The role of parental smoking on adolescent smoking and its social patterning: a cross-sectional survey in six European cities

Joana Alves[1], Julian Perelman[1], Victoria Soto-Rojas[2,3], Matthias Richter[4], Arja Rimpelä[5], Isabel Loureiro[1], Bruno Federico[6], Mirte A.G. Kuipers[7], Anton E. Kunst[7], Vincent Lorant[2]

[1]Escola Nacional de Saúde Pública, Universidade Nova de Lisboa, Avenida Padre Cruz, 1600-560 Lisbon, Portugal
[2]Institute of Health and Society, Université Catholique de Louvain, Clos Chapelle aux Champs 30.05, 1200 Brussels, Belgium
[3]PROESA, Universidad Icesi. Calle 18 No. 122-135 Pance, Casa Rocha segundo piso – Cali, Colombia
[4]Institute of Medical Sociology, Martin Luther University Halle-Wittenberg, Magdeburger Str. 8, 06097 Halle (Saale), Germany
[5]School of Health Sciences and PERLA - Tampere Centre for Childhood, Youth and Family Research, FIN-33014, University of Tampere, Tampere, Finland
[6]Department of Human Sciences, Society and Health, University of Cassino and Southern Lazio, Urban Area of Folcara, 03043 Cassino (FR), Italy
[7]Department of Public Health, Academic Medical Center, University of Amsterdam, PO Box 22660, 1100 DD Amsterdam, The Netherlands
Address correspondence to Joana Alves, E-mail: joana.alves@ensp.unl.pt

ABSTRACT

Background Several studies have observed socio-economic (SE) inequalities in smoking among adolescents, but its causes are not fully understood. This study investigates the association between parental and adolescent smoking, and whether this association is socially patterned.

Methods We used data from a survey administered in 2013 to students aged 14–17 years old of six European cities ($n = 10\,526$). Using multilevel mixed-effects logistic regression, we modelled the probability of being a daily smoker as a function of parental smoking and SE status. We tested whether the smoking association differed across social strata.

Results The prevalence of parental smoking was higher in low SE status adolescents. Boys and girls were more likely to smoke if they have a father [boys: adjusted odds ratio (AOR) = 1.90, 95% CI = 1.47–2.46; girls: AOR = 1.42, 95% CI = 1.09–1.86] and mother (boys: AOR = 1.77, 95% CI = 1.35–2.31; girls: AOR = 3.36, 95% CI = 2.56–4.40) who smoked. Among boys, the odds of smoking when having a smoking parent were higher in lower SE classes. However, this was not statistically significant, nor was it observed among girls.

Conclusions Adolescents are more likely to smoke when their father and mother smoke. Although the susceptibility to parental smoking was similar across social classes, SE differences in parental smoking contribute to the transmission of SE inequalities in smoking.

Keywords adolescent, adolescent behaviour, family, inequality, smoking, socio-economic

Introduction

There is a large body of evidence of socio-economic (SE) inequalities in smoking in adolescence. Most studies report that smoking is more prevalent among adolescents from low SE groups.[1] The SE status (SES) is associated with smoking initiation in young people and a greater likelihood of adolescents to become daily smokers.[2] Additionally, a recent study has shown that the SE inequalities in smoking among adolescents have been rising.[3] Adolescent smoking is a matter of concern because smoking behaviour that starts in adolescence usually persists thereafter, contributing to endless intergenerational cycles of nicotine dependence, tobacco-related diseases and premature mortality.[4] Despite this consistent evidence, there is no convincing explanation of why inequalities in smoking emerge at an early age. Among the possible causes, parental modelling and attitudes appear in the first place. A major risk of adolescents' smoking initiation is the imitation of their

Joana Alves, Research Assistant
Julian Perelman, Professor of Health Economics
Victoria Soto-Rojas, Professor of Public Health
Matthias Richter, Professor of Medical Sociology
Arja Rimpelä, Professor of Public Health
Isabel Loureiro, Professor of Public Health and Health Promotion
Bruno Federico, Associate Professor in Public Health
Mirte A.G. Kuipers, Post-doctoral Researcher
Anton E. Kunst, Professor of Social Epidemiology
Vincent Lorant, Professor of Medical Sociology

parents' smoking behaviour and that observation of parental smoking is associated with adolescent smoking and heavy smoking in early adulthood.[4–7] This relationship remains even when controlling for peer influences.[8] Besides, having both parents smoking more than doubles the risk of smoking.[9–12] This risk is smaller when parents are former smokers or declining smokers; and the earlier the parents quit smoking, the lower the risk of adolescent's smoking.[10,12,13] Several reasons why smoking is transmitted across generations were identified in the literature: (i) contradicting messages (smoking parents simultaneously saying that smoking is dangerous to health), (ii) parents easing adolescent's access to tobacco products and (iii) imitation of parents' smoking behaviours by role modelling.[4,13,14] Additionally, shared genetic traits may include addiction profiles, and nicotine or drug responses.[15,16]

The objective of this paper is to investigate how parental smoking contributes to the SE inequalities in adolescent smoking. On the one hand, the parent–child transmission is expected to contribute to inequalities simply because the adolescents from lower social classes are more susceptible to parental smoking. On the other hand, if parents from low SES are more prone to influence their children's smoking habits, the contribution of parent–child transmission to inequalities might be greater than expected, since adolescents from low SE backgrounds would be more susceptible to parents' smoking habits. A greater vulnerability among the worse-off may occur for at least three reasons: (i) they may receive less information from parental and non-parental sources; (ii) low-educated parents may impose less restrictive norms on their children's tobacco use, and adopt less restrictive norms in regard to their own smoking behaviour, for example smoking in front of their children; and (iii) they may play a less central role in friendship ties, having a lower freedom of choice among friends, and a greater vulnerability to influences. This study tests whether the association between parent and child smoking varies by SES.

Methods

Data

We used data from the SILNE survey (Smoking Inequalities—Learning from Natural Experiments), a self-administered questionnaire applied in 2013 to students of adolescents aged 14–17 from two grades of 50 secondary schools in six European cities: Namur (Belgium), Tampere (Finland), Hannover (Germany), Latina (Italy), Amersfoort (Netherlands) and Coimbra (Portugal), $n = 11\,015$. Cities were selected to be of medium size, be linked to the tertiary sector and have an average income close to the national average. Participating schools were selected from the local register of schools. Schools were stratified into two groups: lower versus higher SES. This status was attributed on the basis of the school type (vocational or general schools), or of the ranking of the school by the educational authorities, or of the area's SE characteristics. The sampling size was computed to estimate a regular smoking proportion difference of 15% from high SES to 20% from low SES (alpha = 5% and beta = 20%).

The survey was applied between January and November 2013, and had a participation rate of 79.4%.

Ethical approval from local or national authorities was requested and obtained in each country. Detailed methods and ethical information can be found in Lorant *et al.*[17] Questionnaires with a high number of missing variables, i.e. >20 missing answers, were dropped. Although the target group was aged 14–17, the classes that we surveyed included students older than 17 years old, which we opted to remove from our sample given that they can be considered as adults. The final sample included 10 526 observations.

Variables

Measures for smoking

The main variable of interest was daily smoking, which was defined as smoking at least one cigarette a day in the last 30 days.[18] This variable results from the positive answer to the question 'have you ever tried cigarette smoking, even just a few puffs?', jointly with the mention that they smoked more than one cigarette per day when questioned 'how many cigarettes have you smoked during the last 30 days ?'. For the latter, the available options were 'none', '1–2 cigarettes during the last 30 days', '1–2 cigarettes per week', '1–5 cigarettes per day', '6–10 cigarettes per day (about 1/2 a pack total)', '11–20 cigarettes per day (about 1 pack total)', '21–30 cigarettes per day' and 'more than 30 cigarettes per day'.

Parental smoking status was assessed by the question 'does any member of your household smoke cigarettes?', with options 'yes', 'no', and 'not applicable' for each potential member of the household. We created two binary variables for smoking status of the biological parents that were members of the household, namely for maternal smoking and paternal smoking (yes = 1, no = 0).

Further analyses were performed using alternative smoking measures (see below). Experimental smoking was defined as trying cigarette smoking, having smoked only one cigarette, not having smoked or smoked 1 to 2 cigarettes in the last 30 days or having smoked only a few times (yes = 1, no = 0).[18] Smoking in the last 30 days is a variable that equals one when adolescent smoked at least one cigarette in the last 30 days, and zero otherwise. Smoking at least weekly was defined as smoking at least one cigarette per week in the last 30 days

(yes = 1, no = 0). Nicotine dependence was a continuous variable based on the Stanford Dependence Index.[19] This index has previously showed good reliability and validity against smoking intensity, and is therefore able to measure aspects of nicotine dependence among adolescents.[19–21] This variable is created as the sum of scores (0–5) of the questions: 'when you are in a place where smoking is not allowed, is it difficult for you not to smoke?', 'do you smoke more in the morning than during the rest of the day?', 'do you smoke even when you are really sick?', 'how deeply do you inhale the smoke?' and 'how soon after waking up in the morning do you smoke your first cigarette?'.

Measures for the SES

Educational level of parents was assessed by the questions 'what is the highest level of schooling your father/mother attended?'. As the education levels differed across countries, we created three categories: high, medium and low. Note that a category 'other school leaving certificate' was available only for Germany but included a very small number of cases, so it was not used in the analysis ($n = 12$ for father and $n = 16$ for mother). More information about the education questions and construction of education variables is provided in Supplementary data, Appendix A.

The Subjective Social Position (SSP) corresponded to the 10-category answers to the question 'imagine that this ladder pictures how country society is made up. Fill in the circle that best represents where your family would be on this ladder.' This variable was recoded in country-specific tertiles, given the low number of cases in some categories.

The Family Affluence Scale (FAS) is a widely used instrument for measuring SE background.[22] It gathers information on four questions: 'does your family own a car, van or truck?', 'do you have your own bedroom?', 'how many computers/ laptops/ tablets does your family own?' and 'during the past 12 months, how many times did you travel away on holiday with your family?'. The sum of these items was categorized into country-specific tertiles.

Other covariates

The variable 'living without father' was dichotomous with a value one if the adolescent lived with her mother and not with her father, and zero otherwise. The variable 'living without mother' was constructed similarly. The reasons for the absence of parents in the family are unknown. We also considered peer smoking, measured by the number of friends that smoke among the up-to-five best friends nominated by the respondent. The variable was then transformed into a binary response that equalled one if the adolescent had one or more than one best friend who smoked, and zero otherwise.

We finally included a variable for academic achievement, computed as the country-specific tertiles from the question 'which of the following best describes your marks during the past year?'. More information about educational achievement questions and how variables were constructed are available in Supplementary data, Appendix B.

Analysis

We used multilevel mixed-effects logistic regression to model the probability [adjusted odds ratio (AOR)] of the adolescent to be a daily smoker as a function of parental smoking (maternal and paternal smoking), SES (subjective social status, FAS, parental education and academic achievement) and family and social context (live without mother, live without father, friends' smoking), adjusting for the age and stratified by sex. This was the base model. The use of a multilevel (hierarchical) model is justified by students being grouped/nested in countries and schools. The students' clustering must be adjusted for in the analysis to account for the fact that residuals are potentially correlated within clusters, hence violating the assumption of independence of the observations.[23]

The effect of SES on the association between parents and child smoking was tested by studying the interactions between parental smoking status and the SE variables. The interactions were introduced separately into the base model. Additionally, we performed a stratified analysis for the different SE groups.

Sensitivity analysis

We replicated the base model and interactions for different measures of smoking: experimental smoking, smoking in the last 30 days, smoking at least weekly and nicotine dependence. The latter was modelled with ordinary least squares, since it is a continuous variable, while the others were modelled with logistic regressions.

All the analyses were conducted with Stata version 13 (StataCorp LP, College Station, TX, USA).

Results

Descriptive statistics are presented in Table 1. Most of the students were aged 15–17 years old; 13% of the girls and 15% of the boys smoked daily; 30% of the students reported that his or her father smoked; and >20% of students reported that their mother was a smoker. Figure 1 shows that the prevalence of parental smoking was significantly higher among low SES adolescents ($P < 0.000$); in other terms, if parents' and children's smoking behaviours are associated, the SE inequalities in smoking will naturally reproduce across generations.

Table 2 summarizes the results of the multivariate analyses. There was no evidence of multicollinearity since the

Table 1 Descriptive statistics of the sample

Variables	*Girls, n (%)*	*Boys, n (%)*
Total population	5496 (52)	4987 (48)
Age		
<15 years	1480 (27)	1211 (24)
15–17 years	4007 (73)	3757 (75)
Smoking		
Daily smoker	725 (13)	747 (15)
Parental smoking		
Paternal smoking	1443 (30)	1326 (30)
Maternal smoking	1177 (24)	1032 (23)
Family and peer context		
Live without father	1234 (23)	969 (20)
Live without mother	193 (4)	204 (4)
Friends smoke	2055 (37)	1950 (39)
City		
Coimbra (PT)	886 (16)	859 (17)
Amersfoort (NL)	951 (17)	930 (19)
Latina (IT)	1218 (22)	817 (16)
Hannover (DE)	709 (13)	699 (14)
Tampere (FI)	739 (13)	744 (15)
Namur (BE)	993 (18)	938 (19)
Academic achievement		
Low	2932 (54)	3153 (65)
Medium	1499 (28)	1066 (22)
High	990 (18)	640 (13)
Subjective social position		
Low	2438 (45)	2046 (42)
Medium	1855 (35)	1753 (36)
High	1080 (20)	1066 (22)
Family Affluence Scale		
Low	2853 (52)	2497 (50)
Medium	1664 (30)	1558 (31)
High	979 (18)	932 (19)
Parental education		
Father—low	1160 (26)	1007 (25)
Father—medium	1747 (39)	1572 (39)
Father—high	1582 (35)	1484 (37)
Mother—low	1000 (21)	814 (20)
Mother—medium	1944 (41)	1754 (43)
Mother—high	1763 (37)	1549 (38)

independent variables were not highly correlated (they were all lower than or equal to 0.7), and the variance inflation factor was lower than 10 (1.5).[23] Among boys, the likelihood of smoking was associated with paternal smoking (AOR = 1.90, 95% CI = 1.47–2.46), as well as maternal smoking (AOR = 1.77, 95% CI = 1.35–2.31). As for girls, the likelihood of smoking was also higher when they had a smoking father (AOR = 1.42, 95% CI = 1.09–1.86) and even greater

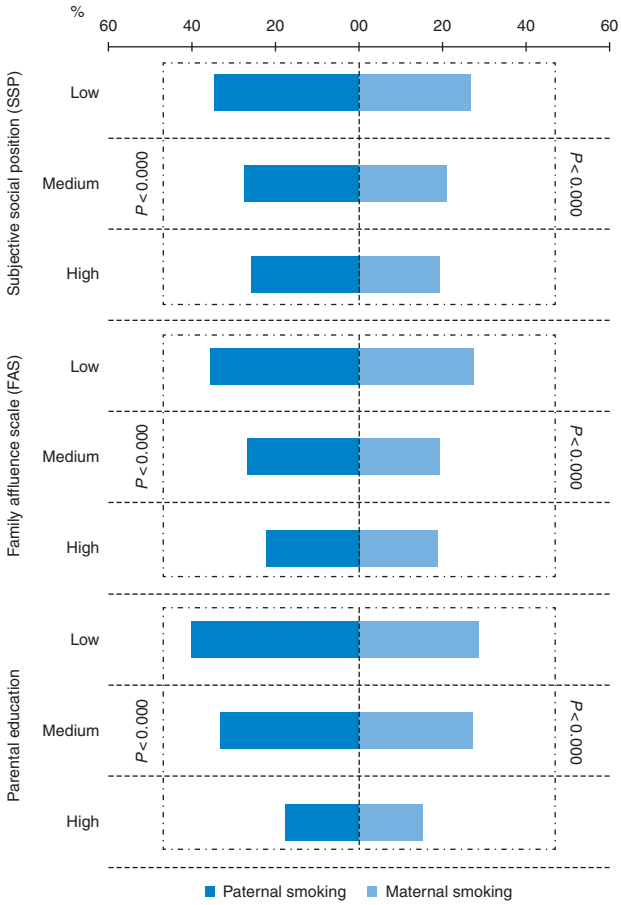

Fig. 1 Prevalence of paternal and maternal smoking according to SE variables. *P* values for the qui-squared test for identical distribution of observations between classes.

when having a smoking mother (AOR = 3.36, 95% CI = 2.56–4.40). Boys and girls having more than one smoking best friend were more likely to smoke (boys: AOR = 4.22, 95% CI = 3.30–5.38; girls: AOR = 4.75, 95% CI = 3.62–6.24). Among the SE variables, only the academic achievement had a significant association with smoking; lower grades increased the risk of smoking (boys: AOR = 2.83, 95% CI = 1.67–4.79; girls: AOR = 8.66, 95% CI = 4.28–17.51, for worst academic achievement compared with best).

The results for the logistic regressions with interactions between paternal smoking and SE variables are presented in Table 3. For boys, most of the odds of smoking when having a smoking parent were higher in lower SE classes, but did not reach statistical significance. For girls, the interactions were also not significant. For girls, the AORs for most interactions were below one in lower SE categories, meaning that the association between parental smoking and adolescent smoking was weaker in low SES adolescents.

Supplementary data, Appendix C presents the AORs for daily smoking stratified by SE variables for boys and girls,

Table 2 Multivariate multilevel mixed-effects logistic regression for the association between daily smoking and SE variables, stratified by sex

Daily smoking	*Boys* *AOR [95% CI]*	*Girls* *AOR [95% CI]*
Age		
<15 years; reference	1	1
15–17 years	2.51 [1.75; 3.60]	2.19 [1.52; 3.15]
Parental smoking		
Paternal smoking	1.90 [1.47; 2.46]	1.42 [1.09; 1.86]
Maternal smoking	1.77 [1.35; 2.31]	3.36 [2.56; 4.40]
Family and peer context		
Live without father	1.67 [1.25; 2.23]	1.43 [1.05; 1.95]
Live without mother	1.72 [0.98; 3.00]	2.13 [1.16; 3.93]
Friends smoke	4.22 [3.30; 5.38]	4.75 [3.62; 6.24]
Academic achievement		
Low	2.83 [1.67; 4.79]	8.66 [4.28; 17.51]
Medium	1.35 [0.76; 2.41]	4.21 [2.02; 8.75]
High; reference	1	1
Subjective social position		
Low	0.95 [0.69; 1.32]	1.09 [0.76; 1.56]
Medium	0.83 [0.61; 1.13]	1.04 [0.73; 1.47]
High; reference	1	1
Family Affluence Scale		
Low	0.77 [0.56; 1.06]	0.72 [0.50; 1.04]
Medium	0.81 [0.59; 1.13]	0.92 [0.64; 1.32]
High; reference	1	1
Parental education		
Father—low	0.86 [0.59; 1.23]	1.03 [0.69; 1.54]
Father—medium	0.76 [0.56; 1.04]	0.90 [0.63; 1.29]
Father—high	1	1
Mother—low	1.15 [0.78; 1.69]	1.03 [0.68; 1.55]
Mother—medium	1.44 [1.07; 1.94]	1.10 [0.79; 1.55]
Mother—high	1	1
Intercept: general	0.01 [0.01; 0.02]	0.00 [0.00; 0.01]
Intercept: city	0.21 [0.08; 0.57]	0.33 [0.12; 0.88]
Intercept: school	0.22 [0.10; 0.48]	0.57 [0.38; 0.85]

respectively. In all strata, the likelihood of smoking was higher when the father and mother were smokers. The stratified analysis confirmed the absence of noteworthy differences between SES strata in the likelihood of smoking daily when parents smoke, for either boys or girls. In line with the interaction analyses, the 95% confidence intervals for estimates for different SE strata were overlapping with each other.

Results for other measures are presented in Supplementary data, Appendix D. Smoking experimentation was not related with parental smoking. Contrarily, the other three measures, smoking in the last 30 days, smoking at least weekly and nicotine dependence, were related with parental smoking. None of the interactions of parental smoking with SE variables were significant for smoking experimentation, smoking in the last 30 days or smoking at least weekly. For nicotine dependence, the interactions were similarly not significant among girls and were significant for only three SE variables for boys. To summarize, the interactions were significant in only 3 out of 48 comparisons, confirming earlier results.

Discussion

Main finding of this study

This study confirmed that adolescents are more likely to smoke when their father and mother smoke. Because the prevalence of parental smoking is greater among the worse-off, the association between parents' and children's smoking behaviours contributes to SE inequalities in adolescent smoking: parental smoking renders SE inequalities sticky across generations. The association between parental smoking and adolescent smoking was approximately similar between SE groups.

Empirical results did not confirm our initial intuition of a greater sensitivity to parental smoking among the worse-off. We had suggested that this greater vulnerability might be related to a lower access to information, in particular from the parents, less restrictive norms at home, and more permeability to influences at school. Our findings possibly indicate that the role model is the most important factor of the parent–children smoking association, regardless of the norms or the information that the parents may transmit to their children about smoking. This interpretation is supported by a study demonstrating that the crucial issue is the parents' behaviours in front of their children, and not what they may tell or impose upon them.[24]

What is already known on this topic

Our study showed an increased likelihood of adolescent daily smoking when parents smoke. This consistent relationship implies that the smoking behaviour is transmitted across generations, confirming earlier studies, some of which have longitudinal designs.[4–13,25] The association with maternal smoking was stronger for girls, while the association with paternal smoking was greater for boys. This finding is consistent with those of other studies, and it could reflect an effect of susceptibility to role models presented by same-sex parents.[14] This stronger relationship between daughter and mother could also be a result of specific messages or social pressures transmitted between female family members regarding traditional norms/roles played in the society.[26]

What this study adds

This study provided new evidence about the effect of parental smoking on adolescents' smoking behaviours. Our results did not confirm that the worse-off adolescents might be more

Table 3 Multivariate multilevel mixed-effects logistic regression for daily smoking, including interactions between parental smoking and SE variables.

	Paternal smoking, AOR [95% CI]			*Maternal smoking, AOR [95% CI]*		
	SES = SSP	*SES = FAS*	*SES = paternal education*	*SES = SSP*	*SES = FAS*	*SES = maternal education*
Boys						
Main effects						
Parental smoking						
Paternal smoking	1.99 [1.20; 3.29]	2.53 [1.46; 4.38]	1.69 [1.05; 2.70]	1.92 [1.48; 2.48]	1.90 [1.47; 2.46]	1.90 [1.47; 2.46]
Maternal smoking	1.77 [1.35; 2.31]	1.76 [1.35; 2.30]	1.76 [1.35; 2.31]	1.25 [0.73; 2.15]	1.55 [0.88; 2.74]	1.29 [0.77; 2.15]
SES						
Low	0.92 [0.62; 1.38]	0.82 [0.55; 1.21]	0.81 [0.52; 1.25]	0.79 [0.55; 1.15]	0.76 [0.53; 1.10]	0.93 [0.60; 1.46]
Medium	0.89 [0.61; 1.31]	0.98 [0.66; 1.45]	0.73 [0.50; 1.05]	0.78 [0.55; 1.12]	0.74 [0.51; 1.09]	1.34 [0.96; 1.88]
High; reference	1	1	1	1	1	1
Parental smoking × SES interaction						
Low	1.06 [0.58; 1.95]	0.79 [0.42; 1.49]	1.19 [0.64; 2.22]	1.83 [0.96; 3.49]	1.07 [0.55; 2.05]	1.99 [0.97; 4.11]
Medium	0.82 [0.44; 1.53]	0.58 [0.29; 1.15]	1.17 [0.65; 2.09]	1.26 [0.64; 2.47]	1.40 [0.68; 2.89]	1.36 [0.74; 2.49]
High; reference	1.00	1.00	1.00	1.00	1.00	1.00
Girls						
Main effects						
Parental smoking						
Paternal smoking	1.62 [0.90; 2.91]	1.55 [0.84; 2.84]	1.62 [0.91; 2.87]	1.42 [1.09; 1.86]	1.41 [1.08; 1.85]	1.42 [1.09; 1.86]
Maternal smoking	3.35 [2.56; 4.39]	3.37 [2.57; 4.41]	3.36 [2.56; 4.40]	3.38 [1.91; 6.01]	3.17 [1.75; 5.75]	4.32 [2.60; 7.18]
SES						
Low	1.18 [0.76; 1.84]	0.74 [0.47; 1.15]	1.06 [0.66; 1.71]	1.11 [0.72; 1.73]	0.74 [0.48; 1.15]	1.17 [0.71; 1.93]
Medium	1.06 [0.69; 1.65]	0.96 [0.62; 1.49]	0.96 [0.63; 1.47]	1.02 [0.66; 1.58]	0.83 [0.54; 1.30]	1.24 [0.83; 1.86]
High; reference	1	1	1	1	1	1
Parental smoking × SES interaction						
Low	0.81 [0.41; 1.59]	0.92 [0.46; 1.85]	0.88 [0.44; 1.78]	0.95 [0.49; 1.87]	0.95 [0.48; 1.89]	0.70 [0.35; 1.42]
Medium	0.92 [0.45; 1.89]	0.87 [0.41; 1.86]	0.82 [0.42; 1.63]	1.05 [0.51; 2.14]	1.33 [0.63; 2.81]	0.72 [0.39; 1.33]
High; reference	1.00	1.00	1.00	1.00	1.00	1.00

All regressions included as confounder the age, family context, peers' smoking behaviour and academic achievement. The adjusted odds ratios for these variables were not included to ease the reading.

susceptible to parental smoking. Consequently, non-parental influences—related to peers and schools—are indispensable to fully understand SE inequalities and their recent growth. However, there is a remarkably constant impact of parental influence across social classes. The strong association between parental and adolescent smoking behaviour was observed across different analyses, controlling for different variables, and among different SE groups. The social differences in parental smoking contributes to the intergenerational transmission of SE inequalities in smoking. This result emphasizes that polices aimed at preventing adolescent smoking may be complemented with parental smoking cessation. By focusing on parents, policies thus have the potential to decrease not only adolescents' smoking but also its social patterning. As stated elsewhere,[27] parents may be also involved in intervention efforts to change adolescents' perceptions of parental behaviour.

Limitations of this study

This study may suffer from some limitations. First, self-reports of adolescent smoking status were not validated by biochemical measures. However, some authors show that the accuracy of self-reported smoking is satisfactory in school-based questionnaires and in self-administered questionnaires.[28] Accuracy is also higher when respondents are assured, as in our case, of the privacy and confidentiality.[17,28] A second limitation is related with parental smoking being reported by the students. However, young adult reports of parental smoking are highly reliable.[29] Also, this study is a cross-sectional analysis, so that we cannot make inferences about causality and transmission of behaviours. Nonetheless, there is little doubt regarding the direction of causality; i.e. parents' behaviours are antecedents of children's attitudes. We have no information regarding parents who stopped smoking. However, the 15- to 18-year-old age

group is critical for the smoking decision.[30] The observation of parental smoking may be more important now than in the past. Finally, all variables in the paper referred to external factors for smoking, such as parental influences and SE conditions. These factors are very likely to affect the smoking behaviour through internal mechanisms, such as the capacity to cope with stress, the hopes and expectations, and self-esteem and trust. Unfortunately, our survey did not include these psychosocial factors, which would help explain the precise mechanisms linking external influences to smoking behaviours. Our clear-cut findings clearly indicate that further research should be developed in that direction.

Supplementary data

Supplementary data are available at *PUBMED* online.

Acknowledgements

This study was presented previously in the 7th European Public Health Conference, Glasgow, 19–22 November 2014, which resulted in an abstract publication in *European Journal of Public Health*, 24(suppl. 2), and also in 5th APES Workshop, Figueira da Foz, 5–7 September 2014.

Funding

This work was supported by the European Commission, Directorate General for Research and Innovation, under the FP7-Health-2011 programme (grant number 278273), as part of the project 'Tackling socio-economic inequalities in smoking (SILNE)'.

References

1 Hanson MD, Chen E. Socioeconomic status and health behaviors in adolescence: a review of the literature. *J Behav Med* 2007;**30(3)**:263–85.

2 Green MJ, Leyland AH, Sweeting H *et al.* Socioeconomic position and early adolescent smoking development: evidence from the British Youth Panel Survey (1994–2008). *Tob Control* 2014; doi:10.1136/tobaccocontrol-2014-051630.

3 Doku D, Koivusilta L, Rainio S *et al.* Socioeconomic differences in smoking among Finnish adolescents from 1977 to 2007. *J Adolesc Heal* 2010;**47(5)**:479–87.

4 Paavola M, Vartiainen E, Puska P. Smoking cessation between teenage years and adulthood. *Heal Educ Res* 2001;**16(1)**:49–57.

5 Yang S, Lynch J, Schulenberg J *et al.* Emergence of socioeconomic inequalities in smoking and overweight and obesity in early adulthood: the National Longitudinal Study of Adolescent Health. *Am J Public Heal* 2008;**98(3)**:468–77.

6 Hoffman BR, Sussman S, Unger JB *et al.* Peer influences on adolescent cigarette smoking: a theoretical review of the literature. *Subst Use Misuse* 2006;**41(1)**:103–55.

7 de Vries H. Parents' and friends' smoking status as predictors of smoking onset: findings from six European countries. *Heal Educ Res* 2003;**18(5)**:627–36.

8 Engels RCME, Vitaro F, Blokland EDE *et al.* Influence and selection processes in friendships and adolescent smoking behaviour: the role of parental smoking. *J Adolesc* 2004;**27(5)**:531–44.

9 Melchior M, Chastang J-F, Mackinnon D *et al.* The intergenerational transmission of tobacco smoking: the role of parents' long-term smoking trajectories. *Drug Alcohol Depend* 2010;**107(2–3)**:257–60.

10 den Exter Blokland EAW, Engels RCME, Hale WW *et al.* Lifetime parental smoking history and cessation and early adolescent smoking behavior. *Prev Med* 2004;**38(3)**:359–68.

11 Peterson AV, Leroux BG, Bricker J *et al.* Nine-year prediction of adolescent smoking by number of smoking parents. *Addict Behav* 2006;**31(5)**:788–801.

12 Gilman SE, Rende R, Boergers J *et al.* Parental smoking and adolescent smoking initiation: an intergenerational perspective on tobacco control. *Pediatrics* 2009;**123(2)**:e274–81.

13 Bantle C, Haisken JP. Smoke signals: the intergenerational transmission of smoking behavior. *DIW Discuss Pap* 1974;**3(1)**:45.

14 Loureiro ML, Sanz-de-Galdeano A, Vuri D. Smoking habits: like father, like son, like mother, like daughter? *Oxf Bull Econ Stat* 2010;**72(6)**:717–43.

15 Avenevoli S, Merikangas KR. Familial influences on adolescent smoking. *Addiction* 2003;**98(Suppl. 1)**:1–20.

16 Munafò MR, Johnstone EC. Genes and cigarette smoking. *Addiction* 2008;**103(6)**:893–904.

17 Lorant V, Soto VE, Alves J *et al.* Smoking in school-aged adolescents: design of a social network survey in six European countries. *BMC Res Notes* 2015;**8(1)**:91.

18 Mayhew KP, Flay BR, Mott JA. Stages in the development of adolescent smoking. *Drug Alcohol Depend* 2000;**59(Suppl. 1)**:S61–81.

19 O'Loughlin J. Reliability of selected measures of nicotine dependence among adolescents. *Ann Epidemiol* 2002;**12(5)**:353–62.

20 Austin SB, Ziyadeh N, Fisher LB *et al.* Sexual orientation and tobacco use in a cohort study of US adolescent girls and boys. *Arch Pediatr Adolesc Med* 2004;**158(4)**:317–22.

21 Rojas NL, Killen JD, Haydel KF *et al.* Nicotine dependence among adolescent smokers. *Arch Pediatr Adolesc Med* 1998;**152(2)**:151–6.

22 Currie C, Molcho M, Boyce W *et al.* Researching health inequalities in adolescents: the development of the Health Behaviour in School-Aged Children (HBSC) Family Affluence Scale. *Soc Sci Med* 2008;**66(6)**:1429–36.

23 Bickel R. *Multilevel Analysis for Applied Research: It's Just Regression*. New York: The Guilford Press, 2007.

24 Albers AB, Biener L, Siegel M *et al.* Household smoking bans and adolescent antismoking attitudes and smoking initiation: findings from a longitudinal study of a Massachusetts youth cohort. *Am J Public Heal* 2008;**98(10)**:1886–93.

25 Chassin L, Presson C, Seo D-C *et al*. Multiple trajectories of cigarette smoking and the intergenerational transmission of smoking: a multigenerational, longitudinal study of a Midwestern community sample. *Heal Psychol* 2008;**27(6)**:819–28.

26 Bauer T, Göhlmann S, Sinning M. Gender differences in smoking behavior. *Heal Econ* 2007;**16(9)**:895–909.

27 Stanton B, Li X, Pack R *et al*. Longitudinal influence of perceptions of peer and parental factors on African American adolescent risk involvement. *J Urban Health* 2002;**79(4)**:536–48.

28 Brener ND, Billy JO, Grady WR. Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: evidence from the scientific literature. *J Adolesc Heal* 2003;**33(6)**:436–57.

29 Marks JL, Swan GE, Pomerleau CS *et al*. Agreement between proband and parental self-report of smoking behavior and nicotine dependence. *Nicotine Tob Res* 2003;**5(4)**:527–33.

30 Göhlmann S, Schmidt CM, Tauchmann H. Smoking initiation in Germany: the role of intergenerational transmission. *Heal Econ* 2010;**19(2)**:227–42.