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ORIGINAL ARTICLE

Socioeconomic status is associated with the prevalence and co-occurrence of risk factors for cigarette smoking initiation during adolescence

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Abstract
Objectives To investigate whether the prevalence or co-occurrence of risk factors for cigarette smoking initiation differ by socioeconomic status (SES) and whether SES interacts with risk factors to increase initiation.
Methods In 2005, 1451 5th grade never smokers (mean age 10.7 years) in Montréal, Canada, provided baseline data, with follow-up in 6th and/or 7th grade (2005–2007). Poisson regression analyses estimated the association between 13 risk factors and initiation. Excess risk of each risk factor in low vs. moderate–high SES participants was assessed.
Results Cigarette smoking was initiated by 9.4% of participants ($n = 137$). Low SES was associated with a higher prevalence and co-occurrence of risk factors. The estimated association of most risk factors with initiation was similar across SES, although participants from low SES neighborhoods whose mothers had no university education had three times the risk of initiation [ARR = 3.10 (1.19, 8.08)] compared to more affluent peers.
Conclusions Tobacco control efforts must address the higher prevalence and co-occurrence of risk factors in lower SES contexts since these may render initiation highly probable in many lower SES youth.

Keywords Socioeconomic status · Adolescents · Cigarette smoking · Smoking initiation · Risk factors

Introduction

The prevalence of cigarette smoking has declined sharply in many countries over the past two decades (Jamal et al. 2015; Reid et al. 2015), but rates of decline are slower among subgroups of lower socioeconomic status (SES). In Canada, for example, despite the general decline in smoking, absolute differences in smoking rates increased across educational levels between 1950 and 2011 (Corsi et al. 2014). Lower SES, whether delimited by occupation, education, income or single-parent family status, remains an important risk factor for cigarette smoking (Hiscock et al. 2012). In both Canada and the US, adults with lower educational attainment and/or income are far more likely to smoke than their better educated or more affluent peers (Corsi et al. 2013; Hiscock et al. 2012; Jamal et al. 2015). Bricard et al. (2016) found that the excess risk of being a smoker at some point in one's lifespan was seven times greater among adult males with the lowest level of educational attainment, and four times greater among females, compared to adults with the highest level of educational attainment. Of more concern is that the excess risk of being

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a smoker during adolescence was approximately 15 times higher among males and ten times higher among females. The higher prevalence of smoking in low SES groups in conjunction with slower rates of decline pose a major public health challenge because, if unchecked, SES disparities in tobacco-related morbidity will persist and possibly increase into the future, affecting lower SES groups disproportionately. In fact, a recent pooled analysis of data from high income countries reported that low SES was associated with 4.8 years of life lost between ages 40 and 85, attributable to being a current smoker (Stringhini et al. 2017).

Parents who smoke influence their children's tobacco use through role modeling, easier access to tobacco products, tacit approval of smoking (Hill et al. 2005), and exposure to secondhand smoke at home and in cars (Montreuil et al. 2016). In a recent systematic review of longitudinal studies of youth, Wellman et al. (2016) reported that both low SES and living in a single-parent family, which is correlated with socioeconomic hardship (DeNavas-Walt and Proctor 2014; Statistics Canada 2013), were robustly associated with initiation in youth. Similarly, a study in four countries (Flemish Belgium, Canada, Romania and England) found that family affluence was inversely related to the likelihood of being a weekly or daily smoker (Pförtner et al. 2015). However, an unresolved issue is whether the higher prevalence of smoking is because low SES youth have greater risk factor exposure, and/or whether low SES youth are more vulnerable to the effects of risk factors. An additive interaction would exist if exposure to a risk factor results in a greater likelihood of initiation among youth in low SES contexts, compared to unexposed youth or exposed youth in higher SES contexts (Kendler and Gardner 2010).

Our objectives in this study were to investigate whether the prevalence and co-occurrence of 13 well-established risk factors for cigarette smoking initiation (i.e., taking a first puff on a cigarette) differ by SES and whether SES interacts with any of these risk factors to increase the risk. We examined two SES indicators: maternal education and the SES of the neighborhood in which the participant was living.

Methods

Data were drawn from the prospective "AdoQuest I" Study (2005–2011) of 1801 5th grade students age 10–11 years at inception, which investigated the co-occurrence of health-compromising behaviors in children (O'Loughlin et al. 2012). We recruited 29 French language elementary schools with > 90 students in 5th grade, in greater Montréal. To balance representation of high, middle and low SES students, eligible schools were stratified into groupings defined by tertile of a school deprivation indicator that incorporated maternal education, parental employment, and a measure of family income that accounts for family size and area of residence. An equal number of schools was randomly selected in each grouping; ten schools in the first, ten in the second and nine in the third grouping (72.5% of schools invited) agreed to participate. All students in all 5th grade classes in participating schools were eligible for recruitment. Characteristics of the "AdoQuest I" sample were comparable to those of two provincially representative samples of similarly aged Québec youth (see Online Resource 1). Participants provided assent and their parents/guardians provided informed consent. The study received approval from the ethics review boards of Concordia University and the Centre de Recherche du Centre Hospitalier de l'Université de Montréal.

Baseline data were collected in spring 2005 using classroom-administered, self-report questionnaires (also used in the 6th grade follow-up). Data on cigarette smoking initiation were collected in fall and spring of 6th grade (2005–2006) and in 7th grade (2006–2007). In 7th grade self-report questionnaires were mailed to participants' homes. Parents completed mailed self-report questionnaires in 2006–2007 and 2008–2009.

We retained baseline never smokers for analysis. To assure inclusion of never smokers exclusively, we examined responses to four cigarette smoking items (i.e., ever smoked; recall of number of days on which participant had smoked in each of the past 3 months, usual number of cigarettes smoked per day, and number of cigarettes smoked in the previous week). If smoking was reported on any of these four items, the participant was excluded. Of the 1801 participants at baseline, 16 (0.1%) were missing data on smoking in 5th grade and 232 (12.9%) had smoked. Of the remaining 1553 never smokers, 102 (6.6%) were missing all data in 6th and 7th grades, yielding an analytic sample of 1451 5th grade never smokers with data on smoking initiation in 6th or 7th grade.

Study variables

Participants were asked: "Have you ever tried cigarette smoking, even just a few puffs?" (yes, no). Self-report of cigarette smoking by youth is valid and reliable (Wong et al. 2012). Cigarette smoking initiation was defined as a 5th grade never smoker reporting yes in 6th or 7th grade.

A neighborhood SES score was assigned to each participant based on the postal code of his/her home address, which is linked to a material deprivation index (Pampalon and Raymond 2000) that describes an 'enumeration area' (i.e., the smallest census unit representing 750 people on average, which is socioeconomically homogeneous) from

the 2006 Census of Canada. The index accounts for the proportion of persons with no high school diploma, the ratio of the number of persons employed to the total population, and the average personal income of persons in the enumeration area (Pampalon and Raymond 2000). Higher deprivation scores represent lower SES. For analysis, we categorized scores into three groupings (i.e., high, moderate, and low neighborhood SES) defined by tertile of the deprivation score. In several analyses, we combined high and moderate neighborhood SES into a single category and compared this with low neighborhood SES.

We also categorized participants into one of three groupings based on maternal education [i.e., high (Bachelor's degree or above), moderate (post-secondary education below a Bachelor's degree) or low (completed secondary or less)]. In several analyses, we compared participants with mothers of high or moderate education vs. those with mothers of low education.

We investigated 13 established risk factors: father's, mother's, siblings' and friends' smoking; home smoking ban; having smokers in the home; smoking in cars; perceived low academic performance; susceptibility to smoking; depressive symptoms; low self-esteem; feeling disconnected from school; and use of non-cigarette tobacco products (Wellman et al. 2016). Because they were protective in previous research, we reverse-coded self-esteem and school connectedness as risk factors (Knol et al. 2011). Online Resource 2 describes the items used to measure each risk factor, response options, coding for analyses, and citations. Cronbach's alpha is reported for continuous scales. We created a variable representing the number of risk factors which each participant reported.

Statistical analysis

We examined the patterns of missing data (see Online Resource 3). The median (inter-quartile range (IQR); minimum–maximum) percentage of missing values across all variables was 2.8% (1.9–7.1; 0–20.4). Neighborhood SES and maternal education were missing 4.2 and 20.4% of values, respectively. Covariates included gender (no missing values) and age (0.8% of values missing). The presence of missing values for the risk factors investigated was unrelated to neighborhood SES (all $p \geq 0.118$) or smoking initiation (all $p \geq 0.258$). The presence of missing values for 11 risk factors was unrelated to maternal education (all $p \geq 0.087$); however, more participants whose mothers had low education were missing data on perceived academic performance (10.4 vs. 6.1%; $p = 0.013$) and self-esteem (7.5 vs. 4.5%, $p = 0.043$). Missing values were replaced using hot deck imputation (Roth 1994; Hawthorne and Elliott 2005), a method in which each missing value is replaced with an observed response from a "similar" participant, using a computational tool in SPSS (Myers 2011) [version 24, 2016; SPSS Statistics for Windows; IBM Corp., Armonk, NY]. Data analyses were undertaken using Stata [version 14, 2016; Stata Corp., College Station, Texas].

To investigate differences in risk factor prevalence by SES, we compared the proportion of children exposed to each risk factor within each category of each SES indicator. We used Kruskal–Wallis tests with Dunn's pairwise comparisons to assess whether co-occurrence of risk factors differed across categories of each SES indicator considered both separately and together [i.e., (1) both SES indicators high–moderate, (2) neighborhood high–moderate/maternal education low; (3) neighborhood low/maternal education high–moderate; (4) both low]. We then examined the frequency of initiation in each category of each risk factor among participants categorized by neighborhood SES and then by maternal education.

Our multivariable analyses involved three steps. We first performed a separate analysis for each risk factor that estimated a model adjusting for SES (either neighborhood SES or maternal education) only, and a second multivariate model that adjusted for SES, age and gender. In step 2, we repeated these analyses including an interaction term between the risk factor and SES. We estimated relative risks (RR), which are preferable to odds ratios in longitudinal studies, especially when the outcome is common (Greenland 2004; Nurminen 1995), with generalized linear models using Poisson regression with a robust variance estimator (IDRE 2016; Stata Corp LP 2016; Zou 2004) which accounted for clustering attributable to participants attending the same elementary school (Williams 2000). In step 3, we calculated the relative excess risk due to interaction (RERI) (VanderWeele and Knol 2014). RERI = 0 when no additive interaction is present; values > 0 indicate a positive interaction (suggesting in this study that the public health impact of a preventive intervention would be greater among children living in low SES neighborhoods or whose mothers have no post-secondary education); values < 0 indicate a negative interaction (VanderWeele and Knol 2014), which would suggest a greater impact among children from moderate–high SES neighborhoods or whose mothers have post-secondary education. RERI were calculated using the estimated regression coefficients ($\hat{\beta}$) from the multivariable Poisson analyses:

$$\begin{aligned}\text{RERI} = {} & \exp(\hat{\beta}_{\text{Riskfactor}} + \hat{\beta}_{\text{SES}} + \hat{\beta}_{\text{Riskfactor}\times\text{SES}}) \\ & - \exp(\hat{\beta}_{\text{Riskfactor}}) - \exp(\hat{\beta}_{\text{SES}}) + 1\end{aligned}$$

(VanderWeele and Knol 2014); CIs for RERI were estimated with the delta method (Hosmer and Lemeshow 1992) using the variance–covariance matrices from the Poisson models.

Results

Compared to those not retained, participants retained for analysis were marginally younger and a higher proportion spoke only French (Online Resource 4). Among retained participants, 45, 35 and 20% lived in high, moderate and low SES neighborhoods, respectively. Twenty-nine percent had mothers with a university degree (high SES), 44% had mothers with post-secondary education below a Bachelor's degree (moderate SES), and 28% had mothers who had completed secondary school (low SES). Both SES indicators were moderate/high for 60% of participants; both were low for 7%; 13% lived in low SES neighborhoods but had mothers with high–moderate education; and 20% lived in high–moderate SES neighborhoods but had mothers with low education.

Higher proportions of participants living in low SES neighborhoods or whose mothers had low education had fathers and mothers who smoked, lived in homes without a smoking ban, had more smokers at home, and perceived that their academic performance was below average (Table 1). Relatively more participants in low SES neighborhoods had friends who smoked and fewer reported that they felt connected to school. Relatively more participants whose mothers had moderate or low education had siblings who smoked and reported exposure to smoking in cars (Table 1). There appeared to be a gradient in the prevalence of others smoking as SES declined.

Co-occurrence of risk factors differed significantly by SES (Table 2). Participants in low SES neighborhoods reported more risk factors than those in either high or moderate SES neighborhoods; there was no difference between moderate and high SES neighborhoods. Similarly, participants whose mothers had low education reported more risk factors than those whose mothers had either high or moderate education. Additionally, participants whose mothers had moderate education reported more risk factors than those whose mothers had high education.

Congruence of SES classification was also significantly related to co-occurrence of risk factors (Table 3). Compared to participants whose SES classification by both indices was high–moderate, those living in high–moderate SES neighborhoods whose mothers had low education reported the highest number of risk factors. Number of risk factors reported was intermediate among those whose SES classifications were both low and those living in low SES neighborhoods whose mothers had high education.

Overall, 9.4% of participants ($n = 137$) initiated cigarette smoking by 7th grade, including 8.6, 8.7 and 12.5% of participants in high, moderate or low SES neighborhoods, respectively [adjusted risk ratio (ARR) (95% CI) = 1.02 (0.70, 1.48) for moderate SES; 1.48 (0.95, 2.30) for low SES]. Similarly, 5.3, 10.4 and 12.5% of participants whose mothers had high, moderate or low education, respectively, initiated smoking [ARR = 1.94 (1.17, 3.22) for moderate education; 2.30 (1.21, 4.37) for low education]. Compared to participants from high SES neighborhoods whose mothers had high education, those for whom both SES indicators were low had three times the risk of initiation [ARR = 3.10 (1.19, 8.08)] while those from moderate SES neighborhoods whose mothers had low education had twice the risk [ARR = 2.32 (1.05, 5.13)].

Table 4 presents the RR for each risk factor adjusted for age, gender and either neighborhood SES or maternal education (with the moderate and high SES categories combined into a single category). See Online Resource 5 for RRs adjusted for SES only. All 13 risk factors were statistically significantly associated with initiation, and the magnitude of the RRs associated with most risk factors was similar regardless of the SES indicator included in the model. Controlling for neighborhood SES, maternal education, age and gender, the risk of initiation was increased by 38% [ARR = 1.38 (1.28, 1.49)] with each additional risk factor reported.

Table 5 presents SES-specific RRs, adjusted for age and gender (see Online Resource 6 for unadjusted RRs). Following recommendations by Knol and VanderWeele (2012), the models were recoded to use a common reference group (i.e., the group with the lowest risk of initiation across the stratifying variable). For neighborhood SES, the reference group was unexposed children in high–moderate SES neighborhoods, and for maternal education, it was unexposed children whose mothers had post-secondary education. The reference for each binary risk factor was coded as zero, and for ordinal risk factors the reference was the lowest level. Continuous variables were categorized by tertile into three groupings; the reference was the tertile grouping representing the lowest risk. As an example, compared to participants from high–moderate SES neighborhoods whose fathers did not smoke, the ARR (95% CI) was 1.20 (0.74, 1.93) among participants from low SES neighborhoods whose fathers did not smoke, 1.66 (1.02, 2.69) among participants from high–moderate SES neighborhoods whose fathers smoked, and 3.15 (1.88, 5.28) among participants from low SES neighborhoods whose fathers smoked.

The seven social modeling risk factors, perceived academic performance, susceptibility to smoking, depressive symptoms and use of other tobacco products were each associated with initiation regardless of neighborhood SES. Low self-esteem was protective among children from high–moderate SES neighborhoods, whereas high self-esteem was a risk factor among children from low SES neighborhoods. Moderate school connectedness was protective only in high–

Table 1 Prevalence of risk factors for smoking initiation by neighborhood socioeconomic status (SES) and maternal education, "AdoQuest I" 2005–2008, Montréal, Canada

Risk factor	Neighborhood SES[a]				Maternal education[b]			
	High ($n = 629$)[c]	Moderate ($n = 482$)	Low ($n = 279$)	p[d]	High ($n = 340$)[c]	Moderate ($n = 508$)	Low ($n = 307$)	p[d]
Father smokes	21.0[e]	24.4	29.2	0.023	16.1[e]	25.6	29.1	< 0.001
Mother smokes	17.2	23.0	25.1	0.007	11.1	21.5	29.8	< 0.001
Siblings smoke	7.1	6.8	9.2	0.416	4.8	8.9	7.8	0.045
Friends smoke	8.6	7.9	13.2	0.032	7.5	9.4	11.3	0.176
Home smoking ban								
None	13.2	18.5	23.4	< 0.001	8.2	17.8	25.3	< 0.001
Partial	34.9	41.1	33.1		33.0	38.2	36.3	
Complete	53.7	40.5	41.7		58.8	44.0	38.4	
Number of smokers at home								
≥ 2	11.4	16.1	18.0	0.001	7.0	16.6	18.6	< 0.001
1	16.1	20.2	22.4		12.8	18.5	25.8	
0	72.6	63.7	59.7		80.2	65.0	55.6	
Number of days exposed to smoking in cars								
≥ 3 days	9.7	11.7	13.2	0.257	5.8	11.0	17.0	< 0.001
1–2 days	11.0	12.7	13.9		10.6	13.4	12.3	
0 days	79.3	75.6	72.9		83.6	75.6	70.7	
Perceived academic performance								
Below avg	2.2	3.8	6.4	0.021	1.9	2.9	6.3	0.001
Average	54.8	53.4	54.6		50.6	55.7	55.1	
Above avg	43.1	42.9	39.0		47.5	41.4	38.6	
Susceptible to smoking	35.3	36.1	38.3	0.667	32.1	37.6	38.1	0.120
Depressive symptoms								
High	39.0	39.1	33.2	0.209	27.5	26.0	30.0	0.272
Moderate	33.9	32.5	40.3		34.7	33.4	34.8	
Low	27.2	28.4	26.4		37.8	40.6	33.6	
Self-esteem								
Low	32.8	35.5	42.4	0.232	32.5	37.4	40.6	0.064
Moderate	31.4	33.9	29.2		33.0	33.6	27.8	
High	32.8	30.6	28.5		34.5	29.0	31.6	

Table 1 continued

Risk factor	Neighborhood SES[a]				Maternal education[b]			
	High ($n = 629$)[c]	Moderate ($n = 482$)	Low ($n = 279$)	p[d]	High ($n = 340$)[c]	Moderate ($n = 508$)	Low ($n = 307$)	p[d]
School connectedness								
Low	34.9	36.5	43.7	0.044	34.1	35.7	42.1	0.159
Moderate	39.9	41.1	38.6		42.0	40.9	37.6	
High	25.2	22.4	17.6		23.9	23.4	20.3	
Use other tobacco products	1.8	2.8	3.1	0.427	2.2	2.9	1.8	0.496

[a]Classification of neighborhood SES is based on tertile groupings of the Pampalon index of material deprivation; higher tertiles = lower SES

[b]Classification of maternal education: low = secondary; moderate = post-secondary < Bachelor's degree; high = Bachelor's degree or higher

[c]*ns* reflect participants with missing values on neighborhood SES or maternal education. After imputation of missing values, *ns* for neighborhood SES = 652 (high), 504 (moderate), 296 (low); *ns* for maternal education = 415 (high), 628 (moderate), 399 (low)

[d]p values are based on χ^2 tests

[e]All proportions were calculated with missing values imputed

Table 2 Median (inter-quartile range, IQR) number of risk factors to which participants were exposed, as a function of SES, "AdoQuest I" 2005–2008, Montréal, Canada

SES indicator	Mdn (IQR)[a]
Neighborhood SES	
Low	5 $(3–6)_a$
Moderate	4 $(3–6)_b$
High	4 $(3–6)_c$
Maternal education	
Low	5 $(3–7)_d$
Moderate	4 $(3–6)_e$
High	4 $(3–5)_f$

[a]$p_{ab} = 0.001$; $p_{ac} = 0.002$; $p_{de} < 0.001$; $p_{ef} = 0.006$

Table 3 Median (inter-quartile range, IQR) number of risk factors to which participants were exposed, as a function of congruence between SES categories, "AdoQuest I" 2005–2008, Montréal, Canada

	Maternal education	
	Low	High–moderate
Neighborhood SES		
Low	5 $(4–6)_b$	4 $(3–6)_c$
High–moderate	5 $(3–7)_b$	4 $(3–5)_a$

The comparison group is high–moderate/high–moderate $(_a)$. $p_{ab} < 0.001$; $p_{ac} = 0.016$

moderate SES neighborhoods. There were no statistically significant additive interactions in any model.

All social modeling risk factors (except siblings' smoking), academic performance, susceptibility to smoking and depressive symptoms were associated with initiation regardless of maternal education. Siblings' smoking and self-esteem were statistically significant only among children whose mothers' education was high–moderate, while school connectedness and use of other tobacco products were significant only among children whose mothers' education was low (Table 4). Two significant positive additive interactions suggest an excess risk of initiation associated with low maternal education. Among children whose mothers had low education, excess risk of initiation was conferred by also having friends who smoked [RERI (95% CI) = 3.74 (0.60, 6.88); $p = 0.019$] or by living in a home without a smoking ban [RERI = 0.38 (0.19, 0.74); $p = 0.039$].

Discussion

Three noteworthy observations emerged in this analysis. First, compared to their moderate and high SES peers, relatively more low SES children were exposed to risk

Table 4 Adjusted risk ratios and 95% confidence intervals (CI) for smoking initiation by 7th grade by potential risk factors, "AdoQuest I" 2005–2008, Montréal, Canada ($n = 1451$)

	Neighborhood SES ARR (95% CI)[a]	Maternal education ARR (95% CI)[b]
Potential risk factor		
Father smokes		
No	1.00	1.00
Yes	1.90 (1.30, 2.79)***	1.87 (1.28, 2.73)***
Mother smokes		
No	1.00	1.00
Yes	2.41 (1.84, 3.16)***	2.31 (1.80, 2.95)***
Siblings smoke		
No	1.00	1.00
Yes	2.12 (1.41, 3.19)***	2.09 (1.39, 3.15)***
Friends smoke		
No	1.00	1.00
Yes	4.34 (3.16, 5.95)***	4.48 (3.35, 5.98)***
Home smoking rules		
Full ban	1.00	1.00
Partial ban	1.39 (0.88, 2.19)	1.36 (0.86, 2.17)
No ban	2.62 (1.79, 3.84)***	2.60 (1.76, 3.83)***
Number of smokers at home		
0	1.00	1.00
1	2.25 (1.52, 3.34)***	2.17 (1.47, 3.18)***
≥ 2	2.92 (1.97, 4.33)***	2.81 (1.88, 4.21)***
Number of days in past week exposed to smoking in cars		
0	1.00	1.00
1–2	1.56 (1.03, 2.35)*	1.54 (1.02, 2.31)*
3–7	3.09 (1.97, 4.05)***	2.93 (1.92, 4.46)***
Perceived academic performance		
Better than average	1.00	1.00
Average	1.43 (1.03, 1.98)*	1.40 (1.02, 1.92)*
Below average	2.50 (1.26, 4.97)**	2.43 (1.25, 4.73)**
Susceptible to smoking		
No	1.00	1.00
Yes	3.41 (2.46, 4.26)***	3.45 (2.45, 4.86)***
Depressive symptoms[c]	1.36 (1.11, 1.66)**	1.37 (1.11, 1.70)**
Self-esteem[c,d]	1.51 (1.22, 1.87)***	1.53 (1.24, 1.89)***
School connectedness[c,d]	1.41 (1.09, 1.82)**	1.41 (1.12, 1.78)**
Use other tobacco products		
No	1.00	1.00
Yes	2.18 (1.34, 3.54)**	2.25 (1.30, 3.87)**
Total number of risk factors	1.38 (1.28, 1.49)***,[e]	

* $p < 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$

[a]All models adjusted for neighborhood socioeconomic status (SES), age and gender. The moderate and high SES categories were combined in these analyses

[b]All models were adjusted for maternal education, age and gender. The moderate and high SES categories were combined in these analyses

[c]Entered as a continuous variable

[d]Reverse coded; higher scores mean lower self-esteem or school connectedness

[e]Adjusted for neighborhood SES, maternal education, age and gender

Table 5 Adjusted risk ratios (ARR) and 95% confidence intervals (CI) for 5th grade never smokers who initiated smoking by 7th grade by risk factors as a function of neighborhood socioeconomic status (SES) and maternal education, "AdoQuest I" 2005–2008, Montréal, Canada ($n = 1451$)

Risk factor	*n* did/did not initiate[a]		Neighborhood SES		*n* did/did not initiate[a]		Maternal education	
	H–M[b]	L[b]	H–M	L	H–M[c]	L[c]	H–M	L
Father smokes								
No	62/772	18/175	1.00[d]	1.20 (0.74, 1.93)	41/629	24/186	1.00	1.56 (0.99, 2.47)
Yes	32/216	18/61	*1.66* (*1.02*, *2.69*)	*3.15* (*1.88*, *5.28*)	24/132	14/74	*2.02* (*1.23*, *3.21*)	*2.58* (*1.35*, *4.93*)
Mother smokes								
No	57/820	21/181	1.00	*1.55* (*1.01*, *2.38*)	44/673	20/193	1.00	1.33 (0.78, 2.28)
Yes	37/176	15/55	*2.51* (*1.80*, *3.48*)	*3.41* (*2.05*, *5.69*)	21/89	18/72	*2.33* (*1.68*, *3.24*)	*3.03* (*1.74*, *5.26*)
Siblings smoke								
No	80/942	30/225	1.00	*1.55* (*1.07*, *2.24*)	59/733	35/241	1.00	*1.69* (*1.07*, *2.68*)
Yes	14/61	6/16	*2.18* (*1.40*, *3.42*)	*3.05* (*1.57*, *5.95*)	6/37	3/25	*2.77* (*1.66*, *4.63*)	2.02 (0.72, 5.72)
Friends smoke								
No	66/941	22/216	1.00	1.48 (0.93, 2.34)	48/723	23/246	1.00	1.19 (0.74, 1.91)
Yes	29/65	13/23	*4.67* (*3.44*, *6.35*)	*5.41* (*3.18*, *9.21*)	16/49	15/19	*3.55* (*2.57*, *4.91*)	*7.48* (*4.51*, *12.40*)
Home smoking rules								
Full ban	28/468	9/100	1.00	1.68 (0.95, 2.97)	24/387	8/93	1.00	1.24 (0.50, 3.06)
Partial ban	34/339	9/84	1.54 (0.93, 2.52)	1.70 (0.84, 3.46)	22/251	10/99	1.40 (0.87, 2.26)	1.62 (0.92, 2.86)
No ban	27/134	15/49	*2.64* (*1.72*, *4.05*)	*4.15* (*2.60*, *6.63*)	14/82	20/55	*2.31* (*1.47*, *3.63*)	*3.73* (*2.31*, *6.02*)
Number of smokers at home								
0	43/711	13/150	1.00	1.28 (0.69, 2.37)	32/593	12/152	1.00	1.29 (0.72, 2.33)
1	27/169	11/51	*2.20* (*1.38*, *3.49*)	*3.13* (*1.93*, *5.09*)	19/112	14/71	*2.22* (*1.34*, *3.69*)	*2.72* (*1.50*, *4.95*)
≥ 2	22/123	12/36	*2.72* (*1.75*, *4.24*)	*4.45* (*2.44*, *8.11*)	14/64	10/45	*2.71* (*1.59*, *4.62*)	*3.82* (*1.97*, *7.40*)
Days/week exposed to smoking in cars								
0	51/788	20/176	1.00	*1.65* (*1.03*, *2.65*)	44/637	18/183	1.00	1.18 (0.69, 2.01)
1–2	17/108	3/35	*1.98* (*1.35*, *2.90*)	1.15 (0.39, 3.39)	8/77	3/36	*1.60* (*1.02*, *2.50*)	1.70 (0.86, 3.37)
3–7	24/95	13/25	*3.02* (*1.81*, *5.05*)	*5.22* (*2.57*, *10.61*)	12/50	15/39	*2.39* (*1.33*, *4.28*)	*4.30* (*2.32*, *7.96*)
Perceived academic performance								
Above avg	27/419	10/94	1.00	1.29 (0.79, 2.12)	19/345	11/99	1.00	1.70 (0.92, 3.15)
Average	54/503	22/116	1.32 (0.87, 2.00)	*2.29* (*1.45*, *3.60*)	35/382	20/124	1.47 (0.96, 2.25)	*2.17* (*1.26*, *3.73*)

Table 5 continued

Risk factor	*n* did/did not initiate[a]		Neighborhood SES		*n* did/did not initiate[a]		Maternal education	
	H–M[b]	L[b]	H–M	L	H–M[c]	L[c]	H–M	L
Below avg	5/25	3/15	*3.01* (*1.46*, *6.23*)	2.46 (0.89, 6.80)	4/11	4/17	*3.22* (*1.64*, *6.33*)	*2.90* (*1.04*, *8.05*)
Susceptible to smoking								
No	31/672	12/163	1.00	1.64 (0.85, 3.15)	21/524	11/176	1.00	1.46 (0.67, 3.16)
Yes	63/329	24/78	*3.55* (*2.25*, *5.60*)	*5.10* (*3.27*, *7.93*)	43/252	27/87	*3.41* (*2.17*, *5.36*)	*5.21* (*2.84*, *9.55*)
Depressive symptoms[e]								
Low	26/371	11/70	1.00	1.84 (0.92, 3.68)	15/295	14/76	1.00	*2.29* (*1.10*, *4.77*)
Moderate	24/312	10/92	1.22 (0.73, 2.04)	1.56 (0.93, 2.63)	19/239	10/94	1.43 (0.83, 2.48)	1.66 (0.87, 3.15)
High	34/249	13/53	*1.90* (*1.33*, *2.71*)	*3.05* (*1.81*, *5.13*)	25/186	11/67	*2.25* (*1.46*, *3.46*)	*3.13* (*1.86*, *5.28*)
Self-esteem[e]								
High	20/312	6/71	1.00	*1.94* (*1.19*, *3.17*)	10/241	9/84	1.00	1.57 (0.85, 2.91)
Moderate	37/306	7/72	1.09 (0.65, 1.82)	1.24 (0.66, 2.30)	27/251	12/73	1.01 (0.63, 1.63)	1.31 (0.68, 2.54)
Low	37/342	20/92	*0.61* (*0.40*, *0.93*)	0.77 (0.38, 1.55)	27/254	15/91	*0.47* (*0.27*, *0.84*)	0.94 (0.47, 1.87)
School connectedness[e]								
High	21/229	5/38	1.00	1.36 (0.79, 2.34)	17/161	5/51	1.00	*1.91* (*1.12*, *3.25*)
Moderate	26/378	10/89	*0.65* (*0.42*, *1.00*)	1.13 (0.65, 1.99)	17/304	10/100	0.71 (0.44, 1.13)	1.25 (0.67, 2.33)
Low	38/311	16/92	0.88 (0.52, 1.49)	1.40 (0.58, 3.36)	24/232	17/93	1.21 (0.71, 2.06)	0.72 (0.31, 1.68)
Use other tobacco products								
No	82/965	31/224	1.00	*1.55* (*1.06*, *2.26*)	59/685	33/240	1.00	1.55 (0.96, 2.48)
Yes	5/17	2/5	*2.23* (*1.24*, *4.00*)	*3.20* (*1.29*, *7.93*)	3/12	1/4	2.25 (0.96, 5.26)	*3.45* (*1.55*, *7.67*)

RRs shown in *italic type* are significant at $p < 0.05$

[a]Denominators differ because of missing data. All models were run using imputed values and adjusted for age and gender. A robust variance estimate accounting for clustering by elementary school attended was used

[b]H–M = high–moderate SES neighborhood; L = low SES neighborhood

[c]H–M = high–moderate (post-secondary) maternal education; L = low (secondary or less) maternal education

[d]We present the ARRs with a common reference group across neighborhood SES (unexposed participants living in high–moderate SES neighborhoods) or maternal education (unexposed participants whose mothers have a Bachelor's degree or higher) and across exposure (unexposed or exposed at the lowest level if the risk factor was measured on an ordinal or continuous scale). As an example, compared to participants from high–moderate SES neighborhoods whose father did not smoke, the ARR for participants from high–moderate SES neighborhoods whose father smoked was 1.66 (1.02, 2.69), for participants from low SES neighborhoods whose father did not smoke was 1.20 (0.74, 1.93), and for participants from low SES neighborhoods whose father smoked was 3.15 (1.88, 5.28); discrepancies are attributable to imputation

[e]Classification of depressive symptoms, self-esteem and school connectedness is based on tertile groupings

factors for smoking initiation, and to co-occurrence of these risk factors. Concordant with a study of 766 5th graders in the Czech Republic (Žaloudiková et al. 2012), the proportion of participants in our study exposed to smoking in the social environment (i.e., as indicated by family members' smoking, absence of a home smoking ban, having smokers at home, and smoking in cars) increased with increasing deprivation, whether measured by neighborhood SES or maternal education. Not surprisingly, these data suggest that smoking-related risk clusters in families, such that if a parent smokes there is a lower likelihood of a smoking ban at home and in the family car. This co-occurrence could set the stage for initiation by fostering a "just too tempting to be resisted" environment. For example, a child watching a parent enjoy a cigarette with a cup of coffee, in conjunction with no home smoking ban and easily available cigarettes, could represent an enticement that is too difficult to withstand. Children living in this environment may not experience the shame or guilt that often accompanies violation of social norms. Further it is possible that smokers' offspring are "primed" to smoke by an interplay among biological and social factors (Hines et al. 2015). In the US in 2012, 30–70% of children ages 4–11 years were exposed to secondhand smoke, as indicated by blood cotinine levels (Federal Interagency Forum on Child and Family Statistics 2016). Also, never smoking youth exposed to secondhand smoke at home or in cars were more likely than their unexposed peers to report symptoms of nicotine dependence, especially cravings for cigarettes (Bélanger et al. 2008).

Second, as expected (Wellman et al. 2016), all 13 risk factors investigated were associated with cigarette smoking initiation, suggesting that smoking onset can only be explained from a multifactorial, multi-level socio-ecologic standpoint (e.g., McLeroy et al. 1988; Whitehead 2007). Because the causes of initiation include multiple individual- and context-level risk factors, it is unlikely that preventive efforts focused on a single risk factor will be effective in the long term. Even if the risk factor is powerful, our data suggest that prevention of initiation must be addressed from multiple standpoints concurrently. For example, it is possible that the recent marked declines in smoking prevalence relate to the converging influences of widespread public health tobacco control programs in conjunction with increasingly prohibitive legislation and policy (e.g., Zellers and Tobacco Control Legal Consortium 2013).

There was no apparent social gradient in use of other tobacco products. It may be that marked differences among elementary school children across SES are not yet evident because the level of use is generally low. In contrast, parental smoking, which is highly prevalent, demonstrated a social gradient, perhaps because children are generally cognizant of their parents' smoking status even if parents smoke only outside the home or when a child does not live with a parent who smokes (e.g., Dalton et al. 2005).

Third, our data do not provide compelling evidence that risk factors for smoking initiation are more potent or that children are more vulnerable to these risk factors in low SES environments. Our results do suggest an excess risk of initiation among children whose mothers have low education and (1) whose friends smoke, or (2) who live in homes without a smoking ban. However, given the cost and complexity of designing and implementing interventions for specific subgroups, more evidence is needed to confirm these findings before they are acted on. In particular, studies in other jurisdictions with differing levels of economic development would increase generalizability.

If indeed low SES children are not more vulnerable to these risk factors, and if the operative factors are the prevalence and co-occurrence of risks, then preventive intervention should focus primarily on reducing risk factor prevalence and co-occurrence. Phelan et al. (2010) suggest that social disparities in health can be diminished by distributing socioeconomic resources relatively equally across SES groups. Tobacco control efforts that reach all SES levels should lower the prevalence and co-occurrence of risk factors, and the effects of such efforts should be proportional to the base rates of such risk factors. Tobacco control efforts with broad reach include extending smoke-free policies to areas where children and young people congregate (e.g., playgrounds, sports fields, private vehicles carrying minors), institution of smoke-free policies in public housing (Berg et al. 2015; US Department of Housing and Urban Development 2016), and efforts to raise the legal age to purchase tobacco to 21 years (Institute of Medicine 2015).

Limitations of this analysis include that most participants were Francophone, which may limit generalizability because smoking rates tend to be higher in this linguistic group in Canada than among Anglophones or Allophones. Self-report of smoking status, although accurate in youth (Wong et al. 2012), may result in some misclassification of smoking status. However, we used multiple indicators of cigarette smoking over two data collections 6 months apart to identify first puff. This intense follow-up likely permitted detection of incident smokers who would not have been identified using less intense methods. Loss to follow-up may have introduced selection bias. Finally, the sample size may have been too small to detect smaller differences between the effects of risk factors for smoking initiation across SES.

Study strengths include the longitudinal design which enhances causal inferences, use of two SES measures for broader representation of the construct, and the inclusion of a wide range of risk factors for initiation.

Conclusion

If not addressed, social disparities in smoking will disproportionately increase the burden of smoking in low SES groups. Relative to advantaged children, more children living in low SES contexts are exposed to well-established risk factors for cigarette smoking initiation. While the risks associated with these factors do not differ substantially across SES, the higher prevalence and co-occurrence may create a "perfect storm" that is difficult for many children to resist. Numerous reports show that, among children who try cigarettes, 25–30% will escalate increasing the risk for long-term nicotine dependence. If the primary issue in low SES contexts is the higher prevalence and co-occurrence of risk factors, then tobacco control programs must address this issue head-on if meaningful impact in reducing initiation and smoking prevalence is to be achieved. Our data support the suggestion by Stringhini et al. (2017) that interventions addressing both SES and specific risk factors will be necessary to mitigate premature mortality related to cigarette smoking.

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Compliance with ethical standards

Conflict of interest The authors declare no conflicts of interest.

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