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Trends in tobacco smoking among adolescents in Lyon, France

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Abstract

To provide information that may promote more effective cancer prevention, we identified factors associated with regular smoking among adolescents in Lyon, France. School grades where these factors began to influence regular smoking were also identified. Seven consecutive cross-sectional anonymous surveys were conducted in three public schools, beginning in grade *6ème* (average age 11.5 years) in 1993 and ending in grade *Terminale* (average age 17.4 years) in 1999. All classes in each respective grade were surveyed, with 3650 completed questionnaires for all years combined. Prevalence of current regular smoking is presented according to school grade for 17 variables identified as significantly related to regular smoking in a multivariate logistic regression analysis. Important factors associated with regular smoking were identified as early as grade *6ème* and included not viewing the taking care of one's health as important, not eating breakfast regularly, associating with groups where smoking occurs, having a best friend who smokes, and having a brother and/or sister who smokes. Not regularly reading was first associated with an increased risk of regular smoking in grade *5ème*. Not living with both parents, alcohol drinking, episodes of drunkenness, illicit drug use, and sexual relationships were positively associated with regular smoking in the middle and later grades, when these questions were first asked. Not playing sports and not playing with computers were initially associated with an increased risk of regular smoking in grade *3ème*.

Keywords: Cross-sectional; Multivariate logistic regression; Primary prevention; Smoking; Youth

1. Introduction

Although adolescent smoking levels in France have declined in recent decades [1], smoking continues to pose a significant public health problem with over 50% of the population being regular or occasional smokers by the age of 18–24 years [2]. Adolescent smoking tends to be associated with a host of high-risk behaviours (excessive alcohol consumption, illicit drug use and sexual activity) [1,3–5], and is a major predictor of adult smoking [6,7]. Large-scale epidemiological studies have identified numerous forms of chronic illness and death associated with smoking [8–10]. These studies have associated smoking with several malignancies, including lip, oropharyngeal, nasal cavity and paranasal sinuses, nasopharyngeal, hypopharyngeal, oesophageal, stomach, pancreatic, laryngeal, lung, bladder, renal, liver and cervical cancers [8]. In addition, high-risk behaviours associated with smoking, such as alcohol drinking, use of marijuana and related products, and sexual activity, have been associated with some of these cancers, as well as others [11–13].

Although various factors have been associated with adolescent smoking, the precise timing of when these factors begin to manifest themselves in adolescent smoking is less well understood. Identifying factors

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associated with adolescent smoking as they relate to age is important to elicit information useful for the primary prevention of several major cancers. In other words, being able to identify risk factors for smoking that are more common at certain ages will allow prevention efforts to be better timed in the young persons' life. This paper will identify associations between potential smoking risk factors and regular smoking according to school grade among adolescents in Lyon, France. Many of the risk factors considered have been identified in the literature, and involve recreational habits, family characteristics, health behaviours, environmental factors, licit and illicit drug use, and sexual behaviour among adolescents. We also assess whether the association between smoking risk factors and regular smoking by school grade is influenced by the gender of the individual.

2. Patients and methods

2.1. Study participants

Study participants came from three schools located in Lyon, France. The schools were conveniently selected from all public-urban schools, although they were chosen to represent varying sizes of student bodies and geographical locations. The majority of students came from middle to upper socio-economic classes. Approximately 70% of all adolescents in Lyon attend public schools. Schools in France are called *collèges* (for students generally aged 10–15 years) and then *lycées* (for students generally aged 16–18 years). School grades for adolescents in France, from youngest to oldest ages, are referred to as *6ème, 5ème, 4ème, 3ème, 2nde, 1ère* and *Terminale*.

The study began in 1993 when questionnaires were administered at the beginning of the school year to all grade *6ème* classes. At the beginning of the 1994 school year, a questionnaire was administered to grade *5ème* classes and so on through to the beginning of the 1999 school year, when a questionnaire was administered to all classes in the *Terminale* grade. All classes for these respective grades were included to minimise bias due to selection. The study design, therefore, involves a series of cross-sectional surveys. Questionnaires did not ask for identifying information, therefore, linking personal responses over time was not possible. This means that trends considered in the study reflect average changes for the overall study population.

A summary of the number of questionnaires completed, response and participation proportions, and gender and age for each grade are given in Table 1. Response proportions were computed by dividing the number of questionnaires collected by the number of students present in the classroom at the time of administration of the questionnaire. It was never lower than 97% and reached 100% for three grades. Participation proportions were computed by dividing the number of questionnaires by the number of students enrolled in the grade, thus reflecting both response and non-absenteeism from school. These proportions varied from 85.3 to 96.1%. No significant differences in response or participation proportions were observed among the three schools. To provide more stable estimates, data from all three schools were combined in the analysis. An average of 521 students were surveyed each year, from grade *6ème* onwards, with slightly more girls than boys. For all grades, there were 3650 questionnaires collected and available for evaluation.

At the beginning of each school year, before administering the survey, students were given a permission slip to be signed by their parents. The form briefly described the study and requested permission for their child to participate in the study. Signatures were obtained from parents of all children, indicating the supportive environment for conducting such studies in Lyon at the time.

Table 1
Description of response and participation proportions, completed questionnaires, gender and age by school grade

	School grade						
	6ème	*5ème*	*4ème*	*3ème*	*2nde*	*1ère*	*Terminale*
Response proportions (%)	100	100	97.3	99.4	100	99.1	99.0
Participation proportions (%)	96.1	94.2	85.3	85.3	95.9	88.9	90.1
Completed questionnaires	601	486	573	518	442	539	491
Girls (%)	48.4	50.0	52.2	52.3	51.8	51.9	54.2
Boys (%)	51.6	50.0	46.6	47.1	48.0	47.5	45.6
Unknown gender (%)	–	–	1.2	0.6	0.2	0.6	0.2
Mean age (years)	11.5	12.3	13.9	14.9	15.6	16.6	17.4

Response proportions were computed by dividing the number of questionnaires collected by the number of students present in the classroom. Participation proportions were computed by dividing the number of questionnaires by the number of students enrolled in the grade.

2.2. Instrument

Content and face validity of the survey instrument was based on the experience and expertise of the authors. An exhaustive literature review provided additional information for guiding the content of the instrument. The validity of the instrument was further refined based on pilot testing of a small number of students in the relevant grades. In addition, not all questions were asked of all grades. Certain items were only felt appropriate for the latter grades, like questions involving illicit drug use and sexual relationships.

Questionnaires were completed during class. They allowed characterisation of the child in terms of age, gender and family structure. In addition to tobacco and basic demographics, questions solicited information on recreational activities, family characteristics, personal health, smoking environments, alcohol and illicit drug use, and sexual activity. A list of the variables we consider in this study is presented in Table 2. Regarding smoking status, students were asked to read the following items and to select the one that corresponds best to them: never smoked; only tried to smoke once; have smoked, but don't smoke now; smoke from time to time, but less than one cigarette per week; smoke between one and six cigarettes per week; smoke more than six cigarettes per week. Smoking status was categorised as never/or one time only (hereafter, referred to

Table 2
Description of study variables involving behaviours related to recreation and family, personal health, smoking environment, drug and alcohol use, and sexual activity

Questions[a]	Responses
Recreation	
Do you play sports?	Yes, No
Do you regularly watch television?	Yes, No
Do you regularly listen to music?	Yes, No
Do you play on the computer?[b]	Yes, No
Do you regularly read?[c]	Yes, No
Family	
Do your parents live together?[d]	Yes, No (divorced or death or other)
Do you live with:[e]	Both parents, One parent, Alone or with a friend
Personal health	
Taking care of your own health is:	Very important, Somewhat important, Not important
Careful about what you eat:	Never, Often, Always
Do you brush teeth:	Two or three times per day, Less
Do you shower or bathe every day?	Yes, No
Do you wash hair at least twice per week?	Yes, No
Do you change underclothes every day?[c]	Yes, No
Do you regularly eat breakfast?	Yes, No
Frequency of eating fast food in last month:[f]	Never, One or two times, Three or more times
Smoking environment	
Does cigarette smoke annoy you?	Very much, Much, A little, Not at all
Smoking occurs at home:	Never, Seldom, Often, Always
Notice smoking in public places:	Never, Seldom, Often, Always
Notice smoking on public transportation:	Never, Seldom, Often, Always
Notice smoking at school:	Never, Seldom, Often, Always
Smoking occurs in classroom:	Yes, No
Smoking in group you associate with:	Yes, No
Does your best friend smoke?	Yes, No
Do your parents smoke?	Neither, Father only, Mother only, Both
Brother and/or sister smokes:	Yes, No
Alcohol, illicit drugs, and sexual activity	
During the last month, did you drink any alcohol?[g]	Never, less than once, Once or more per week, Daily
Have you previously been drunk?[f]	No, Yes (once), Yes (more than once)
Have you previously tried drugs?[d]	Yes, No
Have you ever had a sexual relationship?[d]	Yes, No

[a] Available for grades *6ème–Terminale* unless otherwise indicated.
[b] Available for all grades except grade *4ème*.
[c] Available for all grades except grade *3ème*.
[d] Available for grades *3ème–Terminale*.
[e] Available for grade *Terminale*.
[f] Available for grades *4ème–Terminale*.
[g] Available for grades *5ème–Terminale*.

as never), former, occasional (less than weekly), and regular (weekly) smoker.

2.3. Statistical methods

The distribution of smoking status across school grades was summarised using percentages, separately for girls and boys. Trends were evaluated using the Mantel–Haenszel trend Chi-square test. Independence among distributions was evaluated using the Pearson Chi-square test (hereafter referred to as Chi-square test). Multivariate logistic regression analysis, performed for grade *Terminale* only, was used to compute the odds of regular smoking (versus never smoking). Logistic regression models were computed separately for the category-specific variables listed in Table 2, as well as gender. The best fitting model for each category was determined using backward stepwise regression, based on the 0.2 level. The percentage of regular smoking for those variables identified as statistically significant in the multivariate analysis was derived according to school grades. Unless otherwise specified, tests of significance and confidence intervals were based on two-sided hypotheses at the 0.05 level. Statistical analyses were conducted using Statistical Analysis System (SAS) software, version 8.2 [14].

3. Results

Proportions of the various adolescent smoking behaviours are presented according to grade and gender in Table 3. The trend in the proportion of regular smokers significantly increased over school grades (Mantel–Haenszel (MH) trend Chi-square $P<0.0001$ for both girls and boys). Trends in the proportions of former and occasional smoking were not statistically significant for either girls or boys. The proportion of regular smokers was greater for girls than boys in all grades except *6ème* and significantly so in grades *4ème, 3ème, 1ère* and *Terminale* (Chi-square $P<0.05$).

For grade *Terminale*, multivariate logistic regression was used to assess the relationship between regular smoking versus never smoking and variables within each of the following categories: recreation; family; personal health; smoking environment; and alcohol drinking, episodes of drunkenness, illicit drug use and sexual relationships (Table 4). For the category recreation, regular smoking compared with never smoking was independently lower among respondents who played sports, played on the computer, and regularly read (albeit marginally not significant at the 0.05 level). For the category family, regular smoking compared with never smoking was greater among respondents who lived with only one parent and noticeably greater for those who did not live with either parent. For the category personal health, several variables were independently related to regular smoking status: taking care of your own health considered not important and not regularly eating breakfast. Regular smoking was also associated with a higher frequency of bathing and washing hair. For the category smoking environment, respondents who were more likely to notice smoking on public transportation were less likely to regularly smoke (but this statistic is marginally not significant at the 0.05 level). By contrast, smokers are more common among the ones who respond that cigarette smoke does not annoy you at all. When smoking occurred in the group you associate with, among your siblings, and particularly with your best friend, the respondent was significantly more likely to be a regular smoker. Finally, for the category involving alcohol, illicit drugs, and sexual relationships, regular smoking was independently positively associated with an increasing frequency of alcohol drinking and episodes of drunkenness, as well as having tried illicit drugs and having had a sexual relationship.

The proportion of regular smoking was presented according to school grade for the 17 variables found to be significant in the multivariate analysis (Table 5). Trends among the levels of each of these variables tended to increase over the grades i.e. as the subjects got older. Although the proportion of regular smokers was comparatively low in the early grades, high risk factors were identified as early as grade *6ème*: taking care of your own health viewed as not important, not eating breakfast regularly, smoking in the group you associate with, having a best friend who smokes, and having a

Table 3
Proportions of smoking behaviours according to school grade and gender

School grade	No.	Never smoked or tried once		Former smoker		Smokes less than once per week		Regular (weekly) smoker	
		Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
6ème	601	88.7	91.1	5.5	6.2	3.2	1.4	2.6	1.4
5ème	484	77.4	82.6	10.3	6.2	5.4	2.9	7.0	8.3
4ème	558	62.4	49.5	18.6	19.0	6.8	12.9	12.2	18.6
3ème	512	62.1	43.1	11.5	12.6	8.6	11.2	17.7	33.1
2nde	436	59.1	50.4	9.1	12.8	4.8	4.9	27.1	31.9
1ère	535	49.2	38.7	13.3	17.6	9.0	5.7	28.5	38.0
Terminale	490	49.1	39.1	18.3	16.9	6.3	6.0	26.3	38.0

brother and/or sister who smokes. Not regularly reading and not being annoyed at all by cigarette smoke were associated with an increased risk of regular smoking in grades *5ème* and *4ème*. For the grades where this information was available, a positive association was observed between regular smokers and increasing frequency of alcohol drinking, episodes of drunkenness, illicit drug use, and having had a sexual relationship. Not playing sports or not playing with computers did not begin to be associated with an increased risk of regular smoking until grades *3ème* and *2nde*.

The proportion of regular smokers significantly increased when subjects were living with one parent or neither parent. Unfortunately, this variable was not included in the earlier years. However, the question as to whether your parents live together was asked for grades *3ème* through to *Terminale*. For these grades, the proportions of being a regular smoker significantly increased among subjects with parents not living together versus living together, 43.1% versus 21.3% ($P<0.0001$), 35.8% versus 27.8% ($P=0.1298$), 47.1% versus 29.6% ($P=0.0004$), and 42.4% versus 30.1%

Table 4
Multivariate analysis of the association between regular (weekly) smoking and selected variables according to category among students in grade *Terminale*[a]

Variable	Odds ratio	95% Confidence interval
Recreation		
Do you play sports? (yes versus no)	0.7	0.4–1.0
Do you play on the computer? (yes versus no)	0.7	0.5–1.1
Do you regularly read? (yes versus no)	0.7	0.4–1.1
Family		
Do you live with:		
Both parents	1.0	Reference
One parent	2.2	1.3–3.6
Alone or with a friend	13.0	2.9–58.5
Personal health		
Taking care of your own health is:		
Very important	1.0	Reference
Somewhat important	1.6	0.6–4.3
Not important	70.8	3.3–∞
Do you shower or bathe every day? (yes versus no)	2.2	1.1–4.3
Do you wash hair at least twice per week? (yes versus no)	2.6	1.4–4.7
Do you regularly eat breakfast? (no versus yes)	3.0	1.4–6.4
Smoking environment		
Does cigarette smoke annoy you?		
Very much	1.0	Reference
Much	5.4	1.6–24.8
A little	23.5	5.3–103.9
Not at all	108.9	23.2–510.2
Notice smoking on public transportation:		
Never	1.0	Reference
Seldom	0.9	0.4–2.1
Often	0.6	0.3–1.2
Always	0.5	0.2–1.2
Smoking in group you associate with: (yes versus no)	3.8	1.7–8.2
Does your best friend smoke? (yes versus no)	13.7	7.0–26.9
Brother and/or sister smokes: (yes versus no)	3.4	1.7–6.8
Alcohol, illicit drugs and sexual activity		
During the last month, did you drink any alcohol?		
Never	1.0	Reference
Less than once per week	1.7	0.6–4.8
Once or more per week	2.2	0.7–7.0
Daily	5.7	0.5–63.9
Have you previously been drunk?		
No	1.0	Reference
Yes (once)	1.6	0.6–4.5
Yes (more than once)	3.1	1.3–7.1
Have you previously tried drugs? (yes versus no)	21.9	10.4–46.2
Have you ever had a sexual relationship? (yes versus no)	3.1	1.5–6.3

[a] Variables included in each category were determined using separate multivariate models based on backward stepwise regression results and the 0.2 level of significance. Estimates are adjusted for gender and other variables listed in the respective categories.

Table 5
Proportions of regular (weekly) smokers by school grade and variables within categories

Variable	School grade (%)						
	6ème	*5ème*	*4ème*	*3ème*	*2nde*	*1ère*	*Terminale*
Recreation							
Do you play sports?							
Yes	2.2	7.5	16.2	**23.5**	**26.6**	**30.0**	**29.3**
No	1.4	7.3	13.2	**32.6**	**36.7**	**42.4**	**41.2**
Do you play computer games?							
Yes	2.2	8.0		**19.9**	**21.1**	**27.3**	29.2
No	1.8	7.2		**33.6**	**37.9**	**39.9**	37.0
Do you regularly read?							
Yes	1.5	**5.7**	**12.4**		29.6	**29.6**	30.6
No	3.5	**14.2**	**22.5**		29.4	**42.8**	37.7
Family							
Do you live with:							
Both parents							**28.3**
One parent							**43.2**
Alone or with a friend							**59.3**
Personal health							
Taking care of your own health is:							
Very important	**1.1**	**4.7**	**12.2**	25.9	28.6	**31.6**	**31.1**
Somewhat important	**3.2**	**13.3**	**42.5**	23.3	31.0	**52.6**	**41.7**
Not important	**17.7**	**25.0**	**53.9**	*62.5*	50.0	**50.0**	**85.7**
Do you shower or bathe every day?							
Yes	2.8	6.1	17.1	28.5	31.4	34.2	**35.8**
No	1.3	9.1	12.0	21.6	25.0	31.3	**23.0**
Do you wash hair at least 2 times/week?							
Yes	2.7	9.9	18.2	28.6	30.8	**36.7**	**37.0**
No	1.6	5.9	12.6	23.6	27.1	**26.7**	**25.0**
Do you regularly eat breakfast?							
No	**11.6**	**22.2**	**30.2**	**36.1**	**50.0**	**50.0**	**54.6**
Yes	**1.3**	**6.2**	**12.4**	**22.8**	**25.9**	**29.9**	**28.9**
Smoking environment							
Does cigarette smoke annoy you?							
Very much	*0.0*[a]	***0.0***	**3.1**	**2.9**	**1.7**	**4.8**	**4.7**
Much	0.3	**1.1**	**5.0**	**7.0**	**9.3**	**14.7**	**15.7**
A little	0.5	**5.8**	**12.8**	**23.1**	**30.5**	**30.3**	**36.1**
Not at all	14.1	**32.5**	**37.0**	**56.7**	**61.3**	**63.9**	**60.2**
Notice smoking on public transportation:							
Always	1.9	16.1	**33.3**	**17.7**	36.9	44.4	41.7
Often	0.7	5.5	**10.3**	**17.2**	23.3	**21.5**	27.8
Seldom	2.3	7.3	**12.5**	**24.3**	27.1	**29.2**	31.6
Never	2.9	7.0	**20.8**	**38.5**	40.8	**49.5**	35.9
Smoking in group you associate with:							
Yes	**15.6**	**29.5**	**27.0**	**41.6**	**47.0**	**47.8**	**48.1**
No	**0.2**	**1.2**	**2.1**	**4.0**	**5.1**	**7.0**	**8.5**
Does your best friend smoke?							
Yes	**6.3**	**38.5**	**38.3**	**57.7**	**67.8**	**61.3**	**60.3**
No	**1.2**	**1.1**	**3.3**	**6.9**	**9.5**	**9.1**	**8.8**
Brother and/or sister smokes:							
Yes	**5.6**	**28.4**	**32.8**	**41.7**	**50.0**	**53.9**	**52.5**
No	**1.3**	**2.3**	**10.7**	**18.6**	**20.8**	**23.6**	**23.5**
Alcohol, illicit drugs, sexual activity							
During the last month, did you drink any alcohol?							
Never		**4.6**	**4.8**	**10.0**	**14.1**	**18.0**	**11.5**
Less than once per week		**11.4**	**19.3**	**33.0**	**33.5**	**30.95**	**32.1**
Once or more per week		**13.0**	**37.0**	**40.4**	**48.1**	**53.5**	**44.2**
Daily		***50.0***	**52.6**	**41.2**	***100.0***	***55.6***	**62.5**
Have you previously been drunk?							
No		**3.7**	**7.3**	**12.9**	**13.6**	**12.8**	**11.9**
Yes (once)		**32.4**	**20.8**	**30.8**	**32.2**	**32.0**	**27.5**
Yes (more than once)		**29.4**	**51.9**	**63.4**	**73.7**	**60.9**	**54.4**
Have you previously tried drugs?							
Yes				**64.6**	**79.5**	**66.8**	**60.7**
No				**10.8**	**10.5**	**11.3**	**10.0**
Have you ever had a sexual relationship?							
Yes				**53.4**	**68.4**	**58.4**	**56.0**
No				**19.7**	**20.7**	**22.1**	**18.0**

Bold-typed represent statistical significance in percentages across the levels of the variable within grade, based on the Chi-square test for independence and the 0.05 level. Italic-typed represent estimates based on sample sizes of less than 10.

[a] Insufficient numbers to compute statistics for this variable in this grade.

($P = 0.0167$), respectively. Hence, the protective effect of parents living together against regular smoking was seen at least back to the *3ème* grade when this variable was introduced. The association between the frequency of showering or washing hair and regular smoking was not significant until grades *1ère* and *Terminale*. Greater frequency of showering or washing hair among regular smokers suggests a response to the smoking or a preoccupation with external appearance rather than these behaviours leading to regular smoking. Finally, noticing smoking on public transportation was not consistently associated with regular smoking across the grades.

We were also interested in why former smokers stopped smoking and how optimistic never smokers were about not becoming smokers. To evaluate these questions, we restricted the analysis to grade *Terminale* by which time a sufficient number of individuals could have stopped smoking. The primary reason given for stopping was a concern for their health (42% of girls and 39% of boys). Girls were more likely to give up smoking to avoid becoming addicted (27% versus 20% for boys), but less likely to stop because of the cost (18% versus 37% for boys) and involvement in sports (9% versus 27%). Less common reasons for stopping were to please a loved one (11% for girls and 7% for boys) and because of a doctor's advice (4% for girls and 2% for boys). Finally, boys were more optimistic than girls across all grades about remaining non-smokers, significantly increasing trends in percentages were observed for both girls and boys across the grades, from 71% in grade *6ème* to 85% in grade *Terminale* for the girls (MH trend Chi-square $P < 0.001$) and from 73% in grade *6ème* to 90% in grade *Terminale* for the boys (MH trend Chi-square $P < 0.001$).

4. Discussion

Prevention efforts have the potential to greatly reduce the burden of cancer caused by tobacco smoking. However, effective prevention presupposes an understanding of those factors that explain why individuals smoke and the ages where they have the greatest influence. The primary aim of this study was to identify various factors that may be associated with regular smoking in adolescents according to their age. Multivariate methods were used to identify dominant factors associated with regular smoking. Repeated assessment of the proportions of regular smoking across grades and analyses for various factors allowed us to identify when certain factors began to influence smoking behaviour.

We found 17 variables from five different categories as being associated with regular smoking. Risk factors for regular smoking were identified as early as grade *6ème*. Primary prevention efforts against smoking, as they relate to these factors, must begin early in life, and may initially attempt to modify health views, the importance of eating breakfast, why cigarette smoke is dangerous, and to influence associations with friends and groups. Identifying children in families where their siblings smoke or who do not live with one or both parents, which were found as risk factors, is also important. However, although it may not be possible to change a child's smoking environment or family situation, identifying why these factors are linked to smoking is the next step towards prevention. Furthermore, children prior to grade *5ème* who do not regularly read, and children prior to grade *3ème* who are not active in sports or who do not play on the computer should be targeted as being at a higher risk of starting smoking. Primary prevention efforts may involve increasing participation in these activities.

Although the results indicated that some recreational activities were protective against regular smoking (regular activity in sports, playing on computers, and reading), others were not (frequently listening to music or watching television). Interaction terms were added between gender and activity in sports, between gender and computers, and between gender and reading (data not shown). However, the interaction effects were not significant, suggesting that the relationship between these variables and regular smoking was not dependent on gender. Previous studies have found that participation in sports is negatively associated with smoking and other risk behaviours among adolescents [15,16]. Sports may encourage better general health practices and may take the place of associations with friends who smoke and groups where smoking is present. Perhaps playing on the computer and reading are protective because they replace, at least to some degree, the need to associate with friends and groups where smoking is present.

A previous study involving British adolescents found that those with a good sense of well-being were less likely to be smokers [17]. Another study involving French adolescents, based on the Horn test, found that smoking was associated with a search for relaxation and was used to decrease negative emotions [18], both of which are linked to a lesser well-being. Participation in sports, computers and reading may provide a better sense of well-being. However, while identifying causal mechanisms and mediating processes requires judgement and reasoning that goes beyond statistics, it is likely that many of the variables in the final models are mediating the effect of self-esteem. Although we did not examine the complex, multidimensional (separate domains for social, academic, athletic, etc.) aspects of self-esteem, future research is needed on this important topic.

Bonding with friends is an important part of adolescent development. The impact of peers on regular smoking is greater than that of parents and siblings.

This result is consistent with a previous study involving adolescents from Lyon and Paris, France [2]. Another study conducted in the West of Scotland among youths, aged 15–21 years, likewise found that friends had a larger influence on smoking than did parents or siblings [19]. That study also found that the influence of friends extends beyond adolescence into early adulthood. These findings were observed for both boys and girls, as we also observed. We did not have precise information on smoking restrictions at home, which has been previously shown to be associated with adolescent smoking [20].

Several studies have identified an increased risk of smoking if a best friend smokes or if members of a group with which the child associates smoke [21,22]. Some studies have found the influence to be greater for boys than girls [23], whereas others have found it to be similar or even stronger for girls [24]. In our study, interaction terms were added to assess whether the relationship between regular smoking and their best friend smoking and between regular smoking and their group smoking were dependent on gender (data not shown). None of these interaction terms was significant, indicating no statistically significant difference between girls and boys.

Consistent with smokers being less concerned about personal health, they were also more likely to use alcohol, use illicit drugs, and be sexually active. These associations have been observed in numerous studies [1,3–5]. We also identified episodes of drunkenness as being associated with regular smoking. These factors were among the most strongly associated with regular smoking, across all the grades where the data was available. However, for the alcohol and drunkenness variables, which we have from grade *5ème* onwards, the effects of alcohol drinking and episodes of drunkenness had a less pronounced effect on regular smoking than in subsequent years.

The proportion of former smokers by grade *Terminale* was 17.5%. Reasons for giving up smoking differed between girls and boys, with personal health and becoming addicted reported more often by girls and cost and sports more frequently by boys. Other studies likewise found that the primary reasons given for wanting to stop are cost and health concerns, with boys being more responsive than girls to changes in the price of cigarettes [25,26]. The fact that few individuals indicated that they stopped because of the advice of a physician may not be because physicians would not have an important influence on their smoking behaviour, but because the adolescents had not been in a situation to get advice from a physician or the physician did not take the opportunity to provide such advice. This latter reason has been identified as a major problem in the USA, despite a consensus about the importance of giving advice about stopping smoking [27,28].

The percentage of never smokers expecting to remain smoke-free increased as the subjects aged. By grade *Terminale*, 85% of girls and 90% of boys who had never smoked expected to remain smoke-free. This result is consistent with that of other studies showing that regular smokers typically begin smoking during their early adolescent years [6,7], emphasising the need to begin prevention efforts in early adolescence or before.

This study was intended to represent a single cohort followed over time. However, there is no way of knowing from the data which respondents remained the same over the years. Yet based on records providing a general idea of the level of migration in and out of these schools, we can assume that the vast majority of students were the same from year to year. We also believe the study participants represent, in general, smoking behaviours of adolescents in middle-upper class urban public schools in Lyon. As previous studies have shown differences between urban and rural or public and private schools to be small [2] and as there are few geographical differences in adolescent smoking in France [1], our results can be considered reasonably representative for French adolescents. The similarity of the risk factors identified in this study to those found in other countries, such as the USA or African countries, underlines the universal need for age-specific prevention efforts.

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