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The Role of Cognitive Attributions for Smoking in Subsequent Smoking Progression and Regression among Adolescents in China

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Abstract

Previous studies have documented that cognitive attributions are correlated with adolescent smoking. The present study further explored whether cognitive attributions for smoking influenced adolescents' future smoking behaviors, especially transitions to more advanced stages of smoking.

Participants were 12,382 middle and high school students (48.5% males and 51.5% females) in seven large cities in China. They completed two waves of surveys one year apart. Cognitive attributions for smoking and three smoking behavior outcomes (lifetime smoking, past 30-day smoking, and daily smoking) were assessed. Changes in smoking, including progression from lower stages to higher stages and regression from higher stages to lower stages, over a one-year period, were defined longitudinally. Polychotomous logistic regression was used to examine associations between cognitive attributions for smoking and changes in smoking status over one year, adjusting for demographic characteristics and other plausible confounders.

Seven out of eight cognitive attributions for smoking were associated with subsequent smoking behaviors ($p<0.05$). Curiosity, autonomy, social image, social belonging, and coping influenced earlier stages of smoking, whereas mental enhancement and engagement influenced later stages of smoking. Curiosity, autonomy, social image, and mental enhancement preceded smoking progression; social belonging prevented smoking regression; and coping and engagement both preceded smoking progression and prevented smoking regression.

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Author Disclosures

Contributors

Qian Guo was the Project Manager of China Seven Cities Study (CSCS). She conducted the present smoking attribution research and wrote the manuscript. C. Anderson Johnson was the Principal Investigator (PI) of Transdisciplinary Tobacco and Alcohol Use Research Center and PI of CSCS. He worked closely with Qian Guo on this study and provided instructive and mentor assistance throughout the process. Jennifer B. Unger provided input on statistical analysis and interpretation. Paula H. Palmer and Chih-Ping Chou were co-PI's of CSCS. All authors contributed to and have approved the final manuscript.

Conflict of Interest

All authors declare that they have no conflicts of interest.

This study demonstrates that different cognitive attributions influence smoking at different stages in different ways. These findings could inform smoking prevention and cessation programs targeting Chinese adolescents.

Keywords

Attributions; Smoking; Attribution Theory; Adolescents; China

1. Introduction

Attribution theories describe how people explain the causes of behavior (Heider, 1958; Jones & Davis, 1965; Kelley, 1967). People's explanations of behavior, called "attributions", can be classified into categories based on three dimensions: locus of control (internal or external), stability (stable or unstable), and controllability (controllable or uncontrollable) (Weiner, 1986). Cognitive process of inference may lead to biased attributions (Ross, 1977; Ross, Greene, & House, 1977). For example, people are more likely to attribute their own behaviors to situational (external) factors and attribute the behavior of others to personal (internal) factors (Jones & Nisbett, 1971; Monson & Snyder, 1977). However, attribution theories posit that cognitive attributions are important, because they influence people's self-esteem, expectations, and emotions (Weiner, 1986), which may partially determine their future actions.

Attribution is different from other related constructs such as personal beliefs and outcome expectancies. For example, an individual might have a belief or expectancy that cigarette smoking can help make friends. However, while acknowledging that smoking could possibly help make friends, this individual might perceive that he/she is smoking primarily for other reasons, such as coping with stress. Therefore, a health education message that attempts to dispel the myth that smoking has social benefits would not resonate with this smoker, who believes that he/she smokes to relieve stress.

Attribution research has been conducted to address cigarette smoking, a public health problem worldwide, among adolescents (Allbutt, Amos, & Cunningham-Burley, 1995; Aloise-Young, Hennigan, & Graham, 1996; Barton, Chassin, Presson, & Sherman, 1982; Cronan, Conway, & Kaszas, 1991; Kleinke, Staneski, & Meeker, 1983; McGee & Stanton, 1993; Rugkasa et al., 2001; Sarason, Mankowski, Peterson, & Dinh, 1992; Stanton, Mahalski, McGee, & Silva, 1993; Treacy et al., 2007). However, although previous attribution studies have identified self-reported cognitive attributions for smoking, they did not report whether those attributions were truly correlated with actual smoking behaviors, nor did they examine whether the attributions influenced future smoking behaviors.

We conducted a series of studies to investigate cognitive attributions for smoking among adolescents in China, where one third of smokers in the world reside (Yang et al., 1999). This is the third study in a program of research on attributions and smoking among Chinese adolescents. The first study investigated cognitive attributions for Chinese adolescent smoking, their relative importance, and their associations with actual smoking behaviors (Guo et al., 2010). It used cross-sectional data. The second study investigated whether cognitive attributions for smoking predicted subsequent smoking development and examined hypothesized mediators and moderators (Guo, Unger, Azen, MacKinnon, & Johnson, 2012). This study used two waves of longitudinal data collected one year apart from the same respondents and focused on smoking initiation and progression overall.

In the present analysis, we move further to examine the detailed roles that cognitive attributions for smoking played at different points along the smoking trajectory. We investigate which cognitive attributions preceded changes in stage of smoking, including both progression from lower stages to higher stages and regression from higher stages to lower stages. The detailed pathways are demonstrated in Figure 1. This study addresses some questions raised in the above two studies and provides specific information about cognitive processes relevant to different points on smoking trajectories that may be useful for smoking prevention and cessation programs.

2. Methods

2.1. Participants

The samples in this study were middle and high school students recruited from seven large cities in different regions of China. All schools in the metropolitan area of each city were stratified by median income in the district (high, medium, low) and by school academic performance (high, medium, low), resulting in nine clusters of schools. One middle school and one high school were randomly selected from each of the nine clusters. One classroom from the 7^{th} and 8^{th} grades in the selected middle schools and one classroom from the 10^{th} and 11^{th} grades in the selected high schools were recruited. In addition, one professional high school was selected from each district, major courses of study within each professional school were randomly selected, and students in these majors were recruited from the 10^{th} and 11^{th} grades. As a result, 14,434 students (93.0% of those who were invited) participated in the study. One year later, 12,382 students (85.8% of the total at baseline) completed a follow-up survey.

2.2. Procedures

Self-administered surveys were conducted twice in 2002 and 2003 respectively among recruited students. Prior to data collection, the informed consent and data collection procedures were reviewed and approved by both the University of Southern California (USC) and Chinese Institutional Review Boards. During the data collection, the procedures were monitored through a three-level quality control system, which included faculty and staff from local universities in the seven Chinese cities, Chinese Centers for Disease Control and Prevention, and USC. More details about the methodology of this study have been reported elsewhere (Johnson et al., 2006).

2.3. Measures

Demographic measures included age, gender, ethnicity, and geographic region. Three measures of smoking behaviors were assessed: lifetime smoking (“Have you ever tried cigarette smoking, even a few puffs?”), past 30-day smoking (“During the past 30 days, on how many days did you smoke cigarettes?” and “During the past 30 days, on the days you smoked, how many cigarettes did you smoke per day?”), and daily smoking (“Have you ever smoked cigarettes daily, that is, at least one cigarette every day for 30 days?”).

Cognitive attributions for smoking were assessed with one multiple-choice question: “I smoke, (or might smoke), because: (circle all that apply)”, with seventeen possible reasons for smoking as response options (e.g., “It makes me look good” and “It helps me forget my problems”). At the analytical stage, these response options were classified into eight categories through exploratory factor analysis, representing eight cognitive attributions: curiosity, coping, social image, social belonging, engagement, autonomy, mental enhancement, and weight control. More details about how the measures for cognitive attributions for smoking have been established and utilized by previous studies, including

the detailed procedures of the exploratory factor analysis, have been reported elsewhere (Guo et al., 2010; Guo et al., 2012).

2.4. Statistical Analyses

Frequencies were calculated to describe the demographic characteristics of the sample, both overall and stratified by gender. Chi-square tests were conducted to examine gender differences for each of the variables.

Cross-sectional data were used to define four stages of smoking at baseline and at one-year follow-up, respectively: 1) never smoker (never smoked, even a few puffs), 2) lifetime smoker (smoked, but not during the past 30 days), 3) past 30-day smoker (smoked during the past 30 days, but not daily), and 4) daily smoker (smoked daily during the past 30 days). Longitudinal data were used to create new variables representing dynamic changes in smoking status over a one-year period. The new variables were named and coded based on three factors: smoking status at baseline, change in smoking status over a year, and level of change in smoking status. Based on smoking status at baseline, the new variables were named as: “Never” (for never smokers at baseline), “Lifetime” (for lifetime smokers at baseline), “Month” (for past 30-day smokers at baseline), and “Daily” (for daily smokers at baseline). Based on the changes in smoking status during one-year follow-up, the new variables were coded as: “+” (for students whose smoking had initiated or progressed to a higher stage), “0” (for students whose smoking status had remained at the same stage), and “−” (for students whose smoking had regressed to a lower stage). Lastly, the new variables were coded as: “1” (for students whose smoking had either progressed or regressed to the next higher or lower stage), and “2” (for students whose smoking had progressed or regressed to the adjacent two higher or lower stages). Therefore, for example, if a student was a past 30-day smoker at baseline and became a daily smoker one year later, the new variable representing the change of smoking status was named as “Month” and coded as “+1”. Otherwise, if a student was a daily smoker at baseline but became a lifetime smoker one year later, the new variable was named as “Daily” and coded as “−2”. As a result, four new variables were created, which included Never (with values 0, +1, +2, and +3), Lifetime (with values 0, +1, and +2), Month (with values −1, 0, +1), and Daily (with values −2, −1, and 0). The first letters of these new variables and their corresponding values are presented as the path names in Figure 1 (e.g., n_0, l_1, m_{-1}, d_{-2}) to facilitate better understanding about the meanings.

After the above four new variables were created, polychotomous logistic regression was used to examine associations between cognitive attributions for smoking and changes in smoking status over one year. In each of the polychotomous logistic regression models, one of the four new variables was the dependent variable, eight smoking attributions were independent variables, and gender, age, ethnicity, geographic region, district economy rank, and school academic rank were covariates.

3. Results

3.1. Demographic Characteristics of the Sample

The sample contained 6,354 females (51.5% of the total) and 5,988 males (48.5% of the total). The distributions of ethnicity (96.1% Han vs. 3.9% others) and geographic region (from 12.0% to 15.8% for seven cities) were not significantly different between genders ($p>0.05$), but the distribution of age groups was significantly different ($p<0.0001$). A detailed frequency table describing the demographic characteristics of the sample at baseline and gender differences has been presented elsewhere (Guo et al., 2012).

3.2. Changes in Smoking Status over One Year

As shown in Table 1, the prevalence of lifetime smoking, past 30-day smoking, and daily smoking all increased during the one-year follow-up and among both genders. The percentages of students whose smoking status progressed, maintained, and regressed from baseline to one-year follow-up were 17.0%, 76.3%, and 6.7% respectively. However, among students at higher stages of smoking (such as past 30-day smokers and daily smokers), the percentages of those students whose smoking regressed to lower stages (e.g., 55.4% and 53.8% respectively) were higher than others whose smoking progressed to higher stages (e.g., 11.5%) or remained at the same stages (e.g., 33.1% and 46.2%). In this study, respondents who had ever smoked at baseline could not regress all the way back to never-smoking, and respondents who were already daily smokers at baseline could regress but could not progress further.

3.3. Associations between Cognitive Attributions and Changes in Smoking Status over One Year

As shown in Table 2, seven out of eight cognitive attributions for smoking were significantly associated with changes in smoking status one year later: curiosity, autonomy, social image, social belonging, coping, engagement, and mental enhancement. However, the associations varied by baseline smoking status. Among adolescents who had never smoked, curiosity about smoking was positively associated with smoking initiation (*OR*=2.23; 95%*CI*=1.65, 3.02). Attempts to show autonomy (*OR*=1.80; 95%*CI*=1.05, 3.09), along with curiosity about smoking (*OR*=1.58; 95%*CI*=1.04, 2.41), was positively associated with smoking progression to two higher stages. However, none of the attributions were associated with smoking progression to more than two higher stages ($p>0.05$ for all). Among adolescents who had tried smoking, coping (*OR*=1.81; 95%*CI*=1.37, 2.38) and social image (*OR*=1.85; 95%*CI*=1.28, 2.69) were positively associated with smoking progression to a higher stage. Among adolescents who had already smoked during the past 30 days, coping (*OR*=0.55; 95%*CI*=0.40, 0.75) and social belonging (*OR*=0.66; 95%*CI*=0.45, 0.96) were negatively associated with smoking regression to a lower stage. Engagement (*OR*=1.62; 95%*CI*=1.02, 2.57) and mental enhancement (*OR*=2.19; 95%*CI*=1.26, 3.78) were positively associated with smoking progression to a higher stage. Among adolescents who had smoked daily, engagement was negatively associated with smoking regression back to the previous stage (*OR*=0.39; 95%*CI*=0.17, 0.88) or an even lower stage (*OR*=0.41; 95%*CI*=0.17, 0.98).

4. Discussion

Our previous studies among Chinese adolescents identified specific cognitive attributions for smoking including curiosity about smoking, coping, social image, social belonging, engagement, autonomy, mental enhancement, and weight control (Guo et al., 2010). Seven out of these eight attributions (exclusive of weight control) were associated with actual smoking behaviors (Guo et al., 2010), and six out of the eight attributions (exclusive of social belonging and weight control) were associated with subsequent smoking initiation and progression one year later (Guo et al., 2012). Certain attributions (e.g., curiosity about smoking, autonomy, coping, social image) were more important at the earlier stages of smoking, whereas different attributions (e.g., engagement, mental enhancement) were more important at more advanced stages of smoking (Guo et al., 2010; Guo et al., 2012). Consistencies and inconsistencies between these findings in the Chinese cultural context and other findings from western cultures are discussed elsewhere (Guo et al., 2010; Guo et al., 2012).

Findings from the present study extend the previous attribution studies by demonstrating a comprehensive profile about how cognitive attributions for smoking influenced smoking at

different points along the smoking trajectory in different ways. This study provides new information about which cognitive attributions preceded smoking progression from each of the initial stages to each of the higher stages, and which cognitive attributions prevented smoking from regressing from each of the initial stages to each of the lower stages. Several new questions raised in the previous studies are also addressed in this study.

Social influences have been widely reported as one of the most important reasons for adolescent smoking (Allbutt et al., 1995; Cronan et al., 1991; Rugkasa et al., 2001; Sarason et al., 1992; Stanton et al., 1993; Stanton & Silva, 1993; Treacy et al., 2007). Consistent with previous findings, Guo et al. (2010) found that social image, through which adolescents may want to make friends and obtain respect from friends, and social belonging, through which adolescents may want to maintain friendship and group identity, were both significantly associated with Chinese adolescent smoking (Guo et al., 2010). However, whereas social image was significantly associated with subsequent smoking progression, it was surprising that social belonging was not (Guo et al., 2012), although friend smoking and being offered cigarettes by friends have been widely reported to associate with Chinese adolescent smoking (Chen, Fang, Li, Stanton, & Lin, 2006; Grenard et al., 2006; Hesketh, Ding, & Tomkins, 2001; Zhang, Wang, Zhao, & Vartiainen, 2000; Zhu, Liu, Shelton, Liu, & Giovino, 1996). The present study helps to distinguish the different functions of social image and social belonging attributions in the smoking trajectory. The social image attribution preceded smoking progression among adolescents who were at earlier stage of smoking, whereas the social belonging attribution prevented smoking from regressing among adolescents who were at a more advanced stage of smoking. In other words, adolescents may escalate their smoking to present a social image to others and to make friends. Once they have developed a habit of smoking, it may be difficult for them to quit because they have developed friendships that are based on smoking together and therefore may prefer to continue smoking to maintain their group identity and membership. In Chinese society, sharing and gifting of cigarettes are commonly used as ways to enhance social interactions; refusing to accept a cigarette offer may be perceived as rude and could lead to exclusion from social groups (Rich & Xiao, 2012).

This study indicates that each cognitive attribution actually influenced smoking at a certain point along the smoking development trajectory. Curiosity, autonomy, social image, social belonging, and coping influenced earlier stages of smoking, whereas mental enhancement and engagement influenced later stages of smoking. This implies that health communications might be more effective if they can be targeted and stage-matched. For example, messages that counter-argue the attributions of curiosity, autonomy, social image, social belonging, and coping might be more effective for adolescents who are in the early stages of smoking acquisition, whereas messages that counter-argue the attributions of mental enhancement and engagement might be more effective for adolescents who have already become established smokers.

This study also describes how each cognitive attribution influenced smoking in a particular way. Curiosity, autonomy, social image, and mental enhancement preceded smoking progression. Social belonging prevented smoking from regressing. Coping and engagement produced dual effects both to facilitate smoking progression and to prevent smoking from regressing. These findings indicate that health communications might be more effective if they can be purposive. For example, messages that counter-argue the attributions of curiosity, autonomy, social image, and mental enhancement might be more effective in smoking prevention programs; messages that counter-argue the attributions of social belonging might be more effective in smoking cessation programs; whereas messages that counter-argue the attributions of coping and engagement could be useful in both smoking prevention and cessation programs.

This study finds that, while many adolescents initiated and progressed their smoking during one-year period, many other adolescents regressed their smoking to lower stages. This implies that smoking behavior is unstable in adolescence, which might provide us with a good opportunity for smoking intervention. While it is important to prevent adolescents from trying the first cigarette, it may be equally important to encourage experimenters and occasional smokers to decrease their smoking frequency and number of cigarettes smoked. Once smoking habits and nicotine dependence are established, cessation could become more difficult. To prevent and control smoking progression among adolescents long-term, comprehensive programs with both prevention and cessation components may be more efficient than other programs with only a single component.

This study has several limitations. First, the measures of cognitive attributions might not have covered the full range of possible attributions for smoking among Chinese adolescents. Further studies need to investigate broader cognitive attributions of smoking, as well as to ascertain the psychometric properties of the scale. Second, this study did not take into account the clustering of individuals within the same units (e.g., school, class) in polychotomous logistic regression, due to limited capability of the statistical program used. Third, although the large sample size of this longitudinal study provided a good opportunity to investigate the roles that cognitive attributions played on dynamic changes of smoking status, the power was not sufficient to stratify the analyses by gender. In addition, in this sample, about 1.1% of baseline never-smokers and 3.2% of lifetime smokers progressed their smoking rapidly to daily smoking one year later. However, none of the cognitive attributions significantly predicted this rapid progression. While it is possible that none of the tested attributions contributed to the rapid progression, it is also possible that the number of students having these progressions was too small and there was not sufficient power to detect significant predictors of these progressions.

In summary, this study used longitudinal data to investigate the roles that cognitive attributions played in dynamic changes in smoking behaviors. It demonstrates that each of the cognitive attributions influences smoking at a specific point along the smoking trajectory in a particular way. By identifying cognitive attributions associated with smoking initiation and progression, this study provides evidence for primary and secondary smoking prevention programs. By identifying cognitive attributions associated with smoking progression from each initial stage to each of the higher stages, this study helps us understand why some adolescents progressed their smoking gradually to an advanced stage, but others progressed more rapidly to even more advanced stages within same time period. By identifying cognitive attributions associated with smoking regression from each initial stage to each of the lower stages, this study tells us how the cognitive attributions played different roles in smoking regression and provides us with evidence for smoking cessation programs. This study proposes that anti-smoking programs may benefit from targeted, stage-matched, and purposive strategies. Moreover, it recommends developing and implementing comprehensive anti-smoking programs that incorporate primary and secondary smoking prevention components and smoking cessation components.

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Highlights

We test whether attributions for smoking are associated with future smoking behaviors.> 7 out of 8 attributions for smoking are associated with subsequent smoking behaviors. > Different smoking attributions influence different stages of smoking. > Some attributions precede smoking to progress, others prevent smoking from regressing. > These findings could inform smoking prevention and cessation programs.

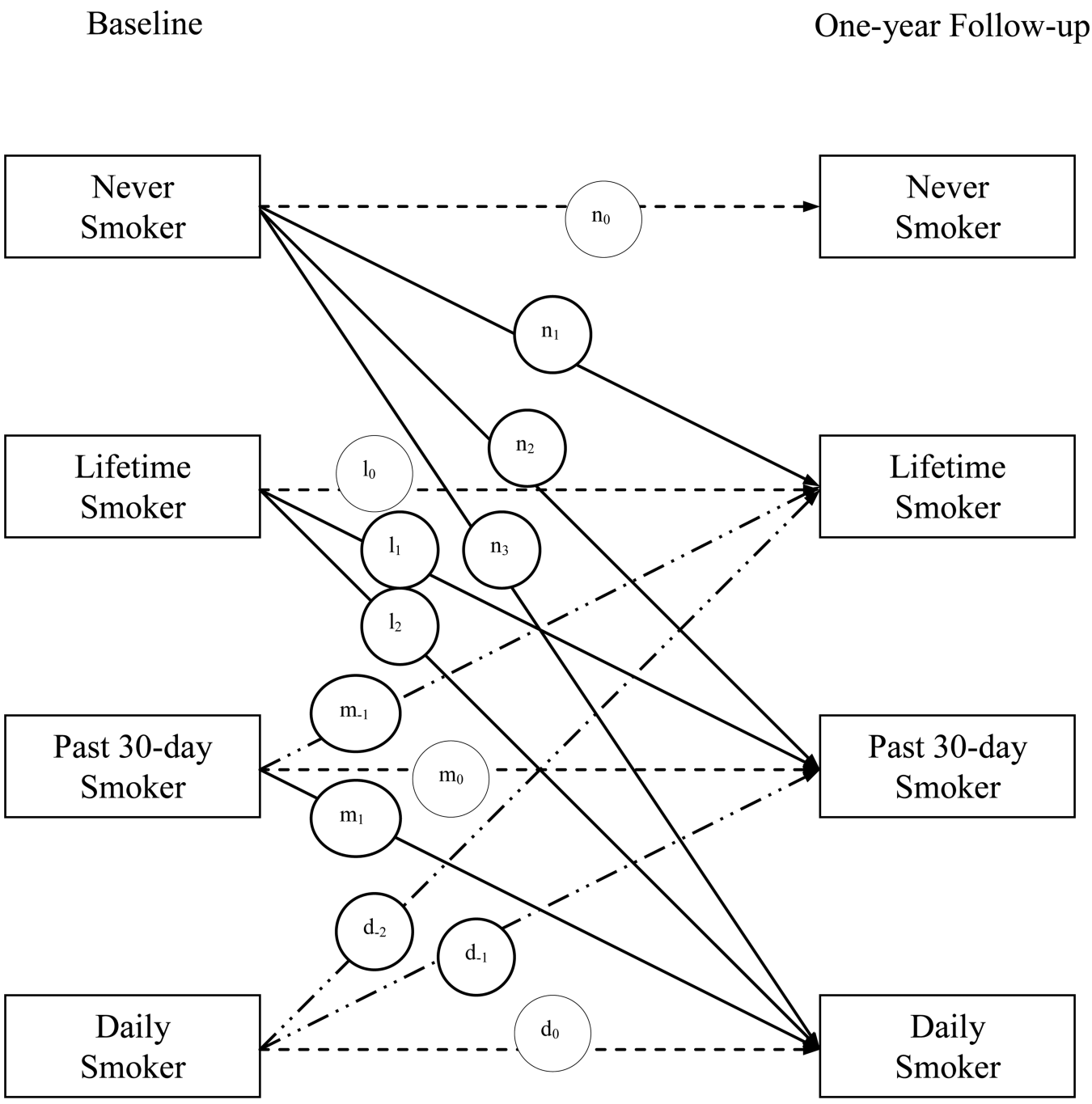

Figure 1.
Paths for changes in smoking status from baseline to one-year follow-up (⟶: smoking progressed; ⋯⟶: smoking maintained; – · ⟶ : smoking regressed)

Table 1

Smoking status of the sample and changes in smoking status over one year

	All	Male	Female	Gender
	n (%)	*n* (%)	*n* (%)	Difference
Smoking status at baseline				
Never smoker	7801 (63.5)	3182 (53.6)	4596 (72.9)	$p<0.0001$
Lifetime smoker	2976 (24.2)	1680 (28.3)	1283 (20.3)	
Past 30-day smoker	1207 (9.8)	829 (14.0)	377 (6.0)	
Daily smoker	294 (2.5)	243 (4.1)	51 (0.8)	
Smoking status at one-year follow-up				
Never smoker	6379 (51.8)	2425 (40.8)	3934 (62.1)	$p<0.0001$
Lifetime smoker	4181 (33.9)	2281 (38.4)	1885 (29.8)	
Past 30-day smoker	1310 (10.6)	857 (14.4)	450 (7.1)	
Daily smoker	451 (3.7)	383 (6.4)	66 (1.0)	
Changes in smoking status over a year				
Smoking regressed	824 (6.7)	504 (8.6)	320 (5.1)	$p<0.0001$
Smoking maintained	9319 (76.3)	4168 (70.7)	5121 (81.4)	
Smoking progressed	2076 (17.0)	1222 (20.7)	847 (13.5)	
Changes in smoking status over a year among baseline never smokers				
Path n_0 (→ never smoker)[1]	6314 (81.4)	2396 (76.0)	3899 (85.2)	$p<0.0001$
Path n_1 (→ lifetime smoker)[1]	907 (11.7)	469 (14.9)	435 (9.5)	
Path n_2 (→ past 30-day smoker)[1]	451 (5.8)	226 (7.2)	224 (4.9)	
Path n_3 (→ daily smoker)[1]	81 (1.1)	61 (1.9)	20 (0.4)	
Changes in smoking status over a year among baseline lifetime smokers				
Path l_0 (→ lifetime smoker)[1]	2472 (83.2)	1336 (79.8)	1125 (87.8)	$p<0.0001$
Path l_1 (→ past 30-day smoker)[1]	403 (13.6)	272 (16.2)	130 (10.1)	
Path l_2 (→ daily smoker)[1]	95 (3.2)	67 (4.0)	27 (2.1)	
Changes in smoking status over a year among baseline past 30-day smokers				
Path m_{-1} (→ lifetime smoker)[1]	667 (55.4)	391 (47.3)	276 (73.2)	$p<0.0001$
Path m_0 (→ past 30-day smoker)[1]	398 (33.1)	308 (37.3)	90 (23.9)	
Path m_1 (→ daily smoker)[1]	139 (11.5)	127 (15.4)	11 (2.9)	
Changes in smoking status over a year among baseline daily smokers				
Path d_{-2} (→ lifetime smoker)[1]	106 (36.3)	67 (27.8)	39 (76.5)	$p<0.0001$
Path d_{-1} (→ past 30-day smoker)[1]	51 (17.5)	46 (19.1)	5 (9.8)	
Path d_0 (→ daily smoker)[1]	135 (46.2)	128 (53.1)	7 (13.7)	

[1]Visually clearer paths are shown in Figure 1.

Table 2

Associations between smoking attributions and subsequent smoking progression and regression[1,2]

	β (se)	OR (95% CI)[3]	p	β (se)	OR (95% CI)[3]	p	β (se)	OR (95% CI)[3]	p
	Among baseline never smokers								
	Path n_1 (→ lifetime smoker)[4]			Path n_2 (→ past 30-day smoker)[4]			Path n_3 (→ daily smoker)[4]		
Curiosity	0.80 (0.15)	2.23 (1.65, 3.02)	**<0.0001**	0.46 (0.21)	1.58 (1.04, 2.41)	**0.03**	−0.02 (0.68)	0.98 (0.26, 3.75)	0.98
Coping	−0.13 (0.18)	0.88 (0.62, 1.25)	0.47	0.14 (0.23)	1.16 (0.74, 1.80)	0.52	−0.42 (0.70)	0.66 (0.17, 2.57)	0.55
Social Image	0.16 (0.29)	1.18 (0.66, 2.10)	0.58	−0.24 (0.42)	0.79 (0.35, 1.80)	0.57	0.81 (0.90)	2.24 (0.38, 13.18)	0.37
Social Belonging	0.12 (0.30)	1.13 (0.63, 2.03)	0.68	0.30 (0.37)	1.35 (0.66, 2.78)	0.41	−0.42 (1.17)	0.66 (0.07, 6.56)	0.72
Engagement	0.04 (0.34)	1.05 (0.53, 2.05)	0.90	0.24 (0.40)	1.27 (0.58, 2.76)	0.55	1.02 (0.94)	2.76 (0.44, 17.39)	0.28
Autonomy	0.31 (0.23)	1.36 (0.86, 2.16)	0.19	0.59 (0.28)	1.80 (1.05, 3.09)	**0.03**	0.09 (0.79)	1.09 (0.23, 5.17)	0.91
Mental Enhancement	−0.10 (0.30)	0.90 (0.50, 1.62)	0.73	0.29 (0.34)	1.34 (0.69, 2.59)	0.38	0.65 (0.84)	1.91 (0.37, 9.94)	0.44
Weight Control	0.31 (0.43)	1.36 (0.59, 3.13)	0.47	0.81 (0.44)	2.25 (0.94, 5.37)	0.07	--	--	--
	Among baseline lifetime smokers								
	Path l_1 (→ past 30-day smoker)[4]			Path l_2 (→ daily smoker)[4]					
Curiosity	−0.03 (0.12)	0.97 (0.77, 1.23)	0.81	−0.46 (0.25)	0.63 (0.39, 1.02)	0.06			
Coping	0.59 (0.14)	1.81 (1.37, 2.38)	**<0.0001**	0.03 (0.29)	1.03 (0.59, 1.83)	0.91			
Social Image	0.62 (0.19)	1.85 (1.28, 2.69)	**<0.001**	0.49 (0.37)	1.64 (0.78, 3.41)	0.19			
Social Belonging	0.20 (0.21)	1.22 (0.81, 1.82)	0.34	0.22 (0.40)	1.25 (0.57, 2.76)	0.58			
Engagement	0.22 (0.21)	1.25 (0.83, 1.87)	0.29	0.37 (0.39)	1.45 (0.67, 3.13)	0.34			
Autonomy	−0.49 (0.27)	0.61 (0.36, 1.04)	0.07	0.38 (0.42)	1.46 (0.64, 3.35)	0.37			
Mental Enhancement	−0.05 (0.30)	0.95 (0.53, 1.69)	0.86	0.20 (0.57)	1.22 (0.40, 3.68)	0.73			
Weight Control	−0.69 (0.49)	0.50 (0.19, 1.30)	0.16	--	--	--			
	Among baseline past 30-day smokers								
	Path m_{-1} (→ lifetime smoker)[4]			Path m_1 (→ daily smoker)[4]					
Curiosity	0.08 (0.15)	1.08 (0.81, 1.45)	0.60	0.09 (0.22)	1.09 (0.71, 1.69)	0.68			
Coping	−0.60 (0.16)	0.55 (0.40, 0.75)	**<0.001**	0.16 (0.23)	1.17 (0.74, 1.85)	0.50			
Social Image	−0.05 (0.20)	0.96 (0.64, 1.43)	0.82	0.46 (0.27)	1.59 (0.94, 2.69)	0.08			

	β (se)	***OR (95% CI)***[3]	***p***	***β (se)***	***OR (95% CI)***[3]	***p***	***β (se)***	***OR (95% CI)***[3]	***p***
Social Belonging	−0.42 (0.19)	0.66 (0.45, 0.96)	**0.03**	0.06 (0.25)	1.06 (0.65, 1.75)	0.81			
Engagement	−0.13 (0.19)	0.87 (0.61, 1.26)	0.47	0.48 (0.24)	1.62 (1.02, 2.57)	**0.04**			
Autonomy	−0.09 (0.22)	0.91 (0.59, 1.41)	0.68	0.18 (0.28)	1.20 (0.68, 2.09)	0.53			
Mental Enhancement	−0.40 (0.25)	0.67 (0.41, 1.09)	0.11	0.78 (0.28)	2.19 (1.26, 3.78)	**0.01**			
Weight Control	−0.03 (0.33)	0.98 (0.51, 1.88)	0.94	−0.66 (0.47)	0.52 (0.21, 1.29)	0.16			
	Among baseline daily smokers								
	Path d_{-2} (→ lifetime smoker)[4]			Path d_{-1} (→ past 30-day smoker)[4]					
Curiosity	0.20 (0.47)	1.22 (0.49, 3.06)	0.67	0.06 (0.44)	1.06 (0.45, 2.49)	0.90			
Coping	−0.57 (0.42)	0.57 (0.25, 1.30)	0.18	−0.37 (0.42)	0.69 (0.31, 1.57)	0.38			
Social Image	0.38 (0.50)	1.46 (0.55, 3.84)	0.45	0.28 (0.45)	1.33 (0.56, 3.18)	0.52			
Social Belonging	−0.32 (0.50)	0.72 (0.27, 1.92)	0.51	0.03 (0.45)	1.03 (0.43, 2.50)	0.95			
Engagement	−0.89 (0.45)	0.41 (0.17, 0.98)	**0.05**	−0.94 (0.41)	0.39 (0.17, 0.88)	**0.02**			
Autonomy	−0.32 (0.61)	0.73 (0.22, 2.38)	0.60	−1.13 (0.55)	0.34 (0.11, 1.02)	0.05			
Mental Enhancement	−0.51 (0.45)	0.60 (0.25, 1.45)	0.26	0.25 (0.40)	1.28 (0.58, 2.82)	0.54			
Weight Control	−1.46 (1.06)	0.23 (0.03, 1.84)	0.17	0.56 (0.72)	1.75 (0.43, 7.11)	0.44			

[1] Age, gender, ethnicity, geographic region, district economy rank, and school academic rank are covariates in the models.

[2] P values smaller than 0.05 are shown in bold.

[3] The reference groups are students whose smoking status remained at the same stages over one year (e.g., on path n_0, l_0, m_0, or d_0).

[4] Visually clearer paths are shown in Figure 1.