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The effectiveness of school-based smoking prevention interventions among low- and high-SES European teenagers

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Abstract

Preventing smoking initiation among adolescents of lower socio-economic groups is crucial for the reduction of socio-economic inequalities in health. The aim of the present study was to examine whether effective smoking prevention interventions in Europe are equally effective among adolescents of low- and high-socio-economic status (SES). As part of the European Union-funded TEENAGE project, three school-based smoking prevention intervention studies in Europe were selected for secondary analyses: (i) a Dutch class competition intervention, (ii) the European Smoking Prevention Framework (ESFA) study and (iii) the A Stop Smoking in Schools Trial (ASSIST) intervention. All three studies differed in effectiveness by SES. The Dutch class competition study only had a significant effect among higher SES adolescents. The results for the ESFA study and ASSIST study were mixed and depended on which SES indicator was used. The conclusion of the study is that stratified analyses provide important insights in differential intervention effects for higher and lower socio-economic groups. Although findings from the different studies were mixed, interventions that use a social network approach in which youngsters are allowed to deliver the intervention themselves may be a successful strategy in targeting adolescents from lower socio-economic groups.

Introduction

There are clear and robust socio-economic inequalities in health in many European countries [1]. The reduction of these inequalities is a major priority of public health policy throughout Europe. Previous studies have consistently demonstrated that smoking behaviour is more prevalent in lower socio-economic groups and contributes to socio-economic inequalities in health [2–6]. Effective smoking prevention in lower socio-economic groups will reduce the gap in health between higher and lower socio-economic groups.

Socio-economic inequalities in smoking behaviour develop in adolescence when youngsters take up smoking. Indeed, an extensive review reported negative associations between socio-economic status (SES) and smoking behaviour. This negative

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association appears to be more consistent among younger adolescents aged 10–14 years [7] indicating that adolescents in lower socio-economic groups start smoking at younger ages. Consequently, adolescence offers the ideal period in life for preventing the development of socio-economic inequalities in smoking behaviour and ultimately health [8].

Many studies have been conducted to evaluate the effectiveness of smoking prevention interventions in adolescents. Yet, there still is little knowledge about the differential effects of these smoking prevention efforts across socio-economic groups. Such information is important given that according to the inverse equity hypothesis [9], effective smoking prevention interventions may even widen inequalities due to their higher effectiveness in high as compared with lower SES groups. Given the potential confounding effect of SES, many studies have incorporated and statistically adjusted analyses for various indicators of SES. These studies provide a pragmatic opportunity to investigate whether there is differential effectiveness of interventions across socio-economic groups. It is the main aim of this study to investigate whether the effects of effective interventions in Europe differ for higher and lower socio-economic groups. Additionally, since girls in lower class are known to be at higher risk of becoming regular smokers later in life [10], we will examine whether intervention effects differ among boys and girls for higher and lower socio-economic groups.

Methods

As part of the European Union-funded TEENAGE project, three effective intervention studies conducted in Europe were reanalysed [11]. The procedure for selection of intervention studies within the TEENAGE project is explained in detail in a previously published manuscript [11]. Briefly, a systematic review was conducted to identify high-quality European intervention studies with clear overall effects that could be selected for secondary analyses. Included intervention studies had to be published in the international scientific literature (English language) since 1995 and conducted in Europe since 1990.

This procedure resulted in the inclusion of three school-based intervention studies: a Dutch class competition study [12], the European Smoking prevention Framework Approach (ESFA) study which involves a wider community [13] and the A Stop Smoking in Schools Trial (ASSIST) study which is a peer-led intervention [14]. Data from the HBSC 2005/6 survey showed that prevalence rates of smoking among 13-year-old adolescents were 4% in the Netherlands and Portugal, while they were 6 and 12% in boys and girls in Wales, respectively [15,18]. Authors were asked to participate either by conducting the stratified analyses themselves based on guidelines developed for this purpose or by making their data available [11]. The authors of all three studies agreed to make their data available for the TEENAGE project.

Study 1. The Dutch class competition study

The intervention study conducted by Crone *et al.* [12] was a group randomized trial conducted among 26 schools in the Netherlands that provided lower secondary education. The schools were ranked by size, stratified by use of a national drug education programme and subsequently randomly assigned to the control and intervention group. At baseline, a sample of 2562 adolescents participated in the study (average age was 13 years).

The intervention consisted of lessons on knowledge, attitudes and social influence, followed by a class agreement not to start smoking or to stop smoking for the next 5 months. Video lessons on smoking and social influence were available as an optional extra during these 5 months. Classes having fewer than 10% smokers after 5 months were entered in the competition. The final activity of the class was to make a photo expressing the idea of a non-smoking class. There were competition prizes for six classes with less than 10% smokers and a photo best expressing a non-smoking class. Intervention school staff were trained and supported in all activities concerning the intervention and evaluation. The control schools used the drug

prevention programme that they normally gave to their students.

Results from multilevel analysis showed that immediately after the intervention, 9.6% of the non-smokers started to smoke in the intervention group, whereas 14.2% started to smoke in the control group [N = 1388, odds ratio (OR) = 0.61, 95% confidence interval (CI) = 0.41–0.90]. After 1-year follow-up, the effect was no longer significant [11]. A more comprehensive description of this intervention trial, the methods and the results can be found elsewhere [12].

Adolescents' SES was measured by two indicators: (i) 'Educational level of parents', measured by asking adolescents to indicate the educational level of their mother and father and recoded into one variable (0 = unknown or missing, 1 = low parental educational level and 2 = mid to high parental educational level) and (ii) 'Work situation of parents', measured by asking adolescents whether their parents worked full time, part time or did not work and was recoded (0 = unknown or missing, 1 = no full-time job in the family and 2 = a full-time job in the family). Adolescents scoring unknown or missing on the SES indicators were not included in the stratified analyses. 'Smoking behaviour' was measured by questionnaires and defined as experimenting with smoking or smoking daily or weekly.

Study 2. The ESFA study

The ESFA study was a community-based intervention that took place in six European countries [13, 16]. The interventions differed substantially between the participating countries. Significant effects were found after 24 months in Finland and Spain. After 30 months, these intervention effects were not significant anymore although positive trends remained in Finland and Spain. Since the strongest and significant long-term effects after 24 and 30 months were found in the Portuguese sample, only data of the ESFA study in Portugal were reanalysed. Two regions, consisting of 14 and 11 schools, respectively, were randomly assigned to the experimental and control condition. At baseline, 3102 adolescents participated in the intervention study in Portugal (average age was 13.5 years).

The school-based intervention programme included lessons on effects of tobacco, reasons for (not) smoking, social influence processes, refusal skills and decision making and a smoke-free competition. Teachers received training, a manual and smoking cessation materials. Schools received the ESFA no-smoking policy manual and non-smoking posters. To the parents, information was offered on how to discuss non-smoking with their adolescents. Pharmacists furthermore offered cessation courses for 150 parents. At the community level, the Portuguese Health Minister and mayor of the community introduced the ESFA study on the national no-smoking day.

Results from multilevel analysis for the Portuguese sample showed that 41.8% of the never-smokers started to smoke 30 months later in the intervention group, whereas 53.8% of the never-smokers in the control group (N = 1304, OR = 0.62, 95% CI = 0.48–0.80). A detailed description of the design, methods and results can be found elsewhere [13].

SES was measured with three indicators: (i) 'Paid job father', measured with one question 'does your father (or male carer) have a paid job?' (1 = yes, works 5 or more days a week and 0 = yes, works less than 5 days a week-no, is homemaker, unemployed, ill or disabled, has retired or I don't have one) and recoded (1 = works 5 or more days a week and 0 = does not work 5 or more days a week); (ii) 'Paid job mother', assessed with a similar question 'does your mother (or female carer) have a paid job?' (1 = yes, works 5 or more days a week and 0 = yes, works less than 5 days a week-no, is homemaker, unemployed, ill or disabled, has retired or I don't have one) and recoded (1 = works 5 or more days a week and 0 = does not work 5 or more days a week) and (iii) 'Pocket money', measured by one question 'How much money can you spend as you like, most weeks? (not including clothing allowance and savings)' (0 = nothing, 1 = low, 2 = middle and 3 = high was recoded into 0 = nothing to low and 1 = middle to high). Smoking behaviour was assessed by a combination of five questions that were cross-validated [17]. Analyses were conducted with being an ever-smoker or never-smoker at follow-up as the outcome.

Study 3. The ASSIST study

The ASSIST study [14] was conducted among 10730 adolescents aged 12–13 years in 59 schools in England and Wales. Schools were randomly assigned to the control group to continue their usual smoking education (29 schools with 5372 adolescents) and intervention group (30 schools with 5358 adolescents) by stratified block randomization.

The ASSIST programme consisted of training influential students to act as peer supporters during informal interactions outside the classroom to encourage peers not to smoke. During the 10-week intervention period, peer supporters undertook informal conversations about smoking with their peers when travelling to and from school, in breaks, at lunchtime and after school in their free time. Peer supporters logged a record of all conversations in a diary. Trainers visited schools four times to meet with peer supporters to provide support, trouble shooting and monitoring of peer supporters' diaries.

Findings of a multilevel analysis using data from all three follow-ups (immediately after the intervention (N = 10047), after 1 year (N = 9909) and after 2 years (N = 9666)) demonstrated that the odds of being a smoker in the intervention group compared with the control group was 0.78 (95% CI = 0.64–0.96). A detailed description of the ASSIST trial can be found elsewhere [14].

SES indicators were (i) 'Family Affluence Score', measured with three questions 'Does your family have a car or van? (0 = no family car of van, 1 = one family car or van and 2 = two or more cars or vans), 'Do you have your own bedroom for yourself? (0 = no and 1 = yes) and 'During the last 12 months, how many times did you travel away on holiday with your family?' (0 = not at all, 1 = once, 2 = twice and 3 = more than twice). The scores of the three indicators were summed and recoded (0 = Scores 0–2; 1 = Scores 3–4 and 2 = Scores 5–6) [16]; (ii) 'Free school meal entitlement', scored using a median split (0 = 19% or less student entitlement and 1 = more than 19% student entitlement); (iii) 'School location in South Wales valleys' was included since the South Wales valleys represent a deprived area (0 = non-valley school and 1 = valley school). Smoking behaviour was measured by questionnaires and defined as smoking in the past week. Validation with salivary cotinine revealed that 1 and 3% of the adolescents who reported to be a non-smoker had cotinine values higher than 15 ng ml^{-1} at 1 and 2 years follow-up, respectively.

Secondary analyses

Given that the studies differed in design and methodologies, we were not able to apply meta-analytic methods but reanalysed the studies using the definitions of variables as defined in the original studies and subsequently conceptually compared the evidence derived from the separate studies.

Study 1. The Dutch class competition study

Data from follow-up at 5 and 12 months were modelled using three-level multilevel models with school at Level 3, class at Level 2 and adolescent at Level 1. Models were estimated using the restricted iterative generalized least squares (RIGLS) estimation procedure combined with first-order penalized quasi-likelihood within MLWin 2.10 beta. The multilevel model was tested separately for adolescents in each of the categories of the two included SES indicators.

Study 2. The ESFA study

Multilevel modelling techniques were used to test for intervention effects on smoking behaviour in different SES categories. Data from follow-up at 30 months were modelled using three-level multilevel models with region at Level 3, school at Level 2 and adolescent at Level 1. Models were estimated using the RIGLS estimation procedure combined with first-order penalized quasi-likelihood within MLWin 2.10 beta. The multilevel model was tested separately for adolescents in each of the categories of the three included SES indicators.

Study 3. The ASSIST study

Data of the assist trial were reanalysed according to methods reported in the ASSIST study [14]. Multilevel modelling was used to explore intervention

effects on adolescent smoking in different SES categories. Data from the three follow-up periods were modelled using a using a three-level multilevel model with schools at Level 3, students at Level 2 and follow-up measurements at Level 1. Models were estimated using the RIGLS estimation procedure combined with first-order penalized quasi-likelihood within MLWin 2.10 beta. Separate analyses were conducted for adolescents in the low, medium and high categories of the included SES indicators.

Results

Study 1. The Dutch class competition study

The results of the secondary analyses are depicted in Table I. Stratified analyses showed that the overall significant effect at 5 months was only present among higher SES adolescents. Similar results were found for stratified analyses on both educational level of parents and work situation. Smoking behaviour was significantly lower in adolescents who indicated that their parents had mid to high completed educations (chi-square $_{(df = 1)}$ = 4.21, $P < 0.05$, OR = 0.35, 95% CI = 0.13–0.95) or who had at least one full-time working parent (chi-square $_{(df = 1)}$ = 4.22, $P < 0.05$, OR = 0.57, 95% CI = 0.33–0.97). The intervention did not result in smoking fewer cigarettes among adolescents who indicated that their parents had lower education (chi-square $_{(df = 1)}$ = 0.33, $P > 0.05$, OR = 0.80, 95% CI = 0.37–1.72) or no full-time job (chi-square $_{(df = 1)}$ = 1.05, $P > 0.05$, OR = 0.55, 95% CI = 0.17–1.73). All significant intervention effects disappeared at 12 months follow-up. The additional analyses stratified by gender and SES furthermore showed that the intervention was only effective at 5 months follow-up among boys with higher parental educational levels (chi-square $_{(df = 1)}$ = 5.56, $P < 0.05$, OR = 0.24, 95% CI = 0.07–0.79).

Study 2. The ESFA study

The results for the multilevel analyses at 30 months follow-up are depicted in Table II. Results of the stratified analyses showed that the intervention effect at 30 months differed depending on whether the father worked full time or not and on the amount of spending money. The intervention was significant in reducing smoking uptake among adolescents with fathers working full time (chi-square $_{(df = 1)}$ = 18.40, $P < 0.01$, OR = 0.56, 95% CI = 0.43–0.73) and among adolescents who indicated to have no to only a low amount of spending money (chi-square $_{(df = 1)}$ = 9.85, $P < 0.01$, OR = 0.62, 95% CI = 0.46–0.84). This effect was not seen among those with a father working less than 5 days a week (chi-square $_{(df = 1)}$ = 0.58, $P > 0.05$, OR = 0.73, 95% CI = 0.33–1.63) and among adolescents reporting to receive mid to high amounts of spending money (chi-square $_{(df = 1)}$ = 3.51, $P > 0.05$, OR = 0.57, 95% CI = 0.32–1.03). The intervention was also found to be effective among adolescents whose mother worked full time (chi-square $_{(df = 1)}$ = 6.69, $P < 0.05$, OR = 0.67, 95% CI = 0.49–0.91) as well as among those adolescents whose mother did not work 5 or more days a week (chi-square $_{(df = 1)}$ = 8.03, $P < 0.01$, OR = 0.51, 95% CI = 0.32–0.81). Additional analyses stratified by gender and SES showed that the intervention was mostly effective among girls.

Study 3. The ASSIST study

Results for the multilevel analyses stratified by low, medium and high affluence scores are depicted in the upper part of Table III. Table IV depicts the percentages smokers and non-smokers in each category of the included SES indicators.

A significant main effect of intervention was found among adolescents scoring low (chi-square $_{(df = 1)}$ = 5.97, $P < 0.05$, OR = 0.71, 95% CI = 0.54–0.93) and high (chi-square $_{(df = 1)}$ = 7.28, $P < 0.05$, OR = 0.68, 95% CI = 0.52–0.90) on the family affluence scale (FAS). Results for the multilevel analyses stratified by free school meal entitlement above 19% and equal or below 19% are depicted in the middle part of Table III. No significant main effects of the intervention on adolescent smoking behaviour were found in either group. However, a trend is visible among adolescents in schools with a low free school meal entitlement (chi-square $_{(df = 1)}$ = 3.56, $P = 0.06$, OR = 0.80, 95% CI = 0.63–1.01). The lower part of Table III shows the results of the multilevel analyses

Table I. *Intervention effects on experimenting with smoking or smoking daily or weekly by socio-economic status after 5 months—the Dutch class competition study*

Results stratified by parental education level

	Low education level of parents						Mid to high education level of parents					
	N	*β*	SE	Chi-square	OR	95% CI	*N*	*β*	SE	Chi-square	OR	95% CI
Intervention effect 5 months	526	−0.22	0.39	0.33	0.80	0.37–1.72	557	−1.05	0.51	**4.21***	0.35	0.13–0.95
Boys	261	−0.38	0.54	0.50	0.68	0.24–1.95	331	−1.43	0.61	**5.56***	0.24	0.07–0.79
Girls	262	−0.34	0.63	0.29	0.71	0.21–2.46	226	−0.84	0.60	1.96	0.43	0.13–1.40

Results stratified by parental work

	No full-time job in the family						A full-time job in the family					
	N	*β*	SE	Chi-square	OR	95% CI	*N*	*β*	SE	Chi-square	OR	95% CI
Intervention effect 5 months	278	−0.60	0.58	1.05	0.55	0.17–1.73	1404	−0.57	0.28	**4.22***	0.57	0.33–0.97
Boys	134	0.48	1.40	0.12	1.61	0.10–24.86	730	−0.62	0.40	2.42	0.54	0.25–1.17
Girls	144	−0.38	0.56	0.47	0.68	0.23–2.04	670	−0.38	0.40	0.89	0.68	0.31–1.50

N, number of participants included; *β*, parameter estimate, log OR; SE, standard error; Chi-square, df = 1. Results based three-level MLWIN analyses (Level 1 = adolescent, Level 2 = class and Level 3 = school) using RIGLS, binomial first-order penalized quasi-likelihood estimation. Analysis adjusted for ethnicity, religion and age. Bold represents statistical significance.
* $P < 0.05$, ** $P < 0.01$.

Table II. *Intervention effects on ever/never smoking by SES after 30 months for baseline never-smokers—the Portuguese participants of the ESFA study*

Results stratified by job father												
	Job father <5 days a week						Job father 5 days a week					
	N	*β*	SE	Chi-square	OR	95% CI	*N*	*β*	SE	Chi-square	OR	95% CI
Intervention effect 30 months	119	−0.31	0.41	0.58	0.73	0.33–1.63	892	−0.59	0.14	**18.40*** **	0.56	0.43–0.73
Boys	44	−0.25	0.76	0.11	0.78	0.18–3.46	396	−0.40	0.21	**3.88***	0.67	0.45–1.00
Girls	75	−0.31	0.47	0.43	0.73	0.29–1.84	496	−0.77	0.24	**10.49****	0.46	0.29–0.74
Results stratified by job mother												
	Job mother <5 days a week						Job mother 5 days a week					
	N	*β*	SE	Chi-square	OR	95% CI	*N*	*β*	SE	Chi-square	OR	95% CI
Intervention effect 30 months	296	−0.67	0.24	**8.03****	0.51	0.32–0.81	715	−0.41	0.16	**6.69****	0.67	0.49–0.91
Boys	126	−0.33	0.36	0.85	0.72	0.35–1.46	314	−0.33	0.23	2.045	0.72	0.46–1.13
Girls	170	−1.03	0.45	**5.30***	0.36	0.15–0.86	401	−0.47	0.28	2.90	0.62	0.36–1.07
Results stratified by spending money												
	None-low spending money						Mid to high spending money					
	N	*β*	SE	Chi-square	OR	95% CI	*N*	*β*	SE	Chi-square	OR	95% CI
Intervention effect 30 months	829	−0.47	0.15	**9.85****	0.62	0.46–0.84	182	−0.56	0.30	3.51	0.57	0.32–1.03
Boys	349	−0.41	0.22	3.46	0.67	0.43–1.02	91	0.11	0.54	0.04	1.11	0.39–3.18
Girls	480	−0.52	0.22	**5.55***	0.59	0.39–0.92	91	−1.12	0.44	**6.54***	0.33	0.14–0.77

N, number of participants included; *β*, parameter estimate, log OR; SE = standard error; chi-square df = 1. Results based on three-level MLWIN analyses (Level 1 = adolescent, Level 2 = school and Level 3 = region) using RIGLS, binomial first-order penalized quasi-likelihood estimation. Bold represents statistical significance.
* $P < 0.05$, ** $P < 0.01$.

Table III. *Intervention effects on smoking behaviour in the past week stratified by SES and gender—the ASSIST study*

Results stratified by FASs

	Low FAS						Mid FAS						High FAS					
	N	*β*	SE	Chi-square	OR	95% CI	*N*	*β*	SE	Chi-square	OR	95% CI	*N*	*β*	SE	Chi-square	OR	95% CI
Intervention effect	2377	−0.34	0.14	**5.97***	0.71	0.54–0.93	5311	−0.11	0.12	0.77	0.90	0.71–1.14	1938	−0.38	0.14	**7.28****	0.68	0.52–0.90
Boys	1171	−0.05	0.19	0.06	0.96	0.66–1.39	2683	−0.09	0.18	0.27	0.91	0.64–1.29	1001	−0.41	0.24	2.89	0.66	0.41–1.07
Girls	1206	−0.52	0.17	**9.02****	0.59	0.42–0.83	2628	−0.13	0.14	0.86	0.88	0.67–1.15	937	−0.33	0.18	3.40	0.72	0.50–1.02

Results stratified by free school meal entitlement

	High % school meal entitlement						Low % school meal entitlement					
	N	*β*	SE	Chi-square	OR	95% CI	*N*	*β*	SE	Chi-square	OR	95% CI
Intervention effect	3701	−0.24	0.20	1.53	0.79	0.53–1.15	6346	−0.23	0.12	3.56	0.80	0.63–1.01
Boys	1868	−0.43	0.24	3.36	0.65	0.41–1.03	3255	−0.18	0.18	0.97	0.84	0.59–1.19
Girls	1833	−0.11	0.22	0.26	0.89	0.58–1.38	3091	−0.20	0.13	2.40	0.82	0.64–1.06

Results stratified by schools located in the Valley or not

	Valley school						Non-Valley school					
	N	*β*	SE	Chi-square	OR	95% CI	*N*	*β*	SE	Chi-square	OR	95% CI
Intervention effect	2079	−0.63	0.26	**5.68***	0.53	0.32–0.89	7968	−0.12	0.11	1.13	0.89	0.71–1.10
Boys	1085	−0.33	0.26	1.63	0.72	0.44–1.19	4038	−0.10	0.17	0.36	0.91	0.66–1.25
Girls	994	−0.91	0.33	**7.85****	0.40	0.21–0.76	3930	−0.11	0.12	0.78	0.90	0.71–1.14

N, number of cases included; *β*, parameter estimate, log OR; SE = standard error; chi-square df = 1. Results based on three-level MLWIN analyses (Level 1 = measurement, Level 2 = individual and Level 3 = school) using RIGLS, binomial first order penalized quasi-likelihood estimation. Adjusted for baseline smoking. Bold represents statistical significance.
* $P < 0.05$, ** $P < 0.01$.

Table IV. *Percentages of baseline smokers and non-smokers by SES indicators in the ASSIST study*

	Non-smoker	Smoker
Low FAS score	93.4	6.6
Mid FAS score	95.1	4.9
High FAS score	94.4	5.6
High free school meal entitlement	92.7	7.3
Low free school meal entitlement	95.3	4.7
Valley school	93.8	6.2
Non-valley school	94.5	5.5

stratified by school location in the South Wales valleys or not. The intervention was significant among adolescents in schools located in the valleys which can be considered to be a more deprived area (chi-square $_{(df = 1)} = 5.68$, $P < 0.05$, OR = 0.53, 95% CI = 0.32–0.89) but not among adolescents in schools on other locations.

Since 'valley' was a school-level variable, we conducted additional analyses that showed that among those adolescents in Valley schools, the intervention was also effective among those with low FAS scores (chi-square $_{(df = 1)} = 5.97$, $P < 0.05$, OR = 0.71, 95% CI = 0.54–0.93). The additional analyses stratified by SES and gender showed that the ASSIST intervention was mostly effective among lower SES girls.

Discussion

The aim of the present study was to examine whether effective smoking prevention interventions among European adolescents were differentially effective among high- and low-SES adolescents. Secondary analyses stratified by indicators of SES of three high-quality school-based interventions with significant positive intervention effects in the overall sample provided mixed results. The review of the literature on which the selection of the three studies was based showed that the majority of interventions were school-based and focused on knowledge, attitudes and social influences. They used a combination of methods (information, lessons and informal conversations) and demonstrated positive intervention effects (at least in the short term) in the general population. Yet, there appeared to be different effects of the interventions for higher and lower SES groups depending on the studies.

The Dutch class competition study appeared to widen the inequalities. In contrast to the other studies, this study only included lower educational level schools and was entirely school based. While schools seem an important setting for smoking prevention, important factors influencing smoking initiation will also be found outside the school, including for example smoking of parents. Such outside school factors may be worse for adolescents of lower socioeconomic groups. The ESFA study targeted schools and intervened in multiple levels outside the school environment (parents, pharmacists and the community). The results were mixed depending on the specific SES indicator used. Based on whether or not adolescents had a father working full time, the intervention appeared to widen inequalities in smoking, based on having a mother working full time, the intervention did not appear to narrow nor widen the inequalities. When using spending money as a SES indicator, the intervention did appear to decrease inequalities in smoking.

The ASSIST study showed the strongest results for adolescents in the Valley schools, located in a deprived area. This intervention was implemented and disseminated by the social networks of the adolescents themselves. Influential students were asked to encourage their peers not to smoke through informal conversations when travelling to and from school and during breaks, lunchtime and free time after school. Although more research is needed to confirm our findings, this social network approach allowing youngsters to deliver the intervention themselves seems promising in preventing the uptake of smoking in deprived adolescents.

Interestingly, results showed that if an intervention was effective among low-SES adolescents, it was particularly the case among low-SES girls and not among low-SES boys. This additional finding is promising since young women in lower classes are known to be at higher risk of becoming regular smokers [10] and because recent evidence further

suggests a marked increase in substance use in girls between 1990 and 2003 [19].

Previous studies have suggested that policies and laws can effectively reduce socio-economic inequalities in smoking [20, 21]. An extensive review of the literature showed that youngsters were sensitive to price and argued that increasing the price of tobacco products would significantly reduce smoking among youngsters [21]. However, whether price increases can reduce socio-economic inequalities in smoking specifically among European teenagers is not yet known to our knowledge. It is feasible that low-SES teenagers are more sensitive to price increases as they receive lower amounts of pocket money. In the selection of the TEENAGE interventions, no studies evaluating policies or laws satisfied the inclusion criteria. If future data will become available, it would be very valuable to examine the effects of policies and laws, including price increases, on smoking rate among low-SES teenagers within Europe.

Some limitations need to be discussed. Firstly, we included three studies from the Netherlands, Portugal and the United Kingdom based on the inclusion criteria [11]. Therefore, the results of these three smoking intervention studies do not allow us to generalize findings for Europe nor for all strategies developed to prevent smoking among adolescents. Secondly, all three studies used different indicators of SES, which hampered a proper comparison. Moreover, results may depend on the indicator used, as was demonstrated in the ESFA study. There also may not be a strong association between indicators such as adolescents' pocket money and household income. Those with less pocket money may well have parents with higher levels of education or income. Thirdly, almost all SES indicators used were self-reported by the adolescents. Adolescents are known to validly report parental occupation and education, but misclassification and higher occurrence of missing values can arise [11, 22, 23] possibly causing some bias in the results. To avoid such methodological problems, the FAS can be used [24], which was used in the ASSIST study. Fourthly, sample size calculations of the interventions were not based on subgroup analyses. Although it would help substantially in improving our understanding of how to effectively design interventions for lower socio-economic groups and therefore should be advocated, this clearly has major logistic and financial consequences. Although sample sizes were still relatively good for our hypothesis-generating project, results of the subgroup analysis need to be interpreted cautiously. Finally, interventions may differ in their effectiveness as a result of differences in fidelity of the intervention. To the extent that the fidelity of the intervention differed between adolescents from higher and lower socio-economic groups, this may have resulted in differential effects.

Our study does have implications for future research. Firstly, while equity-related subgroup analyses in future interventions do have the potential to efficiently enhance our understanding of 'what works' in lower socio-economic groups, our study illustrates the need to reach further consensus about reliable and valid SES indicators in adolescence. The field could rapidly move forward if same indicators were included in each intervention study. It is however beyond the scope of this study to recommend any indicator above the other. Secondly, our study shows the benefits of data sharing, combining available data, even if they cannot be pooled into a single measure, can and should be used for the further development of interventions in lower socio-economic groups.

In conclusion, despite the previously mentioned limitations, the secondary analyses contribute to our knowledge on the effectiveness of European smoking prevention interventions among low- and high-SES adolescents. Findings are mixed and at best suggest that interventions that use a social network approach in which youngsters are allowed to deliver the intervention themselves may be a successful strategy in preventing the uptake of smoking among adolescents from lower socio-economic groups.

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Conflict of interest statement

None declared.

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