Addiction

RESEARCH REPORT

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The role of national policies intended to regulate adolescent smoking in explaining the prevalence of daily smoking: a study of adolescents from 27 European countries

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ABSTRACT

Aims This study seeks to examine whether contextual factors influence adolescents' daily smoking. A focus was placed on three modifiable policies operating at a national level, *non-smoking policy at educational facilities*, *price* and *minimum age for buying tobacco*. **Design** This study is based on a merged data set consisting of the 2001/02 Health Behavior in School-aged Children (HBSC) study and national-level data collected from the 2003 WHO European Tobacco Control Database and the World Development Indicators Database. HBSC is an international study including adolescents from 32 countries in Europe, Israel and North America. Data were analysed with multi-level hierarchical regression models. **Findings** The study found large differences in the prevalence of daily smoking among adolescents, and also large differences between boys and girls within some countries. The study found that smoking bans in schools were associated with lower odds ratios of daily smoking, which was the one positive association in the study. The study found no association between cigarette prices and adolescent daily smoking prevalence, and also the somewhat unexpected finding that having an age limit for allowing adolescents to purchase tobacco was associated with an increased risk of daily smoking. **Conclusions** There was an association between mandatory national bans on smoking and lower smoking prevalence. This should be confirmed by studies that examine whether mandatory bans are more rigorously implemented than voluntary bans. If this association is causal, introducing mandatory bans may reduce adolescent smoking prevalence. The findings that price was unrelated to smoking prevalence undermine findings elsewhere that adolescent smokers are more price-sensitive than adult smokers, but longitudinal studies are needed.

Keywords Adolescents, cross-national, daily smoking, policies.

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INTRODUCTION

Understanding the causes of young people's smoking and developing effective policies for youth tobacco control is a major goal of international public health. There is increasing recognition that tobacco prevention needs to consider different contextual levels, as the most robust explanatory algorithms on tobacco trajectories include interactions between individual factors, proximal environmental factors and contextual factors [1]. Flay & Clayton stress that the goal is a simultaneous consideration of multiple contexts interacting with individual-level factors to explain behavioural patterns [1].

Factors influencing adolescent smoking behaviour are many [2–5], and include national policies [6]. Policies are modifiable, and three of those are price (or national taxes) [6,7], age limit for buying tobacco and smoking restrictions at educational facilities [8–10]. In this cross-national study, we included data related to the economy,

because of the hypothesized relation between a country's stage of development and the prevalence of smoking [11,12].

The aetiology of smoking is best conceptualized as a complex multi-factorial process including economic, social and psychological determinants, and no single variable is a sufficient cause of smoking [13,14]. The economics literature on the relation between price of cigarettes and adolescent smoking shows generally that national taxes can play an important role in deterring adolescent smoking [15]. This knowledge serves as the backbone for the formulation of antismoking policies [16].

The evidence of the literature on the relation between restrictions in schools and adolescent smoking is also ambiguous, but it generally indicates that smoking policies may help to reduce adolescent smoking [8,10,17,18], and that school norms for tobacco use influence youth smoking [19]. The lack of consensus on the effect of policies to control adolescent smoking may depend upon different methodologies [20] or varying measurements of the outcome variable [6]. *Minimum age for buying tobacco* was included based on the hypothesis that countries with minimum age would have lower prevalence of smoking among adolescents, by preventing adolescents from purchasing cigarettes [13].

The present study examines how contextual conditions operating at the macro level influence adolescent smoking. Data are a merged data set consisting of 2001/02 Health Behavior in School-aged Children (HBSC) study [21] and national-level data collected from the 2003 World Health Organization (WHO) European Tobacco Control Database and the World Development Indicators Database. The HBSC standardizes methods and questions to optimize comparability. Macro level variables for 27 countries were included from two sources only (2003 WHO European Tobacco Control Database on policy variables and the World Development Indicators Database for macro-economic country characteristics). Daily smoking was used as the outcome to reduce misclassification by the variance in less-than-daily smoking, and because studies on the price elasticity of cigarettes in adolescents have indicated that light smokers are less sensitive to higher prices [20].

The study focuses upon the influence of three modifiable policy variables. The aim was to analyse the influence of *non-smoking policy at educational facilities*, *price* and *minimum age for buying tobacco* on adolescent smoking, while exploring for the first time the associations between other macro level variables, such as *adult smoking epidemiology* and *macro-economic country characteristics*. The inclusion of other macro level variables was conducted to adjust for their influence on the outcome, in order to asses the influence of the policy variables of primary interest.

METHOD

Health behaviour in school-aged children WHO collaborative study

HBSC is an international study of adolescents from countries in Europe, Israel and North America, conducted in collaboration with the WHO Regional Office for Europe, which collects data on social and health indicators as well as health behaviours. The study provides comparable data on young people's health and life-style from countries with different societal and political systems through use of a common protocol.

The HBSC study consists of repeated cross-sectional cluster sampled surveys among 11-, 13- and 15-year-old school children in representative samples of approximately 1500 students from each of the three age groups in schools among the participating countries. The students answer a standardized questionnaire during a school lesson after instruction from the teacher or researcher. HBSC has been collecting data on adolescents every fourth year since 1982. The 2001/02 HBSC study, on which the present paper is based, included 32 countries with a total of 162 323 students. Due to the relatively low proportion of daily smokers among 11-year-olds, the analyses were conducted on 13- and 15-year-olds only. The three separate HBSC countries, England, Scotland and Wales, were combined into a weighted United Kingdom sample, as the macro level variables were available for the United Kingdom only. Final analyses were conducted on 92 217 students from 27 countries. The number of students ranged from a minimum of 772 in Ireland to a maximum 4433 in the United Kingdom among boys [mean: 1646, standard deviation (SD): 778] and from 833 in Austria to 4572 in the United Kingdom among girls (mean: 1770, SD: 820). The proportion of daily smokers ranged from a minimum of 4% in Sweden to a maximum of 24% in the Ukraine among boys (mean: 12%, SD: 4%) and from 5% in Israel to 20% in Austria among girls (mean: 11%, SD: 4%). Further methodological issues related to the HBSC as a cross-national survey are discussed in a recent paper by Roberts and colleagues [22].

The present study is a multi-level analysis with an individual outcome, exposures measured at a contextual level and covariates at both individual and contextual level. In the process of analysis, three models were fitted using HBSC data merged with data at a national level from the 2003 WHO European Tobacco Control Database and the World Development Indicators Database.

In the HBSC, the students were asked how frequently they smoked, and the outcome chosen was daily smoking. Exposures and covariates were divided into three groups, and analysis consisted of three models with stepwise inclusion of each group of macro level variables. The

three groups were: (i) *national tobacco policy*; (ii) *adult tobacco epidemiology*; and (iii) *macro-economic country characteristics*. Values of the exposure variables are illustrated in Table 1 [23,24].

National tobacco policy

Three variables were included to analyse national tobacco policy. The hypothesis for their inclusion was described in the introduction.

Price was included as purchasing power parity (PPP) adjusted in $US, which is an exchange rate that equalizes the purchasing power of different currencies in their respective country for—in this case—a packet of cigarettes.

Adult tobacco epidemiology

Two covariates were included to take adult prevalence of smoking into account: (i) the *proportion of adult smokers*; and (ii) the *male/female ratio of adult smokers*. These variables were included based on the hypothesis that countries with a higher prevalence of adult smokers would have a higher prevalence of adolescent smokers [25]. The male/female ratio was considered as an additional proxy for the country's developmental stage with respect to the smoking epidemic model [11,12], thereby influencing the prevalence of adolescent smoking.

Macro-economic country characteristics

Two covariates were included to take the country's level of wealth and degree of inequality into account: (i) *gross national income* (GNI); and (ii) *Gini coefficient*, the latter being a measure of income inequality within countries. These variables were included based on the hypothesis that a lower prevalence of smoking was observed in more wealthy countries [26], and that there would be differences in the prevalence of adolescent smoking between countries with different income inequality [12]. A hypothesis has been raised that income distribution might explain some of the variations in mortality across countries with comparable GNI [27–29]. The mechanism is, however, largely unknown, but as smoking is a major risk factor we included the effect of income inequality on smoking to test its potential as confounding of the policy effects.

Non-smoking policy at educational facilities was summed into *ban* as a reference, which was compared to countries with *voluntary restriction*. *Minimum age for buying tobacco* was split into three categories (*no age limit*, *16 years* and *18 years*), as descriptive analyses prior to multi-level modelling revealed potentially contradictory results if dichotomizing this variable. All other variables were included as continuous variables in their absolute value, except for *GNI per capita*, which was divided by 1000, and *Gini coefficient*, which was multiplied by 100.

Statistical analysis

The macro level variables were included as continuous variables, with the exception of *minimum age for buying tobacco* and *non-smoking policy at educational facilities*. Having no minimum age for buying tobacco and having a smoking ban at an educational setting (compared to restriction) was used as a reference. The basis for the division was logistic regression analysis on the effect of each variable separately on the outcome.

Regression analysis with daily smoking as the outcome was conducted with stepwise inclusion of the three groups of contextual variables, and multi-level modelling was used to determine the effects (and confidence intervals) of each group of variables. Model 1 included the three variables on smoking policy, model 2 included this as well as the two variables on adult tobacco epidemiology and model 3 included all three groups of macro level variables.

Interaction terms were tested between gender and the three groups of macro level variables. Because most interactions terms showed significance, the stratification between genders was maintained. Individual confounders including age, gender, family socio-economic status (SES) and a ridit-transformed family affluence scale (FAS) [30], which is an index of material wealth used in the HBSC, were tested. None of the variables on family SES altered the estimates of the contextual variables, and were therefore not included in the final models. All analyses were adjusted for age group and stratified by gender.

The *median of the random odds ratio* estimate is a measure of the effect of the random country effect that is to be compared to the fixed effects of the model. Assuming that two countries are selected randomly, an odds ratio which compares the country with the highest risk to the country with the lowest risk can be calculated. This odds ratio statistic is a stochastic variable, as it depends upon two randomly selected countries. Conventional random effects models assume that the random effects measured at the log-odds scale are normally distributed. From this assumption we can calculate the median of the random odds ratio statistics defined as above. This measure is referred to as the MOR by Larsen and colleagues [31].

RESULTS

Gender showed no overall association with daily smoking, but the association with gender varied significantly between countries. In Austria and Germany, the occurrence of daily smoking was relatively high for both

Table 1 Country information on variables included in the analyses.

	*Tobacco policy**			*Adult smoking epidemiology**		*Macro-economic country characteristics†*	
	Non smoking policy at education facilities	*Minimum age for buying tobacco*	*Price in 2001 (retail price, PPP $US)*	*Proportion of adult daily smokers (%)*	*Male/female ratio of adult smokers*	*Gross National Income 2003 ($US per capita)*	*Gini coefficient*
Austria	Restriction (since 1996)	16 years	4.4	29.0	1.58	26 920	0.30
Belgium	Ban (since 1990)	None	3.9	31.0	1.39	25 870	0.25
Croatia	Ban (since 1999)	18 years	3.4	30.3	1.28	5 380	0.29
Czech Republic	Ban (since 1997)	18 years	3.8	19.5	2.11	7 160	0.25
Denmark	Restriction (since 1995)	None	4.9	28.0	1.16	33 620	0.25
Estonia	Ban (since 2001)	18 years	3.1	29.0	2.50	5 480	0.37
Finland	Ban (since 1977)	18 years	4.3	23.0	1.35	26 970	0.27
France	Restriction (since 1992)	None	3.9	27.0	1.57	25 220	0.33
Germany	Restriction (since 2002)	16 years	3.7	36.4	1.25	25 700	0.28
Greece	Ban (since 1980)	None	2.6	37.6	1.61	13 340	0.35
Hungary	Restriction (since 1999)	18 years	3.4	30.6	1.66	6 410	0.27
Ireland	Restriction (since 2002)	18 years	6.8	27.0	1.08	27 430	0.36
Israel	Ban (since 2001)	None	3.2	30.4	1.75	16 330	0.36
Italy	Ban (since 1975)	16 years	3.0	25.0	1.86	21 630	0.36
Latvia	Ban (since 1997)	18 years	0.8	29.2	3.78	4 380	0.34
Lithuania	Ban (since 1999)	18 years	2.0	32.0	3.26	4 540	0.32
Netherlands	Ban (since 2002)	16 years	3.7	30.0	1.22	26 650	0.31
Norway	Ban (since 1996)	18 years	6.3	29.6	0.99	43 140	0.26
Poland	Ban (since 1999)	18 years	1.7	32.0	1.60	5 270	0.34
Portugal	Restriction (since 1983)	None	4.0	17.2	4.59	11 870	0.39
Russia	Ban (since 2001)	18 years	0.3	36.4	6.52	2 590	0.31
Slovenia	Ban (since 1996)	15 years‡	2.1	23.7	1.39	11 870	0.28
Spain	Ban (since 1988)	16 years	2.2	31.6	1.59	17 450	0.33
Sweden	Ban (since 1993)	18 years	3.8	19.0	0.85	28 950	0.25
Switzerland	Partial restriction (since 1995)	None	2.9	33.0	1.39	41 900	0.33
United Kingdom	(No restriction in 2002)	16 years	7.6	27.0	1.08	28 200	0.36
Ukraine	Ban (since 1998)	18 years	1.5	34.0	4.14	980	0.29

*WHO European Country Profiles on Tobacco Control, 2003. †World Development Indicators Database, World Bank. ‡Included with the 16-year-olds.

boys and girls (in Austria, 15.8% for boys and 20% for girls; in Germany, 18.2% for boys and 19.4% for girls), whereas Estonia, Lithuania and the Ukraine had most smokers among boys (15.5%, 16.7% and 23.6%, respectively), and Finland, Czech Republic and the United Kingdom had most smokers among girls (15%, 14% and 13%, respectively). The lowest overall prevalence of daily smoking was found in Greece (6.1% for boys and 6.2% for girls) and Israel (7.5% for boys and 4.8% for girls), whereas Sweden had the lowest prevalence among boys (4.2%) and Lithuania (7.5%), together with Poland (7.9%), had the lowest prevalence among girls. There was no significant association with individual SES of the family in the multivariate analyses.

Table 1 shows the macro level data which were merged with HBSC data. *Non-smoking policy at educational facilities* varied from bans since 1977 in Finland to restrictions introduced in the year of data collection. Data from the United Kingdom showed that they had voluntary restrictions at the year of data collection, and they were included as such.

Price varied from $US 0.3 in Russia, and to $US 7.6 in the United Kingdom. In countries that had a minimum age for buying tobacco, that minimum age was either 16 or 18 years, except Slovenia, where it was 15 years. For simplicity, Slovenia was pooled with countries that used 16 years as an age specification. Seven countries had no policy on minimum age. The lowest proportion of adult smokers was found in Portugal, with 17.2%, and the highest in Greece, with 37.6%. When comparing the proportions of smokers for men and women, Norway and Sweden were the two countries where women smoked more than men, with a male/female ratio of 0.99 and 0.85, respectively. The highest ratio was in Russia with 6.52.

GNI varied between 980 $US per capita in Ukraine to 43 140 $US per capita in Norway. The *Gini coefficient* was lowest (meaning least inequality) with a score of 0.25 in Belgium, Czech Republic, Denmark and Sweden, and highest in Portugal with a score of 0.39 (Table 1).

Young people in countries that had a voluntary ban on smoking in schools compared to countries with a national ban were more likely to be daily smokers (Table 2). The OR was 1.49 [95% confidence interval (CI): 1.01–2.18] in boys and almost the same in girls, at 1.48 (95% CI: 1.11–1.98). There was no association between higher prices and daily smoking in either boys or girls. Young people in countries with no minimum age for purchasing tobacco had the lowest risk of smoking, followed by countries with a minimum age of 18 years. Young people in countries with a minimum purchase age of 16 years were at the highest risk, and this was statistically significant at 1.52 (95% CI: 1.02–2.26) for boys and 1.84 (95% CI: 1.37–2.49) for girls.

Additionally, the study revealed no significant association between *macro-economic country characteristics*, except for the *Gini coefficient* for girls. For this variable, an increase of 0.01, representing higher inequality, showed an OR of 0.97 (95% CI: 0.95–0.99), meaning that higher inequality was associated with a lower OR of daily smoking among girls.

The random country effect [27] was reduced from 1.49 in model 0 to 1.40 in model 3 for boys and from 1.47 in model 0 to 1.28 in the final model for the girls, indicating that the variables included did reduce country level variance somewhat, but a country variance still remained.

DISCUSSION

In this study, we tested the cross-national associations of adolescent daily smoking by policies and country-level characteristics in 27 countries in Europe. Across this diversity of political and cultural settings, we found large differences in the prevalence of daily smoking among adolescents, and also large differences within countries when comparing boys and girls. The study found that a mandatory national ban on smoking in schools was associated with lower risk of daily smoking when compared to voluntary restrictions. This finding contributes to the literature, and supports the existing evidence that restrictive policies prevent adolescents from smoking [8,17,18]. Because this policy is modifiable and easy to implement, this knowledge will hopefully encourage educational settings to instigate bans against smoking.

This study found that having an age limit at which young people could buy tobacco was associated with a higher prevalence of daily smoking. One potential explanation is that recent policy changes might have been introduced because of the high prevalence of adolescent smoking.

We found no association between price and adolescent daily smoking. Many studies have shown that most smokers are price-sensitive [32], and it has been claimed that young people are relatively more sensitive to higher prices [33,34]. This comparable study of 27 countries, however, could not confirm significantly earlier findings that price is associated with adolescent smoking [6,35], given adjustment for contextual variables. There are two potential explanations for this. First, the effect of price may be clouded by intercountry variables that we did not measure and adjust for in the analysis. This is supported by the residual intercountry variation. Secondly, it could be that some countries markedly changed their tax on cigarettes just prior to the study, and had not seen falls in prevalence at the time of the survey.

A concern common to all policy variables in our study is that they reflect legislation rather than practice. A

Table 2 Odds ratio (OR) (by multi-level modelling) of daily smoking with 95% confidence interval.

Variable		*Category*	*Univariate **	*Model 0*	*Model 1*	*Model 2*	*Model 3*
Boys							
Age group		13–14-year-olds	1	1	1	1	1
		15–16-year-olds	3.70, 3.47–3.95	3.70, 3.47–3.95	3.71.3.47–3.95	3.71, 3.47–3.95	3.71, 3.47–3.95
Tobacco policy	Non-smoking policy at educational facilities	Ban	1		1	1	1
		Voluntary restriction	1.07, 0.76–1.52		1.59, 1.12–2.26	1.48, 1.01–2.16	1.49, 1.01–2.18
	Minimum age	None	1		1	1	1
		16 years	1.39, 0.90–2.14		1.52, 1.04–2.21	1.55, 1.06–2.27	1.52, 1.02–2.26
		18 years	1.40, 0.95–2.05		1.58.1.11–2.25	1.53, 1.06–2.20	1.38, 0.90–2.12
	Price (PPP $US)	$1 increase	0.91, 0.83–1.00		0.86, 0.78–0.95	0.91, 0.80–1.04	0.94,0.81–1.10
Adult tobacco	Proportion of adult smokers	1% increase	1.02, 0.99–1.06			1.01, 0.98–1.04	1.01, 0.98–1.05
epidemiology	Male/female ratio	Increase of 1 unit	1.14, 1.02–1.28			1.08, 0.94–1.24	1.09, 0.93–1.27
Macro-economic country	GNI per capita/1.000	Increase of 1 unit	0.99, 0.98–1.00				0.99, 0.98–1.01
characteristics	Gini × 100	Increase of 1 unit	1.00, 0.97–1.04				0.99, 0.96–1.02
	Random country effect (MOR)			1.49, 1.29–1.65	1.39, 1.21–1.59	1.39, 1.21–1.53	1.40, 1.20–1.56
Girls							
Age group		13–14-year-olds	1	1	1	1	1
		15–16-year-olds	4.05, 3.79–4.33	4.05, 3.79–4.33	4.05, 3.79–4.33	4.05, 3.80–4.33	4.05, 3.79–4.33
Tobacco policy	Non-smoking policy at educational facilities	Ban	1		1	1	1
		Voluntary restriction	1.51, 1.12–2.02		1.45, 1.07–1.97	1.47, 1.06–2.04	1.48, 1.11–1.98
	Minimum age	None	1		1	1	1
		16 years	1.72, 1.18–2.52		1.80, 1.30–2.49	1.81, 1.29–2.53	1.84, 1.37–2.49
		18 years	1.09, 0.78–1.52		1.29, 0.95–1.75	1.28, 0.93–1.76	1.20, 0.87–1.66
	Price (PPP $US)	$1 increase	1.11, 1.01–1.21		1.04, 0.96–1.13	1.03, 0.92–1.15	1.03, 0.92–1.15
Adult tobacco	Proportion of adult smokers	1% increase	0.98, 0.95–1.01			0.99, 0.96–1.01	0.99, 1.97–1.01
epidemiology	Male/female ratio	Increase of 1 unit	0.93, 0.83–1.05			1.01, 0.89–1.14	1.07, 0.95–1.20
Macro-economic country	GNI per capita/1.000	Increase of 1 unit	1.01, 1.00–1.03				1.00, 0.99–1.02
characteristics	Gini × 100	Increase of 1 unit	0.98, 0.95–1.01				0.97, 0.95–0.99
	Random country effect (MOR)			1.47, 1.29–1.62	1.32, 1.22–1.56	1.33, 1.18–1.45	1.28, 1.24–1.33

*Univariate estimates are crude estimates which are adjusted for the variable and age group.

study from the United Kingdom confirms this, as Moore and colleagues found that teenage smoking was associated with degree of policy enforcement [17].

This study found no association between adolescent and adult smoking prevalence. The smoking epidemic model, proposed by Lopez and adapted by others [11,12], postulates that developed countries follow four identifiable stages in the tobacco epidemic, which has been confirmed by many studies using adult subjects. Whether adolescent smoking follows the same trajectory has not been examined.

A general finding for both genders was that MOR in the final model was still relatively high, being 1.40 for boys and 1.28 for girls, indicating that although estimates were somewhat reduced by our analytical models, especially for girls, there was still a country variance to be explained. It is possible that by including other known risk factors for adolescent smoking, the residual inter-country variation would be reduced. Furthermore, not including these variables may mean that the estimates of policy variables we did include are possibly confounded, and this must be considered when interpreting our results. However, not all HBSC country surveys include these data and hence their inclusion was not possible.

Tobacco control policies are probably the most important element in reducing the prevalence of adolescent smoking [36]. However, one policy cannot be successful in itself [36], and more policies are potentially strengthening to each other [10]. Bans can be implemented nationally or locally, and schools can modify policies to suit their circumstances. Because smoking among adolescents is highly prevalent, the health benefit of effective policies is considerable. Our data cast some doubt on the effectiveness of commonly implemented tobacco control policies aimed at young people, and further investigations using longitudinal designs are necessary to investigate their effectiveness further.

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