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Cigarette smoking and multiple health risk behaviors: a Latent Class Regression Model to identify a profile of young adolescents

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ABSTRACT

Cigarette smoking is often established during adolescence when other health-related risk behaviors tend to occur. The aim of the study was to further investigate the hypothesis that risky health behaviors tend to cluster together and to identify distinctive profiles of young adolescents based on their smoking habits.

To explore the idea that smoking behavior can predict membership to a specific risk profile of adolescents, with heavy smokers being more likely to exhibit other risk behaviors, we re-analyzed the data from the 2014 Health Behaviour in School-aged Children Italian survey of about 60,000 first and third grade junior high school (JHS) and second grade high school (HS) students. A Bayesian approach was adopted for selecting the manifest variables associated with smoking; a latent class regression model was employed to identify smoking behaviors among adolescents. Finally, a health-related risk pattern associated with different types of smoking behaviors was found. Heavy smokers engaged in higher alcohol use and abuse and experienced school failure more often than their peers. Frequent smokers reported below-average academic achievement and self-rated their health as fair/poor more frequently than non-smokers. Lifetime cannabis use and early sexual intercourse were more frequent among heavy smokers.

Our findings provide elements for constructing a profile of frequent adolescent smokers and for identifying behavioral risk patterns during the transition from JHS to HS. This may provide an additional opportunity to devise interventions that could be more effective to improve smoking cessation among occasional smokers and to adequately address other risk behaviors among frequent smokers.

KEYWORDS: Adolescents; smoking; risk pattern; co-substances use; latent class regression

SUMMARY

Cigarette smoking is often established during adolescence when other health-related risk behaviors occur. The aim of the study was to investigate the hypothesis that risky health behaviors tend to cluster together and to identify distinctive profiles of adolescents based on their smoking habits.

We analyzed the data from the 2014 Health Behaviour in School-aged Children Italian survey of about 60,000 first and third grade junior high school (JHS) and second grade high school (HS) students. A Bayesian approach was adopted for selecting the variables associated with smoking; a latent class regression model was employed to identify smoking behaviors. A health-related risk pattern associated with different types of smoking behaviors was found.

Heavy smokers engaged in alcohol use and abuse and experienced school failure more often than their peers. Smokers reported below-average academic achievement and self-rated their health as fair/poor more frequently than non-smokers. Lifetime cannabis use and early sexual intercourse were more frequent among smokers.

Our findings provide elements for identifying behavioral risk patterns during the transition from JHS to HS. This may provide an opportunity for interventions that could be effective to improve smoking cessation among occasional smokers and to adequately address other risk behaviors among frequent smokers.

1. INTRODUCTION

Tobacco use during adolescence increases the risk of persistent nicotine dependence in youths, many of which will become regular tobacco users in adulthood (Dick & Ferguson, 2015). Globally, 1 out of every 10 girls and 1 in every 5 boys aged 13-15 years use tobacco, with the highest smoking rates reported for the Western Pacific regions and Europe (World Health Organization [WHO], 2014). Findings from two surveys (2010 waves of the Health Behaviour in School-aged Children – HBSC, and the Global Youth Tobacco Surveillance - GYTS) showed that, by the age of 15 years, over 50% of Italian adolescents had already experimented with tobacco products and that nearly 15% are daily smokers.(Charrier et al., 2014; Gorini et al., 2018) Furthermore, data on susceptibility to initiate smoking within 1 year among those who had not yet tried indicate that about 40% of never-smokers fell into the “susceptible” category in 2010, which decreased to 33.4% in 2014 (Global Youth Tobacco Surveillance, 2010; Global Youth Tobacco Surveillance, 2014; Charrier, Berchiolla, & Gruppo HBSC Italia 2014, 2016).

Preventing and reducing tobacco use by young people is a priority in adolescent health promotion and school-based risk prevention programs. The rationale for targeting adolescents is that it is the phase of life when the health-related behaviors and conditions that underlie major non-communicable diseases usually start or are reinforced (Dick & Ferguson, 2015). Many of the health-related risk behaviors that emerge during adolescence tend to cluster together (Ellickson, Tucker, & Klein, 2001; Guo et al., 2002; Lavikainen, Lintonen, & Kosunen, 2009; Madkour, Farhat, Halpern, Godeau, & Gabhainn, 2010; Mann, Brima, & Stephenson, 2010; Spring, Moller, & Coons, 2012; Stueve & O'Donnell, 2005; Wiefferink et al., 2006). More specifically, adolescents who use tobacco are more likely to be injured, to drink alcohol, to be involved in other risk-taking behaviors such as physical fighting and illicit drug use later (de Looze et al., 2011; Duncan, Duncan, & Hops, 1998; Vega, Chen, & Williams, 2007). Wang (Wang, 2001) found that adolescents who engage in physical fights, in drunk driving and who could be defined as “risk-takers” were more likely to be regular smokers than adolescents who do not exhibit these behaviors, suggesting that also high-risk behaviors may be associated with smoking. Laska, Pasch, Lust, Story, & Ehlinger (2009) examined complex lifestyle patterning among college youth (18- to 25-year-olds) and identified, among others, a higher risk profile characterized by a higher probability of being a smoker, a binge drinker, engaging in sex while intoxicated and driving under the influence. This reveals important information about the health needs of this specific sub-population. Another interesting observation comes from an Australian study among people aged 16-69, according to which younger people were more likely to be part of the “risky smoker” cluster (French, Rosenberg, & Knuiman, 2008).

The tendency of health risk behaviors to cluster together is known to be even greater when tobacco use or drinking or sexual intercourse start during early adolescence. DuRant, Smith, Kreiter, & Krowchuk (1999) examined the relationships between early age of onset of tobacco, alcohol, and cannabis with engaging in multiple risk behaviors among middle school students. He showed that an early age of onset of cigarette use (at 11 years or younger) was the variable that associated the strongest with several other health risk behaviors in young adolescents). A Finnish study found that regular and heavy alcohol use and smoking at the age of 14 are predictors of drunk driving offenses and hospital-treated substance use disorders in later life for both males and females (Riala, Hakko, Isohanni, Jarvelin, & Rasanen, 2004).

In this context, the aim of our study was to further investigate the hypothesis that health risk behaviors tend to cluster together. By focusing on the specific sub-group of young adolescents, we explored the idea that smoking behavior can predict a specific risk pattern or risk profile, with heavy smokers more likely to exhibit other risk behaviors. The specific objective of the study was to draw a comprehensive picture of the behavioral, social, and psychological patterns that characterize young adolescent smoking habits (very frequent,

occasional or non-smokers) and to explore whether and how these patterns may change as adolescents move through school grades. To do this, we applied latent class regression (LCR) and a Bayesian approach for variables selection to identify behavioral clusters in a sample of more than 58,000 students aged 11, 13, and 15 years surveyed in the 2014 Italian HBSC study, which collected data on student health, well-being, social environment, and risk behaviors.

2. MATERIALS AND METHODS

2.1. Participants

We explored the 2014 HBSC Italian database. The HBSC is an international school-based survey that collects data on adolescent health and well-being, social environments, and health behaviours. It has been carried out in Italy in collaboration with the International HBSC Network since 2001. The HBSC consists of repeated cross-sectional cluster sampled surveys involving 11-, 13-, and 15-year-old students in nationally representative samples. It applies standardized sampling methods for selecting schools and classes, questionnaire design, procedures for conducting the survey in the field, and data management (for details see www.hbsc.org) (Chris Roberts et al., 2009).

For the Italian survey, target classes are first and third junior high school (JHS) grades and second high school (HS) grade. For both the 2010 and the 2014 surveys, in which all Italian regions took part, we collected data from regionally representative samples, for a total of more than 63,000 students. A summary of the main areas and questions included in the HBSC questionnaire can be found in a previous paper (Lazzeri et al., 2013).

For this re-analysis of the 2014 HBSC national database, we did not follow the international protocol for selecting the age of the students to be included or not in the analyses (Chris Roberts, Tynjälä, Currie, & King, 2004). Specifically, we did not exclude students older than the expected age for the grade they were attending because we wanted to determine whether school failure was a distinctive component of the adolescent smoker profile, similar to the reported association found between school failure and other risk behaviors such as drinking (Crosnoe, 2006).

2.2. Ethical aspects

Approval was obtained from the principals of the schools participating in the survey. Class teachers administered the survey questionnaire during a regular school day. Parental opt-out consent to participate in the survey was obtained in advance. Students were informed that participation was anonymous and voluntary. The demographic information does not allow identification of individual students involved in the survey. The Ethics Committee of the University of Torino approved the national research protocol.

2.3. Statistical analyses

A two-step analysis was carried out. In the first stage a variable selection procedure was performed to single out the features associated with a very frequent smoking habit as follows: a logistic regression model (LRM) was run on the dependent variable “smoking habit” (smoking every day vs. less frequently or not smoking at all for the second grade HS students; smoking at least once a week/every day vs. less frequently or not smoking at all for the first and third grade JHS students), and a spike-and-slab prior approach was used for variable selection. While the classical approach to variable selection involves the identification of non-zero coefficients of a model variable, the Bayesian spike-and-slab approach uses a hierarchy of priors over the coefficients and the model spaces (all possible subsets of covariates to be used

in the regression model). It uses a mixture of a uniform distribution (the slab) and a degenerate distribution (the spike) at value zero of the coefficients (Mitchell & Beauchamp, 1988). This two-component distribution allows for placing some amount of posterior probability at zero for a subset of regression coefficients. Metropolis-Hastings sampling was then used to identify promising models with a high posterior probability of occurrence. In this analysis, a modified rescaled spike and slab model, which uses continuous bimodal priors for hyper-parameters, was adopted (Ishwaran & Rao, 2005). Variable selection was driven on the basis of a posterior probability of a non-zero coefficient greater than 5%.

The selected variables were entered as manifest variables in an LCR model that identified clusters of adolescents sharing similar smoking habits. The underlying health-related behaviors in each cluster were then identified (Laska et al., 2009). The LCR model requires the specification of the number of clusters (latent classes). A series of models were fitted for two to five clusters. The choice of the best model was based upon the lowest value of the Bayesian information criterion (Lin & Dayton, 1997). The estimated class-conditional response probabilities and a matrix containing each observation's posterior class membership probabilities were also retained from the model.

Statistical analyses were performed using R version 3.4.2 (R Core Team, 2017). R package PoLCA (Linzer & Lewis, 2011) was used to carry out the LCR analysis and BoomSpikeSlab for the spike-and-slab regression (Scott, 2017).

3. RESULTS

Analyses were performed on 58,321 questionnaires. The sample size by school grade was: 33.9% first grade JHS, 33.3% third grade JHS, and 32.8% second grade HS students. Males made up 51.2% of the overall sample. A significant association was observed between gender and school failure, with 7,464 students (60% males) older than the expected age for their school grade ($p < 0.001$). The proportion of school failures, stratified by grade, increased with age from 8.1% (first grade JHS) to 11.1% (third grade JHS) to 19.3% (second grade HS students).

Table I presents the variables that were significantly associated with smoking “*at least once a week or every day*” (for first and third JHS grades) and “*every day*” (for second HS grade), as selected by the spike-and-slab procedure. These variables were subsequently entered in an LCR model. The results are reported in the following two sections: the first section describes how the students clustered according to their smoking habits; the second depicts their behavioral pattern, providing an identikit of very frequent smokers.

3.1. Relationship between smoking habit and latent class membership

On the basis of the self-reported smoking habit (the possible responses to the item “*How often do you smoke tobacco at present?*” were: every day; at least once a week but not every day; less than once a week; I do not smoke), the LCR model identified two latent classes for first grade JHS and three latent classes for third grade JHS and second grade HS students (Table II). The latent classes were named by examining the unconditional prior probabilities presented in Table II.

Table II presents the unconditional prior probabilities for each school grade, i.e., the predicted probability that an individual will belong to each cluster before considering other risk behaviors, social context, and response to survey items (Table I). For first grade JHS, the model found that the two clusters named “smokers” and “non-smokers” indeed separated the student sample ($p < 0.001$). The prior probabilities of class membership are also plotted in Figure 1.

A useful indicator of the goodness of fit of the model is the congruence between the unconditional prior probabilities and the model posterior class membership probability. For first grade JHS students, the predicted class membership by modal posterior probabilities was 0.037 and 0.963 for Latent Class 1 and Latent Class 2, respectively. For third grade JHS students, the predicted class membership by modal posterior probabilities was 0.10, 0.114, and 0.786 for Latent Class 1, Latent Class 2, and Latent Class 3, respectively. For second grade HS students, the predicted class membership by modal posterior probabilities was 0.208, 0.219, and 0.573 for Latent Class 1, Latent Class 2, and Latent Class 3, respectively.

Based on the estimated class-conditional response probabilities (Table II), 94% of first grade JHS students were identified as no-smokers and the remaining 6% as daily, weekly or occasional smokers. Fig. 1 shows that for first grade JHS students, an adolescent who self-reports smoking less than once a week has a stronger prior probability (about 64% according to Table II) of belonging to the first cluster (solid line), whereas the prior probability of belonging to the second cluster (dotted line) is nearly 100% among adolescents who self-report no-smoking.

Three clusters were identified for the third grade JHS students. The first (11% of the sample according to the class-conditional response probabilities) corresponds to a cluster of heavy smokers (solid line). Students who self-reported they smoke every day have a membership probability of about 86%; the membership probability of those who reported smoking more than once a week but not every day was about 65% and that of occasional smokers was about 28%.

The second cluster (76% of the sample, dotted line) grouped chiefly non-smokers and occasional smokers, 83% and 46% membership probability, respectively. Finally, an intermediate cluster (13% of the sample, dashed line) comprised students who self-reported smoking occasionally or weekly but not every day, with a membership probability of about 25%.

Finally, three clusters for the second grade HS students were identified. The first (21% of the sample, solid line) consisted mostly of heavy smokers, whose membership probability was 83%. The second cluster (56% of the sample, dotted line) was composed of mostly non-smokers with a membership probability of 74%. Occasional smokers had a 47% probability of belonging to this cluster, while heavy and weekly smokers had only a 3% probability. Finally, an intermediate cluster (24% of the sample, dashed line) comprised students who mostly reported smoking occasionally (33% membership probability) and students who reported smoking at least once a week but not every day (37% membership probability).

3.2. Profile of adolescent smokers: analysis of the latent classes

Based on the consideration that adolescents with a similar set of responses to the manifest variables tend to cluster within the same risk profile, the class-conditional response probabilities of other self-reported risk behaviors (Table I) were examined to obtain a profile of smokers.

The first grade JHS students who clustered in the smoker profile differed on several measures as compared with their classmates: they tended to experience school failure more often (26 vs. 7% among occasional/non-smokers); to engage in greater alcohol use (49 vs. 2% reported weekly or daily consumption) and abuse (64 vs. 5% experienced binge drinking; 18 vs. 0.07% experienced drunkenness at least twice in their life); and to perceive themselves as being less accepted by their teachers (18 vs. 4%).

Fig. 2 presents the profile of the third grade JHS students. As regards risk behaviors, alcohol misuse was higher among heavy smokers. Feeling a lack of trust in teachers and of acceptance by and of care from teachers were much more frequently reported by the

intermediate profile students but they were more frequently expressed by heavy smokers, too. School failure and below-average academic achievement were more frequent among heavy smokers than among those of the other two profiles.

Living with persons other than biological parents was also associated with the smoking habit. Multiple health complaints were slightly more often reported by the students who clustered in the intermediate profile. Heavy smokers self-rated their health as fair or poor more frequently than their peers.

Fig. 3 presents the profile of the second grade HS students. As concerns risk behaviors, alcohol use and misuse was higher among heavy smokers. Lifetime cannabis use (82%) and having had sexual intercourse (69%) were also more frequent among heavy smokers. The same pattern was observed for the variables concerning eating behavior, like consuming soft drinks daily and skipping breakfast on schooldays. No clear pattern emerged for the association between sparse physical activity and smoking, however.

In relation to the social context, school failure and below-average academic achievement were more frequent among heavy smokers (40 and 28%, respectively). Spending time with friends after 8 p.m. was a frequent behavior among both heavy and intermediate smokers. Multiple health complaints were more often reported by smokers, though the prevalence of health complaints was high also among intermediate and non-smokers. Heavy smokers rated their health as fair or poor (29%) more frequently than other types of smokers.

4. DISCUSSION

The results of our study confirm previous findings about the co-occurrence of risk behaviors together with smoking and support the idea that young adolescents exhibit multiple health risk behaviors that tend to form clusters around similar behavioral patterns. For comprehensive healthy lifestyle promotion strategies to be effective, they will need to address the developmental and health-related behaviors, as well as the social context (parent and peer influences, perception of the school environment) of adolescents of different ages in diverse circumstances. To capture these aspects of adolescent health, we delineated the behavioral patterns that characterize various behavioral smoking patterns and drew up a profile of very frequent teen smokers.

We identified a cluster of 6% first grade JHS students who are already frequent smokers with high rates of alcohol misuse, academic failure, and negative school perception. The lack of information about other risk behaviors (cannabis use and early sexual intercourse) which, under the HBSC protocol, are investigated only among second grade HS students, may render this apparently well-defined risk profile somewhat incomplete. Nevertheless, these results confirm DuRant's conclusions about the importance of screening for substance use during elementary school, as we found that at the beginning of junior high school some students already display multiple risk behaviors (DuRant et al., 1999).

The picture is more complex for third grade JHS students in which a third cluster besides the two clusters of non-smokers and smokers was identified. This cluster (intermediate profile) was mostly made up of adolescents who self-reported smoking frequently but not daily. It emerged also for the second grade HS students and turned out to be twice as large. Third grade JHS occasional smokers were found to share many characteristics with frequent smokers. But, again, the lack of information about other risk behaviors, like experience with cannabis and sexual intercourse, precludes a more detailed description.

As regards the school context, third grade JHS students in the intermediate profile were more likely to perceive their school environment as hostile, though the rate of school failure

was lower as compared with frequent smokers. An association with school failure was observed among the second grade HS students. However, the school environment variables were no longer associated with smoking, suggesting that the school plays a key role in preventing the uptake of risk behaviors at earlier ages. Again, these results are in line with previous studies that highlighted the importance of prevention programs and education initiatives starting in elementary school and continuing through the successive school grades (DuRant et al., 1999). Moreover, our findings support the association of a positive school climate, including supportive, caring, adequately prepared and motivated teachers, with higher academic achievement and better self-reporting of student health, well-being, and health behaviors (Danielsen, Wiium, Wilhelmsen, & Wold, 2010; Jia et al., 2009).

We found no association between smoking and bullying and fighting. This finding contrasts with previous studies that showed co-occurrence of smoking with physical fighting and bullying (Schnohr & Niclasen, 2006; Wang, 2001). Despite the lack of a clear explanation for the absence of this association in our study, the prevalence of bullying others and being bullied at school has always been very low among Italian students attending the three school grades surveyed in HBSC (always lower than 10% among first and third grade JHS students, and lower than 5% among second HS students), especially as compared with other risk behaviors (alcohol consumption and abuse, tobacco and cannabis use, sexual intercourse).

The literature recognizes that evidence about the co-occurrence of risk behaviors may have important implications for the design of intervention programs. Nevertheless, most interventions still target single issues, while few studies have evaluated the impact of programs with a broader approach to prevent or address multiple health problems (Jackson, Henderson, Frank, & Haw, 2012). To date, the most promising approaches for reducing multiple risk behaviors, are those that simultaneously address several domains of risk and protective factors that are predictive of risk behaviors. This means, for example, trying to increase resilience by promoting a positive family influence and healthy school environments (Jackson et al., 2012). An important implication of the clustering of health risk behaviors is that intervening upon any one of them may influence also some of the others but not necessarily in the expected direction (Spring et al., 2012). Spring *et al.* proposed the example of smoking cessation and gaining weight, highlighting the fact that, when cigarette smoking is scaled back, the consumption of treat foods increases due to its reward value, and this results in weight gain. This suggests that intervening simultaneously on two rewarding substances like cigarettes and treat foods may sometimes be less effective than achieving smoking cessation first and then addressing weight management with interventions focused on physical activity and eating habits, for example (Spring et al., 2012).

Further research on these aspects is needed to understand the long-term impact of interventions with proven positive short-term effects and to improve the evidence of effectiveness of interventions addressing multiple risk behaviors.

4.1. Study limitations and strengths

The HBSC questionnaire deeply investigates first and third JHS, and second HS student health, well-being, health behaviors, and social environments; nonetheless, details are lacking about the other risk behaviors of younger students, like cannabis use and sexual intercourse, which make up part of the risk profile of this age group. Furthermore, no data are available about having friends, classmates, siblings or parents who smoke, which the literature reports as being significantly associated with adolescent smoking (Wen, 2005). There are also the methodological limitations common to cross-sectional surveys, like the impossibility to draw causal inferences between variables. These must be considered when interpreting the results.

These limitations notwithstanding, our study has several strengths. The data were collected via an internationally standardized and validated questionnaire on a large, highly

representative sample of the adolescent population in Italy by means of a methodologically sound survey conducted in collaboration with the international HBSC Network. The analyses plan, a commonly used approach in this field, entailed variables selection for clustering the students into profiles via a Bayesian approach, which has proven advantageous in the analysis of highly correlated problems. Finally, based on the information available in the HBSC database, we used age older than that expected for the attended school grade as a surrogate variable of academic failure and as an additional risk factor potentially associated with adolescent smoking.

5. CONCLUSIONS

Evidence for the association between smoking and multiple lifestyle behaviors is still scarce. To overcome this gap, we investigated a complex set of associations among risk/health related behaviors and social context variables. An original result is the profile of a typical adolescent heavy smoker obtained by describing the co-occurring health-related risk behaviors she/he engages in (alcohol and cannabis consumption, binge drinking, sexual intercourse), eating behaviors (daily breakfast) and level of physical activity, perceived well-being (life satisfaction and health complaints), as well as relationships with peers, family, and school context.

This emerging complex picture of behavioral, social, and psychological features, which change through school grades, suggests that timely implementation of interventions, tailored for the adolescent population, is crucial for implementing effective health promotion strategies that improve smoking cessation among occasional smokers and deter very frequent smokers from engaging in other risk behaviors.

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Fig. 1. Smoking behavioral clusters of first and third JHS grade and second HS grade students. Predicted prior probabilities of latent class membership based on self-reported smoking habit.

Fig. 2. Profiles of heavy, intermediate, and non-smokers among third grade junior high school students.

Fig. 3. Profiles of heavy, intermediate, and non-smokers among second grade high school students.

Table I. HBSC variables significantly associated with frequent smoking habits (smoking every day for second grade HS students; smoking at least once a week or every day for first and second grade JHS students) stratified by school grade.

<i>Questions (Q) and answers (A) from the HBSC 2014-questionnaire</i> Variables associated with very frequent smoking, by school grade	School grades		
	First JHS	Third JHS	Second HS
Risk behaviour			
<i>(Q) At present, how often do you drink anything alcoholic, such as beer, wine or spirits? Try to include even those times when you only drink a small amount.</i>			
<i>(A) Every day/ Every week/ Every month/ Rarely/ Never</i>			
Alcohol use: drinking alcohol every week or every day	X	X	X
<i>(Q) Have you ever had so much alcohol that you were really drunk (in your life)?</i>			
<i>(A) No, never/ Yes, once/ Yes, 2-3 times/ Yes, 4-10 times/ Yes, more than 10 times</i>			
Drunkenness: having been drunk on 2 or more occasions – lifetime	X	X	X
<i>(Q) Think about the last 12 months, have you ever drunk 5 or more alcoholic drinks in one occasion (a party, an evening, ...)?</i>			
<i>(A) Yes/ No</i>			
Binge drinking: having experienced binge drinking (5 or more drinks on one occasion) in the last 12 months	X	X	X
<i>(Q) Have you ever taken cannabis (in your life)?</i>			
<i>(A) Never/ 1-2 days/ 3-5 days/ 6-9 days/ 10-19 days/ 20-29 days/ 30 days or more</i>			
Cannabis (second grade HS students only): having tried cannabis at least once - lifetime			X
<i>(Q) Have you ever had sexual intercourse (sometimes this is called "making love" "having sex" or "going all the way")?</i>			
<i>(A) Yes/ No</i>			
Sexual behaviour (second grade HS students only): having had sexual intercourse			X
Eating habits and Physical activity			
<i>(Q) How many times a week do you usually drink Coke or other soft drinks that contain sugar?</i>			
<i>(A) Never/ Less than once a week/ Once a week/ 2-4 days a week/ 5-6 days a week/ Once a day, every day/ Every day, more than once</i>			
Daily soft drink consumption: consuming a soft drink at least once a day			X
<i>(Q) How often do you usually have breakfast (more than a glass of milk or fruit juice)?</i>			
<i>(A) I never have breakfast during the week/ 1 day/ 2 days/ 3 days/ 4 days/ 5 days</i>			
Breakfast: having never breakfast on any school day			X
<i>(Q) Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?</i>			
<i>(A) Never/ 1 day/ 2 days/ 3 days/ 4 days/ 5 days / 6 days/ 7 days</i>			
Moderate-to-vigorous physical activity (MVPA): at least 60 minutes/day on <u>less</u> than 4 days per week			X
Social context: school, peers, family			
<i>(Q) What class are you in?</i>			
<i>(Q) What month and year were you born?</i>			
School failure: students older than age expected for the grade they are attending	X	X	X
<i>(Q) In your opinion, what does your class teacher(s) think about your school performance compared to your classmates?</i>			
<i>(A) Very good/ Good/ Average/ Below average</i>			
Academic achievement (perceived school performance): below average		X	X
<i>(Q) "I feel a lot of trust in my teachers" How much do you agree or disagree with this statement?</i>			
<i>(A) Strongly agree/ Agree/ Neither agree or disagree/ Disagree/ Strongly disagree</i>			
Trust in teachers: feeling a lot of trust in teachers (disagree/strongly disagree)		X	
<i>(Q) "I feel that my teachers accept me as I am" How much do you agree or disagree with this statement?</i>			
<i>(A) Strongly agree/ Agree/ Neither agree or disagree/ Disagree/ Strongly disagree</i>			
Acceptance by teachers: feeling that teachers accept them as they are (disagree/strongly disagree)	X	X	

(Q) "I feel that my teachers care about me as a person" How much do you agree or disagree with this statement? (A) Strongly agree/ Agree/ Neither agree or disagree/ Disagree/ Strongly disagree Care from teachers: feeling that teachers care about them as persons (disagree/strongly disagree)	X	
(Q) How often do you meet your friends outside school time after 8 o'clock in the evening? (A) Hardly ever or never/ Less than weekly/ Weekly/ Daily Meeting friends: spending time with friends after 8 in the evening every week or every day		X
(Q) All families are different (for example, not everyone lives with both their parents, sometimes people live with just one parent, or they have two homes or live with two families) and we would like to know about yours. Please answer this question for the home where you live all or most of the time and tick the people who live there. (A) Mother / Father/ Stepmother/ Stepfather/ Grandmother/ Grandfather/ I live in a foster home or children's home Family structure: living with other than both biological parents (stepfamily, single parent or other)	X	
Health outcomes		
(Q) Would you say your health is.....? (A) Excellent/ Good/ Fair / Poor Self-rated health: rating their health as fair or poor	X	X
(Q) In the last 6 months: how often have you had the following....? (Headache, Stomachache, Backache, Feeling low, Irritability or bad temper, Feeling nervous, Difficulties in getting to sleep, Feeling dizzy) Please tick one box for each symptom. (A) About every day/ More than once a week/ About every week/ About every month/ Rarely or never Multiple health complaints: at least 2 complaints more than once a week or every day	X	X

Table II. Predicted prior probabilities (unconditional prior probabilities) of latent class membership at varying levels of smoking habit and class conditional probabilities of adolescents to belong to latent classes according to school grade.

	Smoking behavior			p-value	
	Latent Class 1	Latent Class 2	Latent Class 3	Class 2 vs. Class 1	Class 3 vs. Class 1
	Smokers	Intermediate	Non-smokers		
Unconditional prior probabilities					
<i>First grade JHS</i>					
Daily smoker	0.999	-	0.001		
Weekly smoker	0.986		0.014		
Occasional	0.636	-	0.364		
No smoker	0.042		0.958		
<i>Third grade JHS</i>					
Daily smoker	0.857	0.128	0.015	<0.001	<0.001
Weekly smoker	0.645	0.242	0.113		
Occasional	0.276	0.261	0.463		
No smoker	0.051	0.122	0.827		
<i>Second grade HS</i>					
Daily smoker	0.827	0.145	0.028	<0.001	<0.001
Weekly smoker	0.509	0.329	0.162		
Occasional	0.157	0.375	0.468		
No smoker	0.027	0.233	0.74		
Class-conditional response probabilities					
First grade JHS	0.057	-	0.943		
Third grade JHS	0.105	0.132	0.763		
Second grade HS	0.206	0.236	0.558		

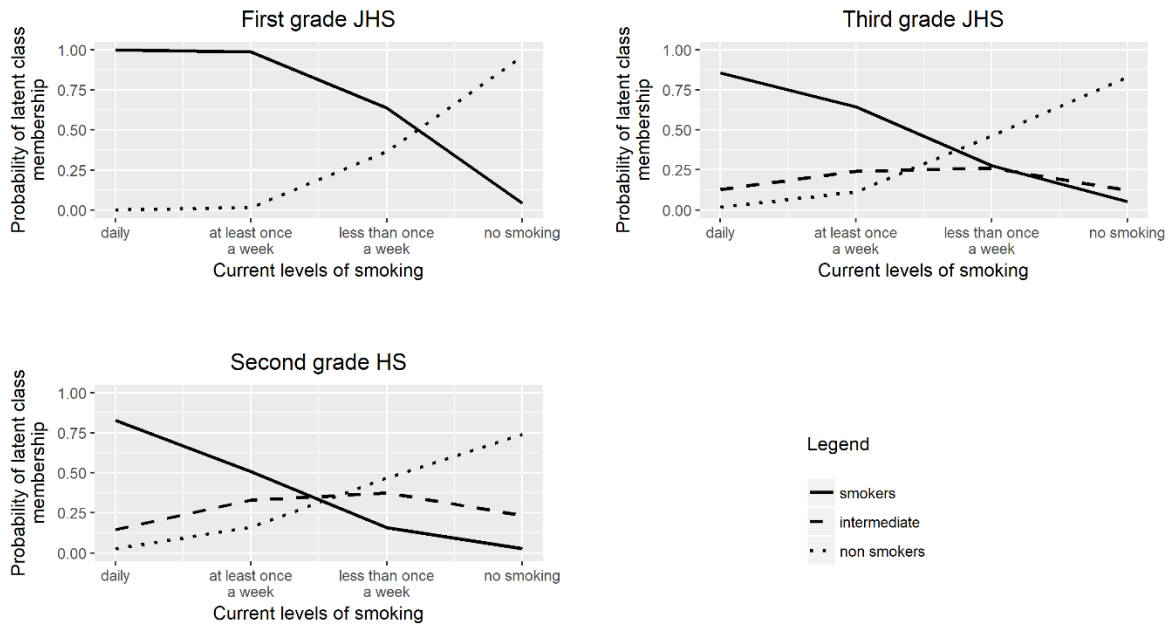


Fig. 1. Smoking behavioral clusters of first and third JHS grade and second HS grade students. Predicted prior probabilities of latent class membership based on self-reported smoking habit.

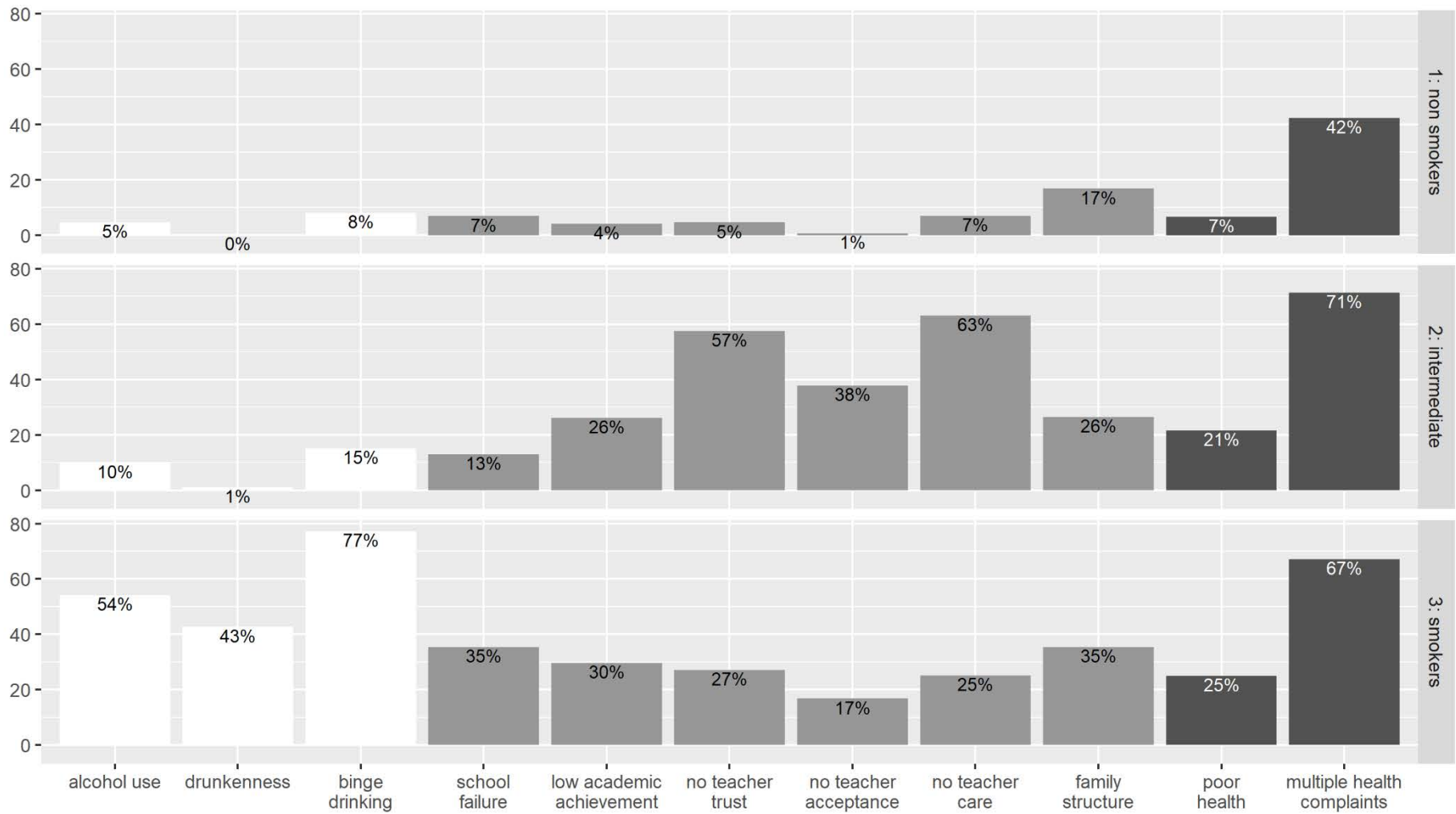


Fig. 2. Profiles of heavy, intermediate, and nonsmokers among the third-grade junior high school students.

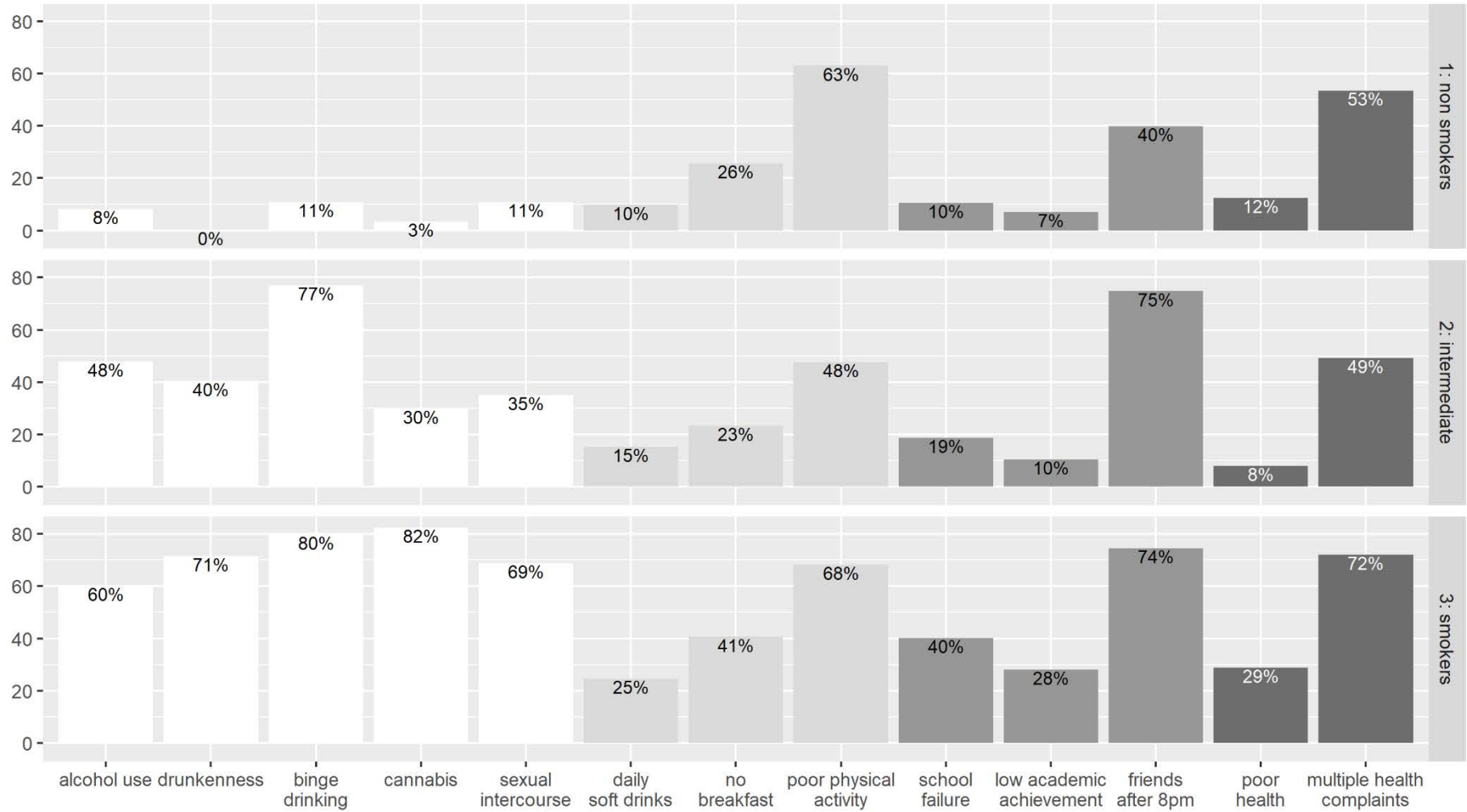


Fig. 3. Profiles of heavy, intermediate, and nonsmokers among the second-grade high school students.