up to 49% in Slovakia, while percentages in most other countries were between 20% and 35% (see table 2). Data from 100 893

respondents who had ever smoked were included in the analyses. We limited our analyses to the adult population aged 25–59 years, in order to exclude the possibility of mortality bias among older smokers.

Smoking status was self-reported and respondents were initially classified as “current daily smoker”, “occasional smoker”, “former smoker” and “never-smoker”. Quit ratios were calculated as the ratio of the number of ex-smokers divided by the number of ever-smokers (current + former smokers). “Occasional smokers” were not included in the analyses because it was not clear from the data from most surveys whether they have ever been daily smokers. Furthermore, occasional smokers differ from current daily smokers in terms of socioeconomic status and health consequences related to smoking.¹³ Table 1 describes the percentage of ever-smokers in each country and each age-sex group.

Educational level represents the highest level of completed education of the respondent. The level of education was initially classified according to national categories, which were subsequently reclassified into four levels of the International System of Classification of Educations (ISCED): primary or no education; lower secondary education; higher secondary education; tertiary education.

Statistical analyses

First, age-standardised quit ratios were calculated for each country, sex and educational level. The direct method of age standardisation was used with the European population of 1995 as the standard.

In the next step we quantified the magnitude of educational inequalities in quit ratios, using the Relative Index of Inequality (RII) and its 95% confidence interval (CI). RII is a regression-based measure that takes into account all educational groups separately. It facilitates comparisons between countries with different educational classifications, provided that all classifications are hierarchical and sufficiently detailed. The RII assesses the association between quit ratios and the relative position of each educational group. This relative position is measured as the

Table 1 National score on Tobacco Control Scale (TSC) and sample characteristics

	Score TCS	Men		Women	
		25–39 years		40–59 years	
		No* (% ever†)	No* (% ever†)	No* (% ever†)	No* (% ever†)
Finland	58	1283 (58.4)	2558 (65.4)	1172 (43.7)	1772 (41.9)
Sweden	60	549 (36.7)	1228 (63.5)	634 (42.4)	1190 (58.3)
Denmark	45	1011 (53.2)	2100 (71.2)	1157 (55.6)	1792 (61.8)
England	73	1012 (57.5)	1446 (61.5)	1228 (53.9)	1509 (55.6)
Ireland	74	323 (50.6)	511 (53.0)	330 (49.7)	470 (44.8)
Netherlands	52	1013 (61.4)	1952 (74.9)	1005 (53.8)	1932 (69.5)
Belgium	50	1252 (59.6)	1968 (76.2)	1179 (53.1)	1442 (56.9)
Germany	36	577 (57.4)	778 (61.0)	521 (49.3)	526 (39.4)
France	56	916 (60.1)	1460 (66.6)	897 (55.0)	1073 (44.3)
Italy	57	8441 (54.0)	12481 (67.6)	5992 (37.3)	7156 (37.8)
Spain	31	1870 (65.3)	2076 (74.4)	1625 (59.4)	1117 (38.3)
Portugal	39	2641 (63.9)	3619 (64.1)	1237 (30.0)	806 (13.2)
Slovakia	49	98 (66.3)	159 (70.2)	45 (37.8)	93 (42.0)
Hungary	47	672 (60.8)	929 (68.2)	712 (58.2)	1024 (60.0)
Czech Rep.	38	162 (63.9)	255 (70.7)	126 (44.2)	202 (54.3)
Lithuania	34	1115 (73.3)	1332 (69.6)	501 (32.2)	358 (17.1)
Latvia	29	146 (75.2)	191 (78.1)	102 (42.0)	96 (26.0)
Estonia	45	424 (77.3)	547 (80.6)	311 (47.7)	466 (45.2)

*No, number of ever (current + former) smokers.

†Ever-smoking ratio (%) = total number of ever-smokers divided by total number of respondents (ever + never-smokers).

Table 2 Surveys included in the study

Country	Year(s)	Name of survey	Non-response rate (%)	Number of ever-smokers* aged 25–59
Finland	1994/96/98/2000/02/04	Finbalt Health Monitor	28.0–35.0	6785
Sweden	2000/01	Swedish Survey of Living Conditions	23.9/22.2	3601
Denmark	2000	Danish Health and Morbidity Survey (DHMS/SUSY)	25.8	6060
England	2001	Health Survey for England (HSE)	33.0	5195
Ireland	1995/2001	Living in Ireland Panel Survey	18.0/22.0†	1634
Netherlands	2003/04	General social survey (POLS)	41.7/38.7	5902
Belgium	1997/2001	Health Interview Survey	41.5/38.6†	5841
Germany	1998	German National Health Examination and Interview Survey	38.6	2402
France	2004	French Health, Health Care and Insurance Survey (ESPS)	30.0†	4346
Italy	1999/2000	Health and health care utilization/Multipurpose Family Survey	13.4/18.3†	34 070
Spain	2001	National Health Survey	15.0	6688
Portugal	1998/99	National Health Survey	NA	8303
Hungary	2000/03	National Health Interview Survey Hungary	21.0/28.0	3337
Czech Rep.	2002	Health Interview Survey	29.3	745
Slovakia	2002	Health Monitor Survey	49.1	395
Lithuania	1994/96/98/2000/02/04	Finbalt Health Monitor	28.0–39.0	3306
Latvia	1998/2000/02/04	Finbalt Health Monitor	20.0–40.0	535
Estonia	2002/04	Health behaviour among Estonian adult population	33.0/38.0	1748

*Ever-smokers = former smokers + current daily smokers.

†% non-response households.

cumulative proportion of each educational group within the educational hierarchy with 0 and 1 as the extreme values. The resulting measure, the RII, can be interpreted as the risk of being a former smoker at the very top of the educational hierarchy compared to the very lowest end of the educational hierarchy.^{14 15} For this paper, the RII was estimated with log-linear regression with control for five-year age group. The regression model had a log-link function and assumed a binomial distribution, using the Genmod procedure of SAS.^{16 17}

Finally, we explored the correlation between national quit ratios and the national score on the TCS and the subscores of the TCS. We applied linear regression analyses, with countries as units of observation. In univariate regression analyses the quit ratio was the dependent variable and the score on the TCS the independent variable. In further analyses we adjusted for gross domestic product (GDP) per capita in the year 2000.¹⁸ GDP is used in this study as a measure for economic development, which may be related to smoking cessation rates independently (for example, through reduced financial and environmental stress relief, increased health literacy and greater self-efficacy in relation to healthy behaviour) from the implementation of tobacco control policies.

The analyses were performed separately for men and women, two age groups (25–39 and 40–59) and two educational groups (high versus low).

Sample sizes are small for some countries. This leads to imprecise estimates for these countries, which might influence the assessment of associations between quit ratios and policies. We evaluated this by also running regression analyses with country-specific quit ratios weighted according to the national sample sizes. Application of these country weights did not change the outcomes of the regression analyses substantially or systematically, and the socioeconomic patterns remained unchanged. In this paper, we only present the results of the unweighted regression analyses.

RESULTS

Quit ratios among men varied from 22.4% in Lithuania up to 62.2% in Sweden among men (see table 3). Generally, the highest quit ratios were found in northern and western European countries, whereas lower quit ratios were found in southern and eastern European countries. Table 4 shows a similar geographical pattern for women.

Among both men and women, higher educated ever-smokers were more likely to have quit than lower educated ever-smokers. Absolute differences in quit ratios between high and low educated smokers were generally larger in the age group 25–39 years than in the age group 40–59 years. The absolute differences between high and low educated smokers among men aged 25–39 years differed from 2.4% in Ireland to 29.2% in Czech Republic. Large variations between countries in absolute gaps were also observed among men aged 40–59 years (from 1.7% in Portugal to 20.1% in England), among women aged 25–39 years (from 1.4% in Portugal up to 26.4% in Sweden) and among women aged 40–59 years (from 0.1% in Portugal to 20% in Ireland).

Relative inequalities were also largest in the age group 25–39 years (table 3). For men aged 25–39 years, the largest relative inequalities in quit ratios were found in the Czech Republic and Latvia. RIIs were smallest in Ireland and Sweden. For men aged 40–59 years, largest RIIs were found in Latvia, Lithuania and Estonia. Relative inequalities in this subgroup were smallest in Portugal and Germany. For women aged 25–39 years, largest inequalities in quit ratios were found in Latvia and Hungary, while Portugal had small inequalities in this subgroup (table 4). For women 40–59 years, the largest relative differences were observed in Denmark and Slovakia, while small inequalities were observed in Latvia and Portugal (see table 4). Although the size of the relative inequalities varied across countries, confidence intervals of the RIIs for most countries overlap. Therefore, the large differences between countries in size of inequalities might to an important extent be the result of chance fluctuations.

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Table 3 Educational inequalities in quit ratios—men

	All ages	25–39 years			40–59 years		
	Quit ratio	Quit ratio		RII* (95% CI)	Quit ratio		RII* (95% CI)
		High†	Low‡		High†	Low‡	
Finland	43.1	35.0	23.6	2.45 (1.70 to 3.52)	53.7	45.5	1.32 (1.15 to 1.50)
Sweden	62.2	59.9	46.8	1.61 (1.19 to 2.18)	65.6	57.2	1.45 (1.23 to 1.71)
Denmark	34.8	31.3	16.1	3.14 (2.10 to 4.71)	42.6	29.9	2.08 (1.68 to 2.58)
England	48.3	39.1	27.6	2.64 (1.83 to 3.82)	64.0	43.9	1.95 (1.67 to 2.28)
Ireland	37.9	29.7	27.3	1.44 (0.72 to 2.89)	57.1	39.4	1.84 (1.37 to 2.47)
Netherlands	48.6	46.1	30.4	2.52 (1.86 to 3.41)	58.2	43.2	1.70 (1.47 to 1.97)
Belgium	43.5	41.1	24.5	3.03 (2.23 to 4.13)	54.8	41.2	1.75 (1.49 to 2.04)
Germany	39.2	27.7	20.7	1.86 (1.08 to 3.20)	52.7	48.1	1.17 (0.93 to 1.47)
France	48.3	45.2	32.1	2.05 (1.48 to 2.85)	58.6	53.9	1.21 (1.02 to 1.44)
Italy	37.3	29.3	23.5	1.76 (1.48 to 2.10)	49.5	44.4	1.20 (1.12 to 1.29)
Spain	30.1	25.3	17.9	2.37 (1.57 to 3.59)	41.5	35.5	1.39 (1.14 to 1.69)
Portugal	33.8	25.9	19.2	1.65 (1.23 to 2.21)	46.2	44.5	1.10 (0.94 to 1.29)
Hungary	32.9	30.8	19.7	3.45 (1.98 to 6.00)	46.6	37.8	1.53 (1.19 to 1.96)
Czech Republic	37.4	51.2	22.0	7.63 (3.45 to 16.89)	48.3	37.5	2.01 (1.29 to 3.13)
Slovakia	42.5	41.6	25.7	1.90 (0.69 to 5.22)	51.9	47.3	1.39 (0.77 to 2.50)
Lithuania	22.4	19.7	11.1	3.28 (1.89 to 5.71)	33.8	22.1	2.13 (1.60 to 2.85)
Latvia	25.0	21.2	13.2	5.02 (1.13 to 22.26)	33.5	22.9	3.61 (1.39 to 9.38)
Estonia	28.0	25.9	21.4	3.32 (1.13 to 4.77)	35.3	24.9	2.13 (1.33 to 3.44)

*Relative Index of Inequality.

†High educated (upper secondary level or higher).

‡Low educated (no, primary or lower secondary level).

Quit ratios were positively associated with score on TCS (see fig 1). The association was positive for both the higher and lower educated group but was somewhat stronger among the higher educated group. The regression coefficients for high and low education were 0.65 (p value: 0.004) and 0.57 (p value 0.014), respectively. This implies that when the score on TCS increases by 10 points (that is, when a country implements more tobacco control policies), the cessation ratio increases in absolute terms by 6.5% and 5.7% in high and low educated groups, respectively. The positive association was found consistently for each age-sex group (see table 5). After

adjustment for GDP the associations slightly attenuated but remained in the same direction and were significant for lower educated men aged 25–39 years and for higher educated men and women aged 40–59 years. The results do not show consistently stronger associations among one of the two educational levels. The association between score on TCS and RII was not significant; regression coefficients were negative for both men aged 25–39 years and 40–59 years (respectively β : $-0.32/\beta$: -0.11) and younger women (β : -0.18), but positive for women aged 40–59 years (β : 0.27).

Table 4 Educational inequalities in quit ratios—women

	All ages	25–39 years			40–59 years		
	Quit ratio	Quit ratio		RII* (95% CI)	Quit ratio		RII* (95% CI)
		High†	Low‡		High†	Low‡	
Finland	45.8	44.0	20.4	2.32 (1.72 to 3.14)	51.9	38.4	1.70 (1.42 to 2.03)
Sweden	53.9	53.7	27.3	2.20 (1.57 to 3.08)	56.7	42.8	1.91 (1.54 to 2.37)
Denmark	37.6	38.4	24.8	2.78 (1.99 to 3.87)	41.9	24.4	2.61 (2.08 to 3.26)
England	48.3	45.8	25.3	2.74 (2.05 to 3.67)	58.6	42.3	1.68 (1.43 to 1.96)
Ireland	35.3	33.8	20.1	3.89 (1.85 to 8.19)	54.6	34.6	2.20 (1.55 to 3.13)
Netherlands	55.0	55.2	33.0	2.76 (2.14 to 3.56)	65.2	48.8	1.70 (1.49 to 1.93)
Belgium	50.3	50.6	35.6	2.51 (1.92 to 3.28)	59.4	42.7	1.90 (1.59 to 2.28)
Germany	40.4	35.7	22.6	3.10 (1.80 to 5.36)	51.3	42.2	1.67 (1.19 to 2.36)
France	53.1	55.7	37.1	2.19 (1.63 to 2.95)	58.0	52.7	1.35 (1.10 to 1.66)
Italy	38.5	37.9	30.3	1.86 (1.56 to 2.21)	44.6	38.4	1.31 (1.18 to 1.45)
Spain	30.1	31.3	21.2	3.16 (2.11 to 4.74)	36.0	31.4	1.51 (1.11 to 2.06)
Portugal	36.2	31.9	30.5	0.96 (0.69 to 1.33)	40.0	39.9	1.19 (0.84 to 1.67)
Hungary	33.4	41.0	17.9	4.60 (2.88 to 7.36)	44.5	30.4	2.05 (1.52 to 2.77)
Czech Republic	43.0	51.3	30.3	3.75 (1.62 to 8.65)	48.8	36.1	2.00 (1.10 to 3.61)
Slovakia	49.4	50.9	29.6	3.17 (1.01 to 9.90)	61.6	49.9	2.45 (1.07 to 5.61)
Lithuania	27.0	26.9	19.3	1.87 (0.97 to 3.60)	29.5	24.1	1.59 (0.80 to 3.14)
Latvia	26.9	31.6	13.0	5.57 (1.29 to 24.14)	31.2	17.8	1.14 (0.35 to 3.70)
Estonia	38.0	40.0	34.2	2.30 (1.25 to 4.23)	39.7	31.0	1.61 (1.02 to 2.54)

*Relative Index of Inequality.

†High educated (upper secondary level or higher).

‡Low educated (no, primary or lower secondary level).

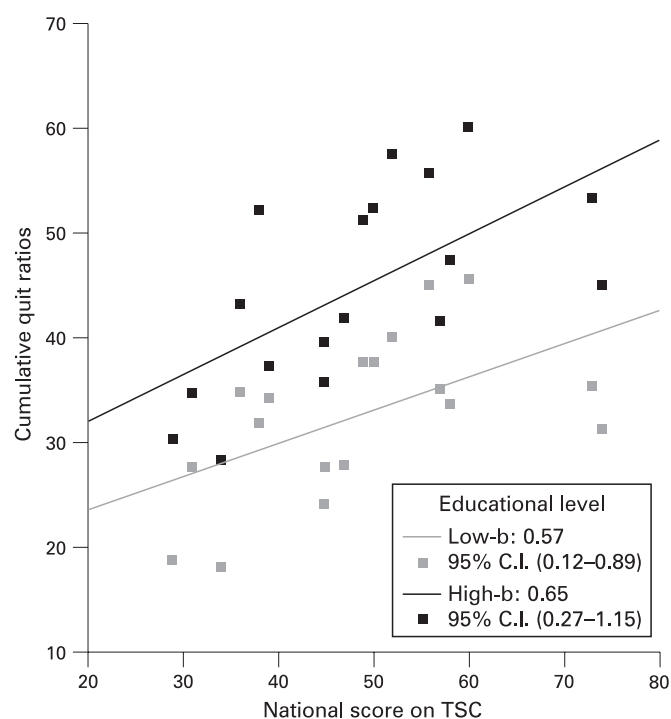


Figure 1 Scatter plot of 18 countries according to their score on the Tobacco Control Scale (TCS) and their quit ratios, for higher and lower educated smokers; men and women together.

The TCS is a combination of subscores on different tobacco control policies. Table 6 shows the associations with quit ratios for each subscore. Regression coefficients were standardised to facilitate comparisons between the subscores. Policies related to cigarette price showed the strongest association with quit ratios. Strong associations with price were found in both educational levels, although not in all age-sex groups. A comprehensive advertising ban showed the next strongest associations with quit ratios in most subgroups. In most age-sex groups, the association was stronger in the higher educated group compared to the lower educated group.

DISCUSSION

Summary of results

Higher educated smokers were more likely to have quit smoking than lower educated smokers. Educational inequalities were found for all age-sex groups and in all countries. Inequalities were generally larger in the age group 25–39 years compared to the group aged 40–59 years. Quit ratios in all subgroups were positively associated with the national score on the TCS. No consistent differences were observed between higher and lower educated smokers regarding the association of quit ratios with

score on TCS. Of all tobacco control policies of which the TCS is constructed, price policies showed the strongest association with quit ratios in both educational levels; next came advertising ban.

Limitations

An important limitation of our study is the lack of an appropriate time difference in reference periods for the measurements of smoking status and of tobacco control policies. Preferably, the measurement of quit ratios should be subsequent to the measurement of the tobacco control policy. Yet, countries were ranked on the TCS based on information from 2004–5. The surveys on the other hand were mostly conducted between the years 2000 and 2004. As there is no appropriate time lag between the measurements of tobacco control policies and smoking behaviour, we should be cautious in drawing conclusions about causality.

Nevertheless, countries with comprehensive tobacco control policies in 2005 are likely to have implemented a more comprehensive tobacco control policy already in the previous years. However, recently, large changes in tobacco control policies occurred in some areas, especially public place bans, public information spending and health warnings. As a result the ranking of countries on these three policy areas changed substantially. Comprehensive public place bans, for example, were implemented in some countries in 2003 to 2005.¹⁹ The ranking of countries on other policies like price, advertising bans and treatment has been stable over the years.¹⁹ A high correlation (0.66) was observed, for example, between tobacco prices in 1990 and 2005.²⁰ Therefore, we also performed the regression analyses with a stripped TCS, only including the subscores on price, advertising bans and treatment. With the “new” TCS none of the regression coefficients as presented in table 5 changed by more than 0.1 points and the pattern by educational level also remained unchanged—for example, the correlation of quit ratios for all ages with the “stripped” TCS (adjusted for GDP) was 0.49 (CI: 0.11 to 0.99) for men and 0.53 (CI: 0.08 to 1.04) for women compared to correlation with complete TCS (adjusted for GDP) of 0.47 (CI: 0.04 to 0.66) for men and 0.45 (CI: –0.07 to 0.66) for women. This supports the idea that the countries’ relative score on TCS in 2005 is a rough proxy for the comprehensiveness of tobacco control policies over a wider span of years. Furthermore, the association between quit ratios and the subscores on the TCS is important in this context, since it cuts down the score into different action points.

Since the study of the association with TCS is based on an ecological design, with 18 countries, we should be aware of confounding by other contextual factors. In the analyses we controlled for the potentially important confounder GDP. GDP did not substantially affect the association between quit ratios

Table 5 Regression coefficient score TCS in model with quit ratios or RII (95% CI)

	All ages	25–39 years		40–59 years	
		High	Low	High	Low
Men					
β^* (no control)	0.65 (0.37 to 0.93)	0.43 (0.20 to 0.66)	0.66 (0.29 to 1.03)	0.77 (0.54 to 1.00)	0.51 (0.19 to 0.83)
β^* (control for GDP)	0.47 (0.19 to 0.75)	0.34 (–0.08 to 0.76)	0.59 (0.33 to 0.85)	0.57 (0.36 to 0.78)	0.29 (–0.03 to 0.61)
Women					
β^* (no control)	0.55 (0.26 to 0.84)	0.43 (0.12 to 0.74)	0.22 (–0.03 to 0.47)	0.67 (0.36 to 0.98)	0.47 (0.17 to 0.77)
β^* (control for GDP)	0.45 (0.13 to 0.77)	0.40 (0.04 to 0.76)	0.25 (–0.04 to 0.54)	0.56 (0.23 to 0.89)	0.24 (–0.11 to 0.59)

*Regression coefficient.

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Table 6 Association between national quit ratios and subscores on TCS adjusted for GDP, by age-sex group and educational level

Subscores	All ages β^\dagger (95% CI)	25–39 years		40–59 years	
		Education		Education	
		High β^\dagger	Low β^\dagger	High β^\dagger	Low β^\dagger
Men					
Price	2.08 (–0.36 to 8.48)	0.94	2.13	2.83*	2.01
Advertising bans	1.33 (1.11 to 8.02)	1.37*	1.47*	1.19*	0.72
Public place bans	0.94 (–2.43 to 5.89)	0.73	2.12	1.02	0.77
Treatment	0.74 (–1.19 to 6.84)	0.61	0.83	0.98	0.35
Campaign spending	0.54 (–3.05 to 6.17)	0.09	0.46	0.89	–0.01
Health warnings	–0.40 (–7.32 to 2.31)	–0.13	–0.65	–0.32	–0.18
Women					
Price	2.07 (–1.09 to 8.66)	1.48	1.18	2.66*	2.45
Advertising bans	1.59 (1.39 to 8.67)	1.56*	1.22	1.42*	0.99
Public place bans	0.41 (–3.84 to 5.26)	0.34	0.24	0.89	0.34
Treatment	0.83 (–1.40 to 7.22)	0.90	0.46	1.16*	0.53
Campaign spending	0.54 (–3.52 to 6.41)	0.31	0.36	0.57	0.40
Health warnings	–0.42 (–9.51 to 3.43)	–0.19	–0.77	–0.29	–0.30

* $p < 0.05$.

†Standardised regression coefficient.

and the score on TCS. The association could also be a reflection of the smoking epidemic. In order to check for this type of confounding, we also adjusted in the analyses for the proportion of ever-smokers in each country. Ever-smoking ratio for men and women aged 25–59 was used as a rough proxy of the stage of the smoking epidemic in countries. The association between quit ratios and TCS did not change substantially after adjustment for ever-smoking ratios, neither did the pattern according to educational level—for example, after adjustment for ever-smoking there was a correlation of 0.46 (CI: 0.01 to 0.69) for men and 0.30 (CI: –0.16 to 0.57) for women. Since two potentially important confounders did not significantly affect the association, it is unlikely that the association between score on TCS and quit ratios in this study is completely due to factors unrelated to tobacco control policies.

The TCS is based on information about policies in 2005. Recently implemented policies are not incorporated, such as the ban on smoking in public places in many European countries. The impact of such policies might therefore be underestimated when using the current version of the TCS. Since we only have smoking data up to 2004, we were not able to study the impact of recently implemented policies, even if the TCS would allow for this. For similar reasons, we could not evaluate the potential impact of smoking cessation services, because these services have only recently been implemented systematically on a large scale in a number of European countries. Furthermore, our study (and the TCS) focused on nationwide tobacco control policies, whereas the availability and accessibility of smoking cessation services may have increased mostly at local levels. Future studies, using an updated TCS, should assess whether newly applied policy instruments are as effective or perhaps more effective than price and advertising bans.

Explanations

In all countries, relative differences in quit ratios between higher and lower educated smokers were smaller in the age group 40–59 years than in the age group 20–39 years. The smaller inequalities in the older age group could be an age effect. Several studies showed that smokers are, irrespective their educational level, more likely to have quit when they became older.^{21–23} If the

age-related increase in quit ratios is similar in both educational groups, the relative differences between high and low education among older age groups will become smaller. On the other hand, the difference in inequalities between age groups could also represent a cohort effect. This would suggest that the inequalities in smoking cessation in the older age group have not become smaller with the cohort growing older, but have always been relative small within older generations compared to younger generations. An Italian study indeed found cohort-specific changes in smoking cessation rates. Relative inequalities in smoking cessation in this study increased from a 23% difference between high and low education in the birth cohort 1940–9 to a 30% difference in the birth cohort 1960–9 among men. Among women, inequalities increased from a 13% difference to a 61% difference.²⁴ In Britain, smoking cessation rates among the non-manual men and women born after about 1955 decline slightly compared to previous birth cohorts, while the rates for men and women in manual classes increased.²⁵

Quit ratios were generally higher in northern and western European countries compared to southern and eastern European countries. Studies on smoking prevalence described a similar north-south gradient in the western part of Europe. (Eastern European countries were not included in previous international overviews).^{8, 26–28}) The smoking epidemic model also describes this north-south gradient in the diffusion of the smoking habit; higher educated men in northern Europe take the lead in the diffusion, lower educated women in southern Europe are the last to follow.²⁹ We found a comparable geographical pattern for smoking cessation, with the difference that not only southern Europe, but also eastern European countries lag behind. Our results suggest that changes in smoking cessation are, in addition to changes in smoking initiation, one of the mechanisms through which the smoking epidemic evolves. Especially in later stages of the smoking epidemic, quitting smoking may contribute to differences in smoking prevalence rates among subpopulations and nations.

We observed positive correlations between quit ratios and the national score on the TCS. Countries with a more developed and comprehensive tobacco control policy have higher quit ratios in both high and low educated groups. The higher quit

ratios might be a direct consequence of tobacco control policies. This would however not be an effect of the tobacco control policies that were measured with the TCS for 2005, but an effect of policies implemented in previous years. Most of the countries with comprehensive tobacco control policies in 2005 are likely already to have had more comprehensive policies in the 1990s or perhaps even earlier. The high correlation between tobacco price in 1990 and in 2005 of 0.66 (see the section "evaluation of data and methods") also supports this view.

The higher quit ratios in countries with comprehensive tobacco control policies could also partly be a consequence of a growing anti-tobacco environment in society. A growing negative attitude of people towards smoking, and sympathy with anti-tobacco policies like public place bans, will have a direct impact on smoking cessation. Smokers will be discouraged to continue smoking and those who try to quit will be supported. A comparative study by Fong *et al* showed that the ban on smoking in public places in Ireland led to more successful quit attempts and more favourable attitudes towards smoke-free laws.³⁰ Borland *et al* showed that the introduction of public place bans led to more smoke-free homes, which in their turn were related to more quit attempts.³¹

Of all subscores of the TCS, quit ratios were most strongly associated with price policies. This corresponds to the ratings of different tobacco control policies by the expert panel of the TCS and the World Bank, who both judged price policies to be the most effective and important tobacco control measures.¹⁻³² Several studies suggest that an increase in tobacco price is a highly effective policy to reduce tobacco consumption, especially among lower socioeconomic groups.³²⁻³⁵ Our results support the idea that price is effective, but we did not find a difference in impact between high and low education. This might be because we measured prevalence instead of consumption level. An increase in price mainly reduces the number of cigarettes smoked and not so much smoking prevalence rates.^{12, 36-38}

Quit ratios were also strongly associated with the subscore "advertising bans". This suggests that an advertising ban is one of the most effective tobacco control measures with regard to smoking cessation included in the TCS. Yet, an advertising ban may not be so important on its own (the experts allocated only 13 points to this policy in the TCS), but probably particularly important in combination with other elements of tobacco control policies. Comprehensiveness of tobacco control policies determines to an important extent the effectiveness of the policies in terms of smoking cessation.³⁹

Our data thus do not suggest that higher educated smokers benefited more from national tobacco control policies than did lower educated smokers. This does not correspond with the finding of earlier studies that observed a larger effect of incidental publicity campaigns among higher socioeconomic groups compared to lower socioeconomic groups.⁹⁻¹⁰ While it is likely that in the 1970s and 1980s higher educated smokers benefited more from the first nationwide tobacco control policies than did lower educated smokers, our results do not indicate a difference between educational groups in the effect of the more recent tobacco control policies.

Implications

Nationwide tobacco control policies seem to have a substantial effect on smoking cessation ratios, when comparing different countries. Tobacco control policies need to be comprehensive (including, among other options, price policies and bans on smoking advertisement) to reduce smoking prevalence in all

socioeconomic groups. At the same time, since the educational inequalities in quit ratios persisted irrespective of the extent to which national tobacco control policies have been implemented in different European countries, there is a need for a special effort to reduce not only absolute levels but also relative inequalities. Specific policies and interventions should aim to foster successful cessation among lower educated smokers. The literature shows that such cessation policies and interventions should be local, proactive, free of charge and directly targeted at low socioeconomic groups, to be effective.^{34-36, 40}

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What this paper adds

Studies have shown an effect of individual tobacco control measures on smoking behaviour. However, so far the effect of nationwide tobacco control policies on smoking behaviour has not yet been studied across countries. The Tobacco Control Scale (TCS) created the opportunity to compare many European countries in their efforts to reduce smoking rates and the association of these efforts with smoking prevalence in national populations. This study showed that countries with a more developed and comprehensive tobacco control policy have higher quit ratios. Price policies and advertising bans showed the strongest correlations with quit ratios. High and low educated groups seem to benefit equally from the nationwide tobacco control policies.

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