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Testing the indirect effect of trait mindfulness on adolescent cigarette smoking through negative affect and perceived stress mediators

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Abstract

Mindfulness refers to an enhanced attention to and awareness of present moment experience. This study examined how trait mindfulness, as measured with six items from Mindfulness Attention Awareness Scale, might influence adolescent cigarette smoking frequency through its impact on depressive affect, anger affect and perceived stress mediators. Self-reported data from Chinese adolescents (N = 5287, mean age = 16.2 years, SD = 0.7; 48.8% females) were collected within 24 schools. The product of coefficients test was used to determine significant mediation paths. Results from baseline cross-sectional data indicated that trait mindfulness had a significant indirect effect on past 30-day smoking frequency through depressive affect, anger affect and perceived stress mediators. Results from 13-month longitudinal data indicated that these indirect effects remained significant for depressive affect and perceived stress but not for anger affect. Findings from this study may suggest that heightening mindfulness among adolescents may indirectly reduce cigarette smoking perhaps by improving affect regulation competencies.

Keywords

Mindfulness; affect regulation; smoking; mediation; adolescents

Adolescence is an integral developmental stage when maladaptive behaviours such as cigarette smoking are initiated. Over 91% of adults who have ever smoked on a daily basis initiated smoking before age 20, and 77% of these adults became regular smokers in their adolescent years (USDHHS, 1994). The initiation of maladaptive behaviours in adolescence is not surprising considering the transitional nature of this pubescent period, often characterized by a heightened exposure to life stressors and negative affect (Jessor, 1993). Consequently, many adolescents smoke in an effort to self-regulate feelings of negative affect and stress. Theoretical models of affect regulation and substance use (Tomkins, 1966; Wills, 1986; Colder & Chassin, 1993) suggest that smoking, paradoxically experienced as both a fast-acting *stimulant* and *relaxant*, is used as a coping response to reduce

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understimulation arising from negative affect and also to dampen overstimulation arising from stress arousal (Gilbert, 1979; Leventhal & Cleary, 1980). Thus, adolescents may smoke to self-regulate burdensome feelings such as stress, depression and anger.

Empirical findings provide some evidence for an affect regulation model of adolescent smoking. For example, when asked why they continue to smoke, the majority of adolescent smokers report using cigarettes to relax (CDC, 1994). Similarly, among adolescent smokers attending a primary care clinic, 72% reported stress relief as their most common reason for progression from experimental smoking to becoming a regular smoker, and 33% indicated smoking helped them cope with their problems (Siqueira et al., 2000). In addition, the level of perceived stress was lowest in never-smokers and higher in experimenters, suggesting a dose–response relationship. Some studies comprising school-based samples also support an affect regulation model of smoking (e.g. Castro et al., 1987; Sussman et al., 1993; Dugan et al., 1999; Skara et al., 2001). Wills (1986) found, among an ethnically diverse sample of adolescents from three junior high schools, subjective stress to prospectively predict increases in smoking at 1-year follow-up. Byrne et al. (1995) sampled 6410 Australian adolescents from various socio-economic backgrounds and found that stress was associated with both present smoking status and smoking onset from a previously non-smoking status.

Adolescent smoking is also linked with negative affect, including both depressive (Patton et al., 1998; Windle & Windle, 2001; Brook et al., 2004) and anger affect (Seltzer & Oechsli, 1985; Johnson & Gilbert, 1991; Forgays et al., 1993; Siqueira et al., 2000). Covey and Tam (1990) identified a strong cross-sectional association between depressive affect and number of cigarettes smoked among 11th graders even after adjusting for peer, sibling and parent smoking; worry; and other covariates. Kandel and Davies (1986) surveyed public high school youth at ages 15–16 and 9 years later found that depressive symptoms were predictive of heavy smoking. Results from a national survey of adolescents in the United States indicated that depressive symptoms increased the rate of smoking initiation by 13% and 19% for adolescents reporting low and high depressive symptoms, respectively (Escobedo et al., 1998). Data from an ethnically diverse school-based sample of adolescents indicated that intense anger was associated with both initiation and maintenance of smoking (Johnson & Gilbert, 1991). Similarly, Siqueira et al. (2000) found that anger was associated with a greater likelihood to experiment with smoking, as well as current smoking status.

Identifying factors that may reduce smoking attributable to the self-regulation of negative affect and stress is critical for developing effective smoking prevention programmes. Mindfulness, an enhanced attention to and awareness of present moment experience (Brown & Ryan, 2003), is one protective characteristic that may play a role in cigarette smoking behaviour as it appears to be positively associated with affect regulation competencies. For example, trait mindfulness, as measured with the Mindful Attention Awareness Scale (MAAS), has been shown to have strong inverse associations with negative affect and stress indicators and positive associations with indicators of behavioural regulation and emotional well-being (e.g. Brown & Ryan, 2003; among adults, MAAS correlates with depressive affect, $r = -0.37$; anger affect, $r = -0.41$; and stress symptoms, $r = -0.46$). Emerging evidence from functional magnetic resonance imaging studies conducted among adults also suggest that trait mindfulness (as measured with the MAAS) is inversely associated with self-rated negative affect and that it also plays a role in supporting self-regulation processes that are identifiable in specific brain regions (Creswell et al., 2007; Herwig et al., 2010).

Studies examining the association between trait mindfulness and psychosocial factors among adolescents are scant. In one cross-sectional study, Marks et al. (2010) found that trait mindfulness attenuated the association between life hassles and symptoms of depression and stress among Australian high school students. A recent cross-sectional study (Blacket

al., in press) conducted among Chinese adolescents found medium- to large-size correlations between trait mindfulness and depressive affect ($r = -0.40$), anger affect ($r = -0.29$) and perceived stress ($r = -0.54$), which were similar to those findings garnered from adult samples (Brown & Ryan, 2003). Black et al. (in press) also showed that trait mindfulness explained variance in negative affect/stress measures beyond other psychosocial constructs, suggesting the incremental validity of trait mindfulness.

The primary aim of this study is to evaluate mediation models that test the influence of mindfulness on adolescent smoking through depressive affect, anger affect and perceived stress mediators. Based on the affect regulation model of smoking, we hypothesized that mindfulness would be inversely related to smoking behaviour through its attenuating effect on negative affect and perceived stress mediators. This aim addresses a main gap in mindfulness research, which is a lack of understanding of the mechanisms linking trait mindfulness to health behaviour in naturalistic contexts. A secondary aim of this study is to verify the trait nature of mindfulness over time as measured with the MAAS (Brown & Ryan, 2003). A *trait* is defined here as a distinguishable characteristic that differs between individuals, but is relatively stable within individuals over time. Although mindfulness, as operationalized with the MAAS, is discussed as a trait characteristic in the extant literature, no longitudinal data support this claim. Therefore, verifying the trait nature of mindfulness with the use of growth curve modelling methods is important to contextualize the findings resulting from the primary aim of this study mentioned above. Based on previous convention, we hypothesized that the MAAS would function as a stable trait characteristic across time.

Methods

Participants and procedures

Data were collected as part of a longitudinal study conducted by collaborating researchers from the Pacific Rim Transdisciplinary Tobacco & Alcohol Use Research Center. The objective of the Transdisciplinary Tobacco & Alcohol Use Research Center project was to investigate the determinants of health behaviour among adolescents in Chengdu, China. All consent procedures and survey instruments for this study were approved by the Institutional Review Boards of the University of Southern California and Chengdu Center for Disease Control and Prevention, China. A total of 24 schools ($N = 24$) in Chengdu, China, enrolled in the study. Within the 24 schools that participated, there were a total number of 1060 classes. Of those, a total of 338 classes were randomly selected to participate in this study and a very high percentage (98.12%) of students within these classrooms agreed to participate in the study.

Parental consent forms were distributed to students within the selected classrooms, and those students acquiring written or verbal parental consent and giving personal assent completed a self-reported paper-and-pencil questionnaire in their classroom during school hours. The students whose parents did not sign the parental participation permission form and/or who did not actively assent were excluded from the study. Participants voluntarily took part in the study and were informed that they could discontinue their participation at any time. Classroom teachers were not present during the survey period so that participating students would feel confident about the confidentiality of their responses. The same participants completed surveys in their respective classroom from 10th to 12th grade for a total of five waves of data collection. This study examines the data specifically from waves 2, 3 and 5 because the measures of interest were collected during these waves. For clarity purposes, these waves of data collection are referred to as Time 1 (T1), Time 2 (T2) and Time 3 (T3), respectively, in this study. The data collection interval between T1 (March 2008) and T2 (June 2008) was 3 months; between T2 and T3 (April 2009) was 10 months; and between

T1 and T3 was 13 months. Due to missingness resulting from attrition and non-response across time, our sample size at T1 was 5287, at T2 was 4885 and at T3 was 3500.

Measures

Demographic data—It included respondent's age, gender, parent education and type of school attended (regular or vocational).

Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003)—The MAAS is a 15-item single-dimension measure of trait mindfulness, which is operationalized as the frequency of open and receptive attention to and awareness of ongoing events and experience. Response options ranged from 1 (*almost never*) to 6 (*almost always*). To control for social desirability, respondents are instructed to respond to the MAAS in a way that reflects their actual experience rather than in a way they think their experience should be. In this study, a 6-item short version of the MAAS was measured based on previous psychometric research that indicates a 6-item MAAS (items 7–13 and 14 from Brown & Ryan, 2003) has equivalent and in some cases stronger evidence for construct validity relative to the full 15-item MAAS among Chinese adolescents (6-item Cronbach's $\alpha = 0.89$; 6-item MAAS had better model fit and showed stronger gender invariance than the 15-item MAAS; mean item-total correlation = 0.71; Black et al., in press). Other psychometric studies also corroborate the utility of our shortened version of the MAAS (Van Dam et al., 2010). Example items used in this study included the following: "I find it difficult to stay focused on what's happening in the present", "I could be experiencing some emotion and not be conscious of it until sometime later" and "I rush through activities without being really attentive to them." One item was modified to make it appropriate for adolescents: we changed the item "I *drive* places on automatic pilot and then wonder why I went there" to "I *go* places on automatic pilot and then wonder why I went there." Item scores were reverse coded and means were calculated to make higher mean scores indicate higher mindfulness.

Mediators—Three items from the Center for Epidemiologic Studies Depression Scale (CESD, Radloff, 1977; Cronbach's $\alpha = 0.90$ among Asian adolescents, Yang et al., 2004; this study, Cronbach's $\alpha = 0.87$) were used to assess depressive affect (e.g. On how many of those days [referencing the past 7 days] did you have trouble shaking off sad feelings?). CESD response options ranged from 1 (*less than 1 day*) to 5 (*5–7 days*). Three items from the Aggression Questionnaire anger subscale (AQ, Buss & Perry, 1992; Cronbach's $\alpha = 0.89$ among Asian adolescents, Ang & Yusof, 2005; this study, Cronbach's $\alpha = 0.81$) were used to assess the affective component of anger (e.g. I have trouble controlling my temper). AQ response options ranged from 1 (*not like me at all*) to 5 (*completely like me*). Six items from the Perceived Stress Scale (PSS, Cohen et al., 1983; Cronbach's $\alpha = 0.81$ among Asian adolescents, Xie et al., 2006; this study, Cronbach's $\alpha = 0.86$) were used to assess respondent perceptions of life situations as stressful in the past month (e.g. In the last month, how often were you unable to control the important things in your life?). PSS response options ranged from 1 (*never*) to 5 (*always*). Mean scores were calculated for each mediator measure and higher mean scores indicated higher endorsement of each respective construct.

Current cigarette smoking—Frequency of current smoking was assessed with one item: "During the past 30 days, on how many days did you smoke cigarettes?" which is a valid measure used in the national Centers for Disease Control and Prevention Youth Risk Behavior Survey. Response options were coded on a 7-point scale ranging from 1 (*0 days*) to 7 (*all 30 days*), with higher scores indicating greater smoking frequency. Due to a positive skew, this variable was log transformed to help normalize its distribution.

Analyses

Data cleaning and descriptive statistics were conducted using SAS 9.2 software. Data were imported into Mplus version 5 and frequencies were cross-examined between Mplus and SAS to assure correctness of transferred data. Each variable's distribution was assessed for normality through skew and kurtosis and all variables approximated a normal distribution except for the current smoking variable, which was log transformed. The unconditional means models for each dependent variable indicated the presence of smoking behaviour clustering within schools (ICC > 0.02). Thus, our mediation models were hierarchical to account for students nested within schools in order to obtain more accurate SE estimates (Krull & MacKinnon, 2001). Criterion for significance testing was $p < 0.05$ using a two-tailed test.

Mediation path analysis was conducted in Mplus, which is a program that allows all regression equations in the mediation model to be estimated simultaneously. Mediation is the scenario where an independent variable (X) causes an intervening variable (M), which in turn causes the dependent variable (Y). In our study, we tested the following hypothesized pathway: trait mindfulness (X) inversely predicts negative affect and perceived stress mediators (M), which in turn reduce the impact of M on smoking behaviour (Y). Path models are controlled for baseline score on the mediator and outcome variables, and adjusted for age, gender, parent education, school type and treatment condition. Significance tests for mediation were conducted using the product of coefficients tests (MacKinnon et al., 2002). According to this procedure, a variable can be tested as a mediator by dividing the estimate of the product of paths $a \times b$ by its corresponding SE and comparing this value with a standard normal distribution to determine significance. The product of these two parameters $a \times b$ is the mediated or indirect effect, and the coefficient c relating the X variable to the Y variable adjusted for the mediator is the non-mediated or direct effect. Relative to other tests of mediation, the product of coefficients tests appears to be one of the best tests among several methods for testing mediation in terms of having the most power and accurate type 1 error rates (MacKinnon et al., 2002). A pattern of results that indicates statistically significant indirect effects but not direct effects represents the strongest demonstration of a mediation effect (Kline, 2005). Percent mediated was calculated by dividing the total effect by the indirect effect.

To assess the trait behaviour of mindfulness over time, a latent growth model (LGM) was tested in Mplus to determine the growth in mean MAAS level across a 13-month period. The MAAS was assessed at three time points including baseline (T1) and 3-month (T2) and 13-month (T3) follow-up periods. Initially, the intercept and slope growth factors were estimated in a simplified model without covariates. Then, growth estimates were regressed on gender, age, parent education and school type.

Considering that ad hoc procedures for handling missing data such as listwise deletion or mean substitution often result in biased parameter and/or SE estimates, our mediation modelling and LGM procedures used full information maximum likelihood estimation as implemented in Mplus to yield more accurate estimates while adjusting for the uncertainty associated with the missing data (Little & Rubin, 2002). The full information maximum likelihood estimation does not impute missing values but directly estimates model parameters and SEs using all available raw data for each respondent. Attrition analyses were also conducted to determine the baseline differences in demographic characteristics between those with complete data (completers) and missing data (non-completers) at 13-month follow-up (N at Time 3 = 3500). Reasons for missing data included absence from school; inability to locate respondent; non-response to items; and refusal to complete subsequent surveys. Attrition analyses showed that completers were slightly younger (mean age for completers = 16.17 years, non-completers = 16.24 years, $t = 3.37$, $p < 0.001$) and had

slightly higher SES (mean SES for completers = 4.18, non-completers = 3.99, $t = 4.64$, $p < 0.001$).

Results

Demographics

T1 participants' ages ranged from 14 to 20 years ($M = 16.2$ years, SD = 0.7; see Table I), and the ratio of males and females was relatively equivalent. Over 45% of respondents reported ever smoking a cigarette in their lifetime. Over 24% of the sample reported smoking in the past 30 days, and almost 5% of the sample reported daily smoking.

Bivariate correlations—Table II shows that at T1, MAAS level was inversely and significantly correlated, in medium to large magnitude, with the T1 mediators PSS ($r = -0.47$), CESD ($r = -0.37$) and AQ ($r = -0.25$) and in smaller magnitude with the log of T1 smoking frequency ($r = -0.15$). Significant and inverse correlations were held between T1 MAAS and T2 PSS ($r = -0.35$), CESD ($r = -0.29$) and AQ ($r = -0.19$). T1 MAAS level also maintained a significant inverse correlation with T3 smoking frequency ($r = -0.08$). Table II also provides the mean scores for measures across time and indicates if these means significantly differed across time. Each mediating variable (i.e. PSS, CESD, AQ) had significant mean differences from T1 to T2 and the mean log of smoking significantly differed between all three time points.

Mediation findings—Table III provides the cross-sectional mediation path coefficients; all constructs in this model were measured at T1. Significant indirect effects linking MAAS to the smoking outcome were found for PSS (indirect $\beta = -0.046$, $p < 0.01$), CESD (indirect $\beta = -0.040$, $p < 0.01$) and AQ (indirect $\beta = -0.026$, $p < 0.01$). Total and indirect effect estimates indicated full mediation for all three models. Table IV provides the longitudinal mediation path coefficients. Baseline measures were assessed at T1; mediators were assessed at T2 (3 months post-baseline); and the smoking outcome was assessed at T3 (13 months post-baseline). Significant indirect effects linking MAAS to the smoking outcome included PSS (indirect $\beta = -0.009$, $p < 0.01$) and CESD (indirect $\beta = -0.005$, $p < 0.05$). Marginally significant indirect effects were found for AQ (indirect $\beta = -0.003$, $p < 0.10$), indicating a trend for mediation. Total and indirect effect estimates indicated full mediation for all models. To test the potential for significance when reversing the direction of association between the predictor and the mediator, each one of the three longitudinal mediation models was analysed by switching the positions of the mediator (M) and the predictor (X). Results from these models indicated non-significant indirect effects, suggesting lack of empirical support for these alternative models.

Linear growth in the MAAS

Table V provides the linear growth estimates for mean MAAS scores over time. In the reduced model without covariates, the intercept was 4.095, which indicates the average initial MAAS level for the total sample at baseline. There was very slight positive mean linear growth in the mean MAAS level over time ($B = 0.012$, $p < 0.01$). There was a substantial range of individual differences around the average initial MAAS level ($B = 1.685$, $p < 0.01$), but there is no significant range of individual differences in the rate of linear increases in MAAS level over time ($B = 0.008$, ns).

The negative covariance in the intercept and slope parameters ($B = -0.073$, $p < 0.01$) indicates those who report high MAAS levels at T1 tended to have a slight decrease in mean MAAS scores over time, while those who report low levels of MAAS at T1 tended to report a slight increase in MAAS level over time. The LGM results for the adjusted model

indicated males had lower initial MAAS levels, and age and parent education were related to higher initial MAAS levels. All the demographic covariates entered in the model had little influence on the rate of change of MAAS levels over time (range of *B* for covariates = −0.003 to 0.01).

Discussion

This study, conducted in a naturalistic school-based setting with Chinese adolescents, incorporated trait mindfulness within an affect regulation model of substance use and verified the trait nature of mindfulness when measured with items from the MAAS. The results of this study are consistent with our initial predictions in several respects. First, findings from our mediation analyses suggested mindfulness was inversely associated with adolescent smoking behaviour through its influence on negative affect and perceived stress mediators. Findings from both cross-sectional and longitudinal data supported our prediction that trait mindfulness might indirectly reduce smoking frequency by its attenuating effect on negative affect and perceived stress indicators. Our findings provide initial support for models that suggest mindfulness may protect against adolescent maladaptive behaviour through its attenuating influence on negative affect and stress, perhaps through affect regulation competencies (Hede, 2010; Herwig et al., 2010). Further support for the hypothesized direction of our models was obtained by switching the placements of the mediator and the predictor in the mediation model to evaluate alternative frameworks; results from these models indicated no significant indirect effects on smoking when negative affect/stress measures were modelled as the predictor and trait mindfulness as the mediator.

Our findings corroborate previous research that supports an inverse relationship between trait mindfulness, as measured with the MAAS, and depressive affect, anger affect and stress among adult (Brown & Ryan, 2003) and adolescent samples (Marks et al., 2010; Black et al., under review). Our findings extend this literature by proposing a testable model of trait mindfulness and affect regulation, which elucidates one possible mechanism whereby mindfulness may protect against adolescent smoking behaviour. This study also addresses recent discussion regarding the integration of mindfulness within models of health behaviour (Black, 2010). Moreover, this study adds to previous research by being one of the first to use longitudinal data to support a prospective relationship between trait mindfulness and negative affect/stress among adolescents in a naturalistic school-based setting.

Second, using latent growth modelling, we found the MAAS behaved as a trait characteristic across a 13-month period; data indicated high between-subjects variability in the initial level of MAAS scores, but low within- and between-subjects level of change in MAAS scores over time. Moreover, demographic variability in age, parent education and school type had little influence on the trajectory of MAAS, suggesting that mindfulness may be a unique characteristic that may be most sensitive to mindfulness training alone rather than intrapersonal and social factors. Previous research has supported this notion and suggests that trait mindfulness is highest among those that practice mindfulness skill building techniques (Brown & Ryan, 2003). Overall, our growth modelling results support the conceptualization of mindfulness, as measured with the MAAS, as a trait characteristic that is relatively stable over time. This specific finding adds to previous literature (Brown & Ryan, 2003) by elucidating the growth estimates of mindfulness using longitudinal data, which allows for stronger inferences about the trait nature of the MAAS.

Certain limitations in our study require comment. First, our sample consisted of Chinese adolescents, which implies that our findings may not generalize to adolescents in other countries. Moreover, we found that those who completed the 13-month follow-up assessment were slightly younger and had slightly higher SES at baseline compared with

non-completers, which might limit the generalizability of our findings to the original baseline sample. However, these mean differences were small and did not appear to be of practical significance. We recommend that studies replicate our proposed model with data from adolescents and adults in various countries. Second, our mediation model did not capture a direct measure of affect regulation (e.g. Negative Mood Regulation Expectancies Scale; Catanzaro & Mearns, 1990), which limits a more direct interpretation of the actual self-regulation mechanisms leading mindfulness to attenuate negative affect and smoking. Future studies should directly measure affect regulation competencies and determine if these competencies would mediate the relationship between trait mindfulness and negative affect/stress indicators. This area of research is promising considering recent brain imaging studies that have suggested increased affect regulation capacity among those with increased levels of trait mindfulness (Creswell et al., 2007; Herwig et al., 2010). Third, our study had methodological limitations such as it relied on the self-report data that may be vulnerable to respondent bias; however, research have shown little discrepancy between self-reports and biochemical assessments of adolescent cigarette smoking (Stacy et al., 1990), and respondents were continually assured that their responses were confidential prior to questionnaire completion. Moreover, the smoking measure used in this study is not as sensitive perhaps as other measures that quantify the actual number of cigarettes smoked per day (e.g. one cigarette per day vs. one pack per day). However, our smoking measure has been used routinely in previous research and provides a valid measure of adolescent smoking behaviour. Future research may consider using both smoking measures.

Our findings have implications for practical application. Although the MAAS, as a measure of trait mindfulness, produces relatively stable scores over time, mindfulness can nevertheless be heightened through specific mindfulness practices (Brown & Ryan, 2003; Shapiro et al., 2007) such as Mindfulness-Based Stress Reduction. Mindfulness-based interventions are increasingly being adapted for and delivered to adolescents, and have shown promise to reduce some adolescent maladaptive behaviours (see reviews by Black et al., 2009; Burke, 2010). However, no research to date has reported outcomes for mindfulness-based programmes for adolescents in China. Therefore, programmes such as Mindfulness-Based Stress Reduction that use techniques to heighten mindfulness may perhaps prove useful to substance abuse prevention programmes targeted to adolescents in school-based settings in China and other countries. To verify this notion, future research trials are needed to determine if mindfulness-based interventions can increase mindfulness among adolescents in naturalistic school-based settings, and to determine if these interventions bolster affect regulation competencies and reduce various substance use behaviours.

In summary, the results from this study provide evidence suggesting that trait mindfulness is inversely associated with adolescent smoking behaviour through its attenuating influence on negative affect and stress indicators in both cross-sectional and longitudinal models. Further, findings from this study support the notion that the MAAS functions as a trait measure of mindfulness among adolescents across a 13-month period. Mindfulness can be cultivated with practice, and this may suggest that future studies should examine the effects of mindfulness-based interventions on affect regulation competencies and substance use among adolescents in naturalistic school-based settings.

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Table I

Demographic characteristics of Chinese adolescents at T1 ($N = 5287$)

Variable	*M*	SD	*N*	%	Range
Gender					
Female			2583	48.9	
Male			2704	51.1	
Age	16.2	0.7			14–20
Parent education	4.1	1.6			1–7
Lifetime smoking *					
Yes			2426	45.8	
No			2871	54.2	
Past 30-day smoking					
0 days			3977	75.8	
1–2 days			350	6.7	
3–5 days			151	2.9	
6–9 days			138	2.6	
10–19 days			200	3.8	
20–29 days			184	3.5	
All 30 days			248	4.7	

Note:

* Response to the measure “Have you ever tried cigarette smoking, even a few puffs?”.

Table II

Pearson bivariate correlations and mean scores across time

Variable	MAAS	PSS	CESD	AQ	Smoking†
MAAS		−0.35*	−0.29*	−0.19*	−0.08*
PSS	−0.47*		0.43*	0.20*	0.03
CESD	−0.37*	0.60*		0.15*	0.07*
AQ	−0.25*	0.31*	0.26*		0.06*
Smoking	−0.15*	0.11*	0.14*	0.11*	
T1 *M*(SD)	4.4 (1.1)‡	2.5 (.9)‡	2.0 (.9)‡	2.5 (1.1)‡	0.33 (0.63)‡
T2 *M*(SD)	4.5 (1.1)‡	2.5 (.9)¶	2.0 (.8)¶	2.6 (1.0)¶	0.30 (0.61)¶
T3 *M*(SD)					0.31 (0.61)§

Notes: Lower left of the diagonal includes T1 intercorrelations; upper right of the diagonal includes intercorrelations between T1 and T2. MAAS, Mindful Attention Awareness Scale; CESD, Center for Epidemiologic Studies Depression Scale; PSS, Perceived Stress Scale; AQ, Aggression Questionnaire.

†Log of current smoking frequency at T3.

‡,¶,§Columns sharing the same letter indicate non-significant difference in mean scores between the indicated time points using a paired sample *t*-test.

*$p < 0.01$.

Table III

Cross-sectional mediation path analysis for past 30-day smoking frequency

Model path	*B*	SE	95% CI for *B*	*β*	Percent mediated†	R^2
PSS model						
MAAS→PSS	−0.368	0.013	(−0.394, −0.343)	−0.463*		
PSS→Smoking	0.073	0.012	(0.049, 0.096)	0.099*		
MAAS→Smoking	−0.082	0.014	(−0.109, −0.056)	−0.140*		
Indirect effect	−0.027	0.004	(−0.036, −0.018)	−0.046*	100	
Model R^2 for PSS						0.236
Model R^2 for smoking						0.312
CESD model						
MAAS→CESD	−0.292	0.001	(−0.314, −0.270)	−0.366*		
CESD→Smoking	0.080	0.015	(0.054, 0.105)	0.108*		
MAAS→Smoking	−0.086	0.015	(−0.115, −0.057)	−0.147*		
Indirect effect	−0.023	0.004	(−0.031, −0.015)	−0.040*	100	
Model R^2 for CESD						0.139
Model R^2 for smoking						0.218
AQ model						
MAAS→AQ	−0.253	0.016	(−0.283, −0.222)	−0.253*		
AQ→Smoking	0.061	0.007	(0.048, 0.074)	0.103*		
MAAS→Smoking	−0.094	0.014	(−0.121, −0.067)	−0.160*		
Indirect effect	−0.015	0.002	(−0.019, −0.011)	−0.026*	100	
Model R^2 for AQ						0.077
Model R^2 for smoking						0.218

Notes: MAAS, Mindful Attention Awareness Scale; CESD, Center for Epidemiologic Studies Depression Scale; PSS, Perceived Stress Scale; AQ, Aggression Questionnaire.

†Percent mediated = indirect effect/total effect. Each model is adjusted for age, gender, parent education, school type, mediator score, treatment exposure and smoking frequency at baseline. Hierarchical models are used to account for students nested within schools.

*$p < 0.01$.

Table IV

Longitudinal mediation path analysis for past 30-day smoking frequency

Model path	*B*	SE	95% CI for *B*	*β*	Percent mediated†	R^2
PSS model						
MAAS→PSS	−0.147	0.016	(−0.115, −0.179)	−0.178*		
PSS→Smoking	0.034	0.010	(0.014, 0.055)	0.048*		
MAAS→Smoking	0.002	0.011	(−0.019, 0.023)	0.003		
Indirect effect	−0.005	0.002	(−0.002, −0.008)	−0.009*	100	
Model R^2 for PSS						0.221
Model R^2 for smoking						0.476
CESD model						
MAAS→CESD	−0.129	0.013	(−0.104, −0.155)	−0.165*		
CESD→Smoking	0.025	0.009	(0.007, 0.043)	0.033*		
MAAS→Smoking	−0.002	0.010	(−0.022, 0.019)	−0.003		
Indirect effect	−0.003	0.003	(−0.011, 0.000)	−0.005**	100	
Model R^2 for CESD						0.187
Model R^2 for smoking						0.475
AQ model						
MAAS→AQ	−0.079	0.019	(−0.041, −0.116)	−0.082*		
AQ→Smoking	0.019	0.007	(0.005, 0.033)	0.031**		
MAAS→Smoking	−0.004	0.010	(−0.024, 0.016)	−0.007		
Indirect effect	−0.001	0.001	(−0.007, 0.000)	−0.003***	100	
Model R^2 for AQ						0.193
Model R^2 for smoking						0.475

Notes: MAAS, Mindful Attention Awareness Scale; CESD, Center for Epidemiologic Studies Depression Scale; PSS, Perceived Stress Scale; AQ, Aggression Questionnaire.

†Percent mediated = indirect effect/total effect. Each model is adjusted for age, gender, parent education, school type, mediator score, treatment exposure and smoking frequency at baseline. Mediator assessed at 3 months post-baseline and outcome assessed at 13 months post-baseline. Hierarchical models are used to account for students nested within schools.

*$p < 0.01$,

**$p < 0.05$,

*** $p < 0.10$.

Table V

Linear growth estimates of mean MAAS scores across 13 months

Growth factors	*B*	SE	*P*-value
Unadjusted model			
Mean[†]			
Intercept	4.095	0.020	*
Slope	0.012	0.002	*
Variance			
Intercept	1.685	0.050	*
Slope	0.008	0.001	*
Covariance	−0.073	0.004	*
Covariate adjusted model			
Mean			
Intercept	1.803	0.078	*
Slope	0.012	0.008	
Variance			
Intercept	0.908	0.037	*
Slope	0.004	0.001	*
Covariance	−0.037	0.003	*
Covariates[‡]			
Intercept			
Gender (male)	−0.096	0.019	*
Age	0.154	0.004	*
Parent education	0.041	0.007	*
School type	0.009	0.007	
Slope			
Gender (male)	0.009	0.002	*
Age	−0.003	0.001	*
Parent education	0.006	0.001	*
School type	0.010	0.001	*

Notes:

[†]Intercept = average initial MAAS level; slope = linear growth in average MAAS level; Intercept = range of individual differences around the average initial MAAS level; slope = range of individual differences in the rate of linear increases in MAAS level over time.

[‡]Estimates from intercept and slope growth factors regressed on covariates.

*$p < 0.01$.