Health Psychology
2004, Vol. 23, No. 2, 168–177

0278-6133/04/$12.00 DOI: 10.1037/0278-6133.23.2.168

Prevalence and Predictors of Transitions in Smoking Behavior Among College Students

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The prevalence of smoking among college students is surprisingly high and represents a significant public health issue. However, there are few longitudinal studies of smoking in this population. This study examined the prevalence and predictors of transitions in smoking behavior among a cohort of 548 college students. Over the course of 4 years, 87% of daily smokers and almost 50% of occasional smokers continued to smoke. Among nonsmokers, 11.5% began smoking occasionally and none became daily smokers. In general, predictors of smoking behavior change were significant only among baseline occasional smokers and included gender, smoking outcome expectancies, and affect regulation expectations. Peer and parental smoking, demographics, affect, stress, and alcohol use were generally not predictive of change. Tobacco control interventions targeted at college students are clearly warranted.

Key words: smoking, college students, cohort study

College students represent approximately one third of 18–24-year-old U.S. adults (U.S. Bureau of the Census, 1997) and the prevalence of smoking among college students is surprisingly high given the strong inverse relationship between education and smoking in the general population (Escobedo & Peddicord, 1996). Almost 30% of college students have smoked within the past 30 days, 16.5% smoked on 20 or more of those days, and among the 30% of college students who are current smokers, 34% smoke 11 or more cigarettes per day (CDC, 1997; Rigotti, Lee, & Wechsler, 2000). Unfortunately, the prevalence of smoking among college students increased during the mid-1990s and has remained stable over the last few years (Rigotti et al., 2000; Wechsler, Rigotti, Gledhill-Hoyt, & Lee, 1998). Thus, smoking among college students is widespread and represents a significant public health issue. However, there are few prospective studies of smoking behavior in this population. Instead, most studies have been cross-sectional and have examined the association of smoking with demographic and lifestyle factors (e.g., Rigotti et al., 2000; Wechsler et al., 1998).

Important questions regarding the eventual fates of college student daily smokers, occasional smokers, and nonsmokers remain to be answered. That is, what proportion of daily smokers quit or reduce their smoking during college; what proportion of nonsmokers begin to smoke; and, what proportions of occasional smokers progress to daily smoking or cease using tobacco? Questions related to predictors of smoking behavior among college students include whether the same constructs predict initiation, progression, and cessation of smoking, or whether the predictors differ by stage of smoking behavior. To date, there are few studies that address these issues, and both theoretical accounts of smoking among college students as well as intervention efforts require additional data on the longitudinal course and predictors of smoking behavior in this population.

Longitudinal Course of Smoking

Researchers tracking smoking behavior have suggested that smoking is relatively stable from adolescence to young adulthood (Bachman, Wadsworth, O'Malley, Johnston, & Schulenberg, 1997; Chen & Kandel, 1995), but there is evidence indicating that some individuals change their smoking behavior during this developmental period. In a study tracking smoking behavior pathways between adolescence and young adulthood (Chassin, Presson, Sherman, & Edwards, 1991), 9% of the sample initiated smoking after high school and another 9% were adolescent smok-

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ers who quit in young adulthood. In a study of 18- and 19-year-old smokers, 18% successfully quit smoking over the subsequent 4 years (Zhu, Sun, Billings, Choi, & Malarcher, 1999). Among college student daily smokers, 19% reported beginning to smoke daily only after age 19 and 70%–80% have attempted to quit (CDC, 1997; Everett et al., 1999). Thus, a sizable proportion of college smokers did not become daily smokers until after high school and the proportions of college age smokers who quit smoking, or tried to quit, are similar to those found among older smokers. These data suggest that smoking behavior is mutable during the college years and that both prevention and cessation programs may be warranted.

Predictors of Smoking Behavior

Various models of nicotine dependence and drug motivation have been used to identify constructs posited to influence smoking behavior. In physical models of dependence, it is proposed that smoking history and total amount of nicotine exposure should predict greater likelihood of smoking and of becoming dependent (Fagerstrom, 1978), in problem behavior models it is suggested that smoking should be associated with other risky behaviors including alcohol and other drug use (Jessor, 1991), in social learning models it is posited that peers and family influence smoking behavior (Petraitis, Flay, & Miller, 1995), in cognitive models it is argued that associations encoded in memory should affect smoking (Brandon & Baker, 1991), and in affect regulation models it is hypothesized that affective variables are key determinants of smoking behavior (Baker, Morse, & Sherman, 1987). Thus, in the current study we examined families of predictor variables derived from previous research and theory, including demographics and lifestyle, smoking history, family and peer smoking, smoking outcome expectancies, affect, and affect regulation related constructs.

Demographics and Lifestyle

Cross-sectional data show higher smoking rates among college students who are White, dissatisfied with their education, less religious, members of fraternities or sororities, do not participate in athletics and view athletics as not important, and who consume more alcohol (Emmons, Wechsler, Dowdall, & Abraham, 1998). Prospective data indicate that alcohol use predicts smoking progression among adolescents and cessation among current smokers (Mayhew, Flay, & Mott, 2000; McClure, Wetter, de Moor, Cinciripini, & Gritz, 2002). Prospective predictors of unaided smoking cessation among young adults include higher education and valuing a healthy lifestyle (Rose, Chassin, Presson, & Sherman, 1996).

Smoking History

There is strong evidence for the predictive potency of prior tobacco use on future smoking behavior for both adolescents and young adults (Chassin, Presson, Sherman, & Edwards, 1990; Derzon & Lipsey, 1999; Mayhew et al., 2000; USDHHS, 1994; Zhu et al., 1999). Lighter smoking and smoking for fewer years have also been shown to be predictors of unaided smoking cessation among both younger and older adults (Cohen et al., 1989; Marlatt, Curry, & Gordon, 1988; Rose et al., 1996).

Family and Peer Smoking

In both a meta-analysis that included cross-sectional and prospective studies and a detailed review of the adolescent literature, it was concluded that peer and family smoking prospectively predicted smoking progression at numerous points throughout the initiation process (Derzon & Lipsey, 1999; Mayhew et al., 2000). Similar conclusions were reported in the U.S. Surgeon General's Report, *Preventing Tobacco Use Among Young People,* although the effects of parental smoking were less clear (USDHHS, 1994). Initiation of smoking after high school is associated with peer and parental smoking, whereas quitting in young adulthood is associated with less parental smoking (Chassin et al., 1991). Among adults and young adults, cessation is predicted by fewer friends who smoke, less parental smoking, and fewer household smokers (Chassin et al., 1991; Cohen et al., 1989; Marlatt et al., 1988; Rose et al., 1996). Parental smoking may be a better predictor of smoking uptake than of cessation (Chassin, Presson, Rose, & Sherman, 1996) and may be particularly important in the development of established smoking (Chassin, Presson, Pitts, & Sherman, 2000). In sum, data on peer and familial smoking suggest that they are important in both smoking uptake and cessation.

Smoking Outcome Expectancies

Positive outcome expectancies for smoking differentiate cross-sectionally among smoking levels in both college students (Brandon & Baker, 1991) and adolescents (Anderson, Pollak, & Wetter, 2002) as well as prospectively predict withdrawal, postcessation emotional distress, and relapse among adults attempting to quit (Wetter et al., 1994). Thus, data from across the age spectrum demonstrate associations between smoking behavior and smoking outcome expectancies.

Affect and Affect Regulation Related Constructs

Recent studies have highlighted the importance of the link between negative affect and smoking, although the directionality of the association is not entirely clear. In a longitudinal adolescent sample, depression predicted future smoking after controlling for current smoking, and smoking predicted future depression after controlling for current depression (Windle & Windle, 2001). Among young adults, a history of depression predicted future smoking, and smoking predicted future depression (Breslau, Peterson, Schultz, Chilcoat, & Andreski, 1998). Some evidence suggests that smoking and emotional distress have a reciprocal relationship over time such that emotional distress may lead to initial smoking and more regular smoking may then increase distress (Orlando, Ellickson, & Jinnett, 2001). Among 18–19-year-old smokers, depression predicts continued smoking 4 years later (Zhu et al., 1999), and smoking rates are higher among college students who are unhappy (Emmons et al., 1998). Finally, affective variables have also been shown to be better predictors than nicotine dependence variables when predicting smoking cessation among adults (Kenford et al., 2002).

In addition to negative affect per se, affect regulation motives are related to smoking among adolescents (Mayhew et al., 2000), and research with college students demonstrated that affect regulation expectations both for smoking and for other means were

related to smoking motivation and self-administration (Wetter, Brandon, & Baker, 1992). Thus, both negative affect and affect regulation motives for smoking appear to shape smoking behavior.

Study Purpose

The current study examined changes in smoking behavior and predictors of those changes over a 4-year period among a longitudinal cohort of college students. Because of a lack of prior research on the natural history of smoking among college students, we were particularly interested in the proportions of students who transitioned among smoking behavior categories during the study period. Families of predictor variables were derived from both prior research and theory (Petraitis et al., 1995).

Method

Participants and Procedure

Participants ($N = 698$) were students enrolled in the introductory psychology course at the University of Wisconsin—Madison. Approximately 30% of all undergraduates enroll in the course and enrollees are typically freshman or sophomores. Participants in the study were surveyed twice—once at baseline and again approximately 4 years later. Individuals who participated in the baseline survey received extra-credit points. There were no incentives for completing the follow-up survey. Because we were interested in the progression of smoking for typical college students, we excluded individuals who were over age 24 at baseline. We also excluded baseline former daily smokers because their numbers were too small to justify including them as a separate group, and we did not want their inclusion to contaminate the nonsmokers group. Of the 698 participants who participated in the study at baseline, 51 were excluded from the analyses: 2 participants did not report their smoking history, 5 participants were over age 24, 40 participants were former daily smokers, and 4 participants were both former daily smokers and over age 24. Of the remaining 647 participants surveyed at baseline, 548 (85%) provided follow-up data. Occasional and daily smokers were oversampled in the current study. Thus, the sample did not reflect the smoking status distribution of the Madison undergraduate population at large. However, prior research indicated that approximately 10% of Madison undergraduates were daily smokers, 27% were occasional smokers, and 63% were nonsmokers (Fiore et al., 1993). Thus, 37% of the Madison undergraduates were occasional or daily smokers, a proportion consistent with recent data indicating that 38% of college students smoked in the past year (Rigotti et al., 2000).

Attrition

The 548 participants in the longitudinal cohort were compared with the 99 individuals who were lost to follow-up on all of the available predictor variables including baseline smoking status. The only statistically significant differences were on age (18.9 years for the baseline-only group vs. 18.5 for the cohort), $t(645) = 3.78$, $p = .0002$, and race (82% White for the baseline-only group and 94% for the cohort), $\chi^2(1, N = 647) = 18.7$, $p < .0001$. Thus, compared with the longitudinal cohort, more non-White and older students were lost to follow-up.

Baseline Measures

Smoking status and history. Mutually exclusive smoking status categories were generated for daily smokers, occasional smokers, and nonsmokers. Daily smokers indicated that they smoked "every day"; occasional smokers indicated that they smoked "every few days," "every few weeks," or "every few months"; and nonsmokers indicated that they "never" smoked. Among daily smokers, additional data were collected on the number of years smoking, cigarettes smoked per day, and the Fagerstrom Tolerance Questionnaire (Fagerstrom, 1978).

Demographics. Demographic information included age, gender, socioeconomic status (SES), and race/ethnicity. SES was assessed by "My family's social class level is: lower/government aid; upper lower/blue collar; middle/blue collar; upper middle/white collar; lower upper/management; or, upper upper/wealthy." Race/ethnicity was coded as Black, White/Non-Hispanic, Hispanic, Asian/Pacific Islander, Native American, or Other.

Alcohol use. The Michigan Alcohol Screening Test was used to assess symptoms and negative consequences of alcohol use (Hedlund & Vieweg, 1984). Coefficient alpha was .72. Frequency of alcohol use and the average amount of alcohol consumed per occasion were used to calculate the number of drinks per month. However, alcohol measures were not given to students during one data collection period. Therefore, only 359 of the 548 participants in the cohort (66%) have data on alcohol use.

Family smoking. Family smoking was assessed by asking participants to indicate which household members smoked ("mother," "father," "sibling," or "other") when they were growing up.

Peer smoking. Four items assessed peer smoking: (a) "Does your best friend smoke?"; (b) "If you are currently involved in an intimate relationship (i.e., spouse, boyfriend, girlfriend), does your partner smoke?"; (c) "If you have roommates, do they smoke?"; and, (d) "What percentage of your primary social circle of friends smoke?"

Smoking outcome expectancies. Likelihood scores for the four subscales (Positive Reinforcement [PR], Negative Reinforcement [NR], Weight/Appetite Control [WT], Negative Consequences [NC]) of the Smoking Consequences Questionnaire (Brandon & Baker, 1991) were calculated. Coefficient alphas for the subscales ranged from .91 to .97.

Affect and stress. Positive Affect and Negative Affect were assessed using the Positive and Negative Affect Scale (Watson, Clark, & Tellegen, 1988). Stress was assessed using the 14-item Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983). Coefficient alpha was .84 for Negative Affect, .88 for Positive Affect, and .86 for the Perceived Stress Scale.

Affect regulation expectations. Affect regulation expectations were measured using the Affective Information Processing Questionnaire (Wetter et al., 1992). Participants read 32 vignettes characterized by negative affect and provide ratings of (a) the controllability of their affect in that situation by smoking, (b) the controllability of their affect in that situation by means other than smoking, and (c) the likelihood that they would smoke in that situation. Three subscale scores are calculated—Affect Control by Smoking, Affect Control by Other Means, and Likelihood of Smoking. Coefficient alphas ranged from .95 to .98.

Follow-Up Measure: Smoking Status

Mutually exclusive smoking status categories were generated for daily smokers, occasional smokers, and nonsmokers at the follow-up time point using the identical criteria as those used to determine baseline smoking status.

Data Analyses

Baseline comparisons. Analyses of variance and chi-square tests were used to evaluate differences among the baseline smoking status categories on the predictor variables.

Bivariate longitudinal analyses. Because follow-up smoking status was assessed as a sequence of ordered categories (1 = nonsmoker, 2 = occasional smoker, and 3 = regular smoker), ordinal logistic regression (cumulative logit model with the proportional odds assumption) was used to model the associations of the predictor variables with follow-up smoking status (Scott, Goldberg, & Mayo, 1997). For each analysis, standard diagnostic procedures were conducted including assessment of the tena-

bility of the proportional odds assumption. With few exceptions, diagnostics indicated no assumption violations. Interpretation of odds ratios (ORs) in a cumulative logit model is the same as in a binary logit model, with the exception that the reported odds ratios reflect the effect of the predictor on the odds of being in a higher rather than a lower smoking category at follow-up, regardless of how higher versus lower is dichotomized (the proportional odds assumption). A series of analyses (not shown) examined the interaction of baseline smoking status with each predictor. Results revealed a large number of interactions between baseline smoking status and the predictors, indicating that the effects of the predictors on follow-up smoking status differed across baseline smoking status categories. Therefore, all analyses examined the effects of the predictors within each baseline smoking status category separately.

To assess the unadjusted bivariate association between follow-up smoking status and the predictor variables, we conducted separate ordinal logistic regression analyses in which follow-up smoking status was regressed on each variable. No covariates were included in these unadjusted analyses. A series of adjusted analyses controlled for gender, age, SES, and race/ethnicity. In addition, the adjusted analyses for the occasional smokers also controlled for the frequency of baseline smoking (every few months, every few weeks, every few days), and the adjusted analyses for the daily smokers also controlled for baseline cigarettes per day and years smoking. Adjusted analyses examining the effects of a specific control variable (e.g., gender) controlled for the effects of all other control variables. To maintain the Type I error rate at $p = .05$ within each family of variables (e.g., peer smoking), we applied a Bonferroni correction for multiple comparisons within each family, and the predictors that remained significant after the Bonferroni correction are noted. Another series of analyses (not shown) evaluated the interaction of each control variable (gender, age, SES, and race/ethnicity) with each of the other control variables and with each of the predictors separately in predicting follow-up smoking status. The proportion of significant interactions was exactly equal to what would be expected by chance (5%), and there were no consistent patterns of results. Thus, they were not further considered.

Multivariate longitudinal analyses. For the occasional smokers, there were a number of strong and statistically significant correlations within and across sets of significant predictor variables (i.e., there was substantial collinearity among predictors). Therefore, structural equation modeling (SEM) was used to generate a multivariate model for the occasional smokers. SEM was selected to model associations because the sets of predictor variable can be considered indicator variables for specific latent constructs. The statistically significant correlations among the measures within predictor sets support the use of this approach. SEM was used with maximum likelihood and alternative procedures. Maximum likelihood estimation results are reported because of the similarity of the final results with those of other estimation procedures.

Results

Participant Characteristics

Among daily smokers, mean cigarettes smoked per day was 11.5 ($SE = .54$) and mean years of daily smoking was 2.6 ($SE = .14$). Among occasional smokers, 33% smoked every few days ($n = 94$), 34% smoked every few weeks ($n = 96$), and 33% smoked every few months ($n = 94$). Characteristics of the longitudinal cohort by baseline smoking status category are presented in Table 1. There were significant differences in the expected direction between each of the smoking status categories for the peer smoking, smoking outcome expectancy, affect-related expectations, and smoking-related variables, with the exception of NC expectancies. Nonsmokers expected more negative consequences than did occasional or daily smokers, but there were no differences between the latter groups. For family smoking, fathers of daily smokers were more likely to smoke than were fathers of nonsmokers. Daily and occasional smokers did not differ on the alcohol variables, but both groups scored higher on all of the alcohol variables than did nonsmokers. There were no differences among smoking status categories for any of the demographic, affect, or stress variables.

Longitudinal Progression of Smoking

Table 2 shows each baseline smoking status category by smoking status at follow-up. None of the nonsmokers progressed to daily smoking, although 11.5% became occasional smokers. Among occasional smokers, 14.4% progressed to daily smoking, 34.9% remained occasional smokers, and 50.7% quit smoking. Among daily smokers, almost 60% continued to smoke on a daily basis with 13.4% quitting smoking and 28.2% reducing their smoking.

Predictors of Follow-Up Smoking Status

Baseline nonsmokers. Among baseline nonsmokers, only two variables (sibling smokes, OR = 3.73, $p = .04$; affect control by smoking, OR = 2.90, $p = .046$) were significant predictors of follow-up smoking status in the unadjusted analyses, and only sibling smokes continued to be a significant predictor (OR = 5.71, $p = .02$) after controlling for gender, age, SES, and race/ethnicity. None of the predictors remained significant after applying a Bonferroni correction. Therefore, multivariate analyses were not conducted for baseline nonsmokers.

Baseline occasional smokers. Among baseline occasional smokers, male gender, positive smoking outcome expectancies (PR, NR, and WT), affect control by smoking, likelihood of smoking, frequency of baseline smoking, and desire for a cigarette were positively associated with higher smoking status levels at follow-up (see Table 3). Affect control by other (nonsmoking) means and likelihood of being a nonsmoker were inversely associated with follow-up smoking status. All of these relations continued to be significant in the adjusted analyses except for likelihood of being a nonsmoker and desire for a cigarette. Positive smoking outcome expectancies (PR, NR, and WT), affect control by smoking, affect control by other means, and frequency of baseline smoking continued to be significant predictors in both the unadjusted and adjusted analyses after applying a Bonferroni correction for multiple comparisons. Likelihood of smoking remained significant in the unadjusted analyses only.

As we noted earlier, SEM was used to generate a multivariate model for occasional smokers. Separate models by gender or race were not evaluated because of the paucity of interaction effects involving these factors in the ordinal logistic regressions. Because of the substantial collinearity among the smoking outcome expectancy and affect regulation expectation scales and the results of an exploratory factor analysis, an SEM was generated that included all the control variables (age, gender, race, SES, and frequency of baseline smoking) and the significant bivariate predictors of follow-up smoking. The affect regulation and expectancy variables were modeled as latent variables that were then used as indicators of an overarching latent variable (affect and effect expectations) in a hierarchical factor structure. Thus, this model included five

Table 1
Characteristics of the Sample Cohort at Baseline

Predictor variable	Nonsmokers (n = 122)		Occasional smokers (n = 284)		Daily smokers (n = 142)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Demographics						
Gender (% female)	51.6		50.7		57.8	
Age	18.6	1.0	18.5	0.9	18.4	0.8
Socioeconomic status	4.2	1.1	4.1	0.9	4.2	0.9
Race/ethnicity (% White)	95.9		94.3		92.8	
Family smoking (%)						
Mother smokes	27.1		30.6		33.8	
Father smokes*	32.8_{a}		$41.6_{a,b}$		51.4_{b}	
Sibling smokes	15.6		13.4		21.8	
Any household member smokes	53.3		57.4		64.8	
Peer smoking (%)						
Best friend smokes*	12.3_{a}		44.8_{b}		73.6_{c}	
Partner smokes*	10.0_{a}		29.9_{b}		48.5_{c}	
Roommate smokes*	16.8_{a}		28.4_{b}		57.7_{c}	
Percentage of primary friends who smoke*	16.1_{a}		35.0_{b}		59.3_{c}	
Affect/stress						
PANAS Positive Affect	3.2	0.7	3.2	0.8	3.2	0.7
PANAS Negative Affect	2.3	0.7	2.4	0.7	2.3	0.8
Perceived Stress Scale	1.8	0.5	1.9	0.6	1.9	0.6
Smoking outcome expectancies						
Positive Reinforcement*	1.4_{a}	1.7	3.4_{b}	2.0	5.8_{c}	1.2
Negative Reinforcement*	1.3_{a}	1.9	3.3_{b}	2.2	5.5_{c}	1.8
Appetite/Weight Control*	1.8_{a}	2.3	2.5_{b}	2.3	4.1_{c}	2.5
Negative Consequences*	7.0_{a}	2.1	6.3_{b}	1.6	6.2_{b}	1.2
Affect-related expectations						
Affect Control by Smoking*	0.1_{a}	0.4	1.1_{b}	1.4	3.0_{c}	1.7
Affect Control by Other Means*	8.8_{a}	0.7	7.8_{b}	1.4	5.8_{c}	1.8
Likelihood of Smoking*	0.1_{a}	0.4	1.8_{b}	2.0	5.6_{c}	2.0
Alcohol-related variables						
Michigan Alcohol Screening Test*	3.1_{a}	3.5	4.0_{b}	3.7	4.5_{b}	4.9
Frequency of alcohol use*	5.6_{a}	4.1	7.8_{b}	4.9	8.4_{b}	4.9
Average quantity consumed per occasion*	5.2_{a}	2.6	6.5_{b}	3.2	6.7_{b}	3.3
Average number of drinks per month*	34.3_{a}	33.0	56.6_{b}	60.1	62.1_{b}	53.1
Smoking-related variables						
Likelihood of being a nonsmoker in 1 year*	8.5_{a}	1.8	7.1_{b}	2.3	4.5_{c}	2.7
Desire a cigarette right now*	0.1_{a}	1.0	1.4_{b}	2.4	4.6_{c}	2.9

Note. Group differences were tested using analysis of variance for continuous variables and chi-square tests for categorical variables. Overall tests significant at $p < .05$ were followed by all possible combinations of pairwise tests (different subscripts indicate statistically significant differences). PANAS = Positive and Negative Affect Scale.
* $p < .05$.

manifest variables (frequency of baseline smoking, gender, age, SES, and race/ethnicity) and three latent variables (affect regulation expectations, smoking outcome expectancies, and affect and effect expectations). The model included those baseline occasional smokers with complete data across the set of measures under consideration (n = 281).

The final model was developed by sequentially eliminating nondirectional and directional paths that were not contributing to the explanatory power of the model (i.e., these paths were not statistically significant). At each step, the addition of previously eliminated paths was also considered. In the final model (see Figure 1), all estimated paths are statistically significant at $p < .001$ with the exception of the path from gender to follow-up smoking status (p = .01). Standardized estimates of path coefficients are shown in Figure 1.

Table 2
Follow-Up Smoking Status by Smoking Status at Baseline

Baseline smoking status	Follow-up smoking status: 1		2		3	
	%	*n*	%	*n*	%	*n*
1. Nonsmokers	88.5	108	11.5	14	0	0
2. Occasional smokers	50.7	144	34.9	99	14.4	41
3. Daily smokers	13.4	19	28.2	40	58.5	83

Note. Overall, $\chi^2(4, N = 548) = 208.4$, $p < .0001$. For baseline nonsmoker versus baseline occasional smoker, $\chi^2(2, N = 406) = 54.0$, $p < .0001$; for baseline nonsmoker versus baseline daily smoker, $\chi^2(2, N = 264) = 157.3$, $p < .0001$; and for baseline occasional smoker versus baseline daily smoker, $\chi^2(2, N = 426) = 98.8$, $p < .0001$.

Table 3
Predictors of Smoking Status at Follow-Up for Baseline Occasional Smokers (n = 284)

	Unadjusted analyses		Adjusted analyses	
Predictor variable	OR	*p*	OR	*p*
Demographics				
Gender (female is referent)	1.63	.03	1.87*	.008
Age	1.09	.50	1.15	.29
Socioeconomic status	0.97	.84	0.91	.49
Race/ethnicity (White is referent)	0.64	.38	0.72	.54
Family smoking				
Mother smokes	1.27	.33	1.34	.25
Father smokes	1.09	.71	1.07	.79
Sibling smokes	0.87	.67	0.88	.71
Any household member smokes	1.32	.23	1.31	.25
Peer smoking				
Best friend smokes	1.11	.66	1.03	.90
Partner smokes	0.90	.71	0.76	.38
Roommate smokes	1.11	.69	0.86	.96
Percentage of primary friends who smoke	1.00	.30	1.00	.71
Affect/stress				
PANAS Positive Affect	0.92	.59	0.88	.39
PANAS Negative Affect	0.91	.55	1.02	.91
Perceived Stress Scale	0.95	.80	1.05	.84
Smoking outcome expectancies				
Positive Reinforcement	1.30*	< .001	1.25*	.0009
Negative Reinforcement	1.19*	.001	1.16*	.01
Appetite/Weight Control	1.13*	.01	1.15*	.009
Negative Consequences	0.89	.09	0.92	.28
Affect-related expectations				
Affect Control by Smoking	1.30*	.0009	1.24*	.01
Affect Control by Other Means	0.73*	< .0001	0.77*	.004
Likelihood of Smoking	1.20*	.001	1.16	.03
Alcohol-related variables				
Michigan Alcohol Screening Test	1.06	.06	1.04	.22
Frequency of alcohol use	1.03	.31	1.01	.85
Average quantity consumed per occasion	1.00	.99	0.94	.18
Drinks per month	1.00	.41	1.00	.83
Smoking-related variables				
Frequency of baseline smoking		.005		.001
Every few weeks vs. every few months	1.74	.05	2.04	.02
Every few days vs. every few months	2.53*	.001	2.97*	.0003
Likelihood of being a nonsmoker in 1 year	0.90	.03	0.91	.10
Desire a cigarette right now	1.11	.03	1.07	.18

Note. Adjusted analyses control for frequency of baseline smoking, gender, age, socioeconomic status, and race/ethnicity. Odds ratios (ORs) marked with an asterisk indicate relations that remain significant after applying a Bonferroni correction to maintain alpha at $p < .05$ within each family of variables. PANAS = Positive and Negative Affect Scale.

Maximum likelihood estimation of the final model yielded $\chi^2(55, N = 281) = 104.0$, $p < .001$; root-mean-square error of approximation (RMSEA) = .056 (90% confidence interval [CI]: 0.040, 0.073); root-mean-square residual = .081; goodness-of-fit index (GFI) = .944; comparative fit index = .959. Because of the level of nonnormality in some of the observed variables, the Satorra–Bentler (Satorra & Bentler, 1988) scaled maximum likelihood results were also considered, $\chi^2(55, N = 281) = 96.4$, $p < .001$; Robust comparative fit index = .961) as well as the appropriate transformation of the Satorra–Bentler chi-square result, RMSEA = .052 (90% CI: 0.034, 0.068). Use of a Bartlett adjustment, which adjusts for the number of common factors and manifest variables in the model and the sample size, as well as a less conservative Bartlett adjustment that only corrects for the number of manifest variables and the sample size, yielded decreases in the RMSEA point estimates and CI limits of no more than 0.01. To further take into account sample size and number of manifest variables, we also evaluated adjustment to the Satorra–Bentler scaled statistic, $\chi^2(55, N = 281) = 94.7$, $p < .001$; RMSEA = .051 (90% CI: 0.033, 0.067). The similarity of standard maximum likelihood procedure results with the Satorra–Bentler-scaled and Bartlett-modified results indicate that nonnormality had little impact on the findings and that sample size was adequate. Thus, although the chi-square results shows that there is a statistically significant difference between the parameterized model and the covariance structure of the data under the standard normal theory maximum likelihood chi-square statistic, the normal theory goodness-of-fit measures and the goodness-of-fit measures based

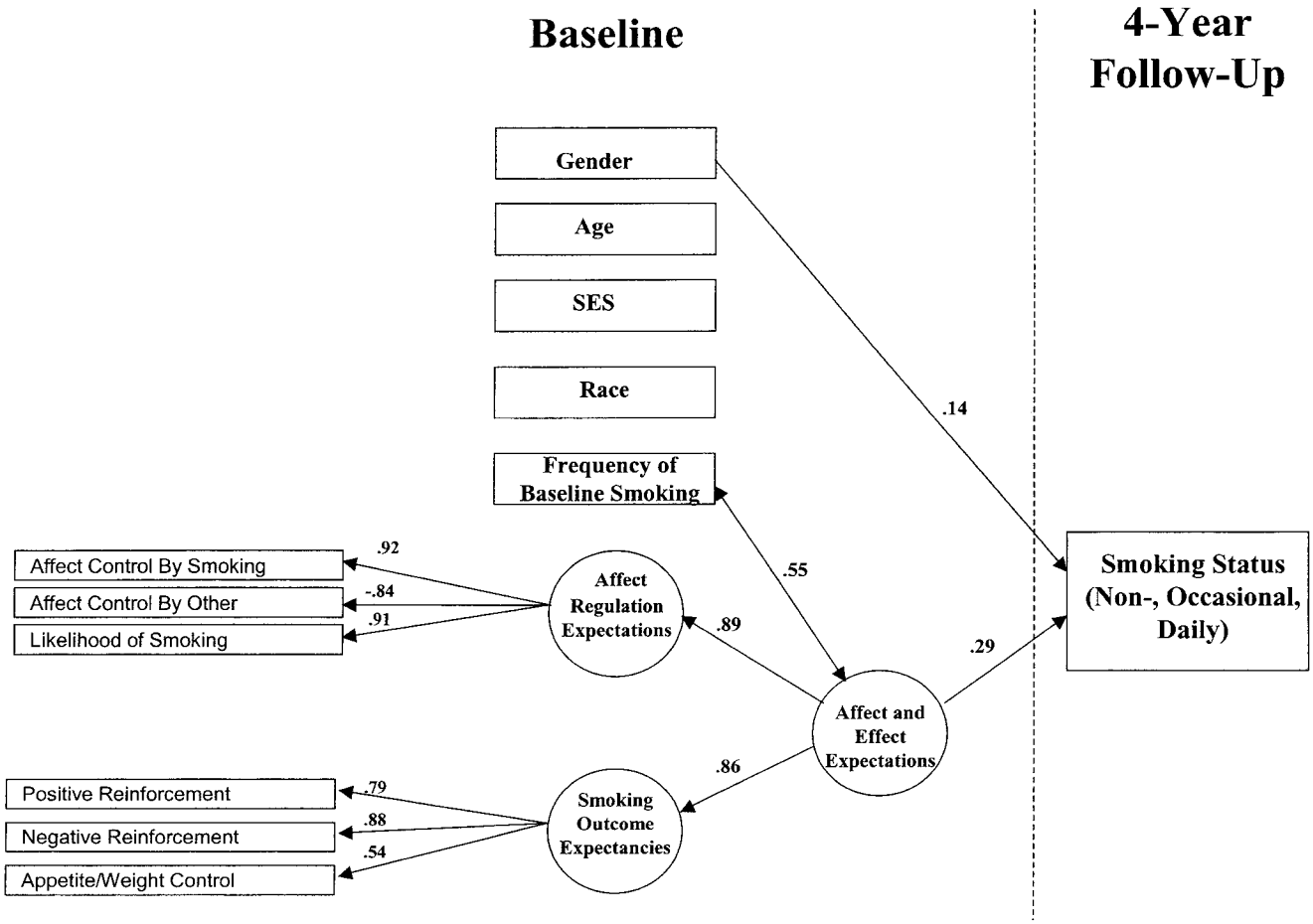

Figure 1. Structural equation model of changes in smoking behavior over time for baseline occasional smokers. All coefficients are statistically significant at $p < .05$. All standardized path coefficients are significant at $p < .001$, except for the path from gender to 4-year smoking status, which is significant at $p = .01$. SES = socioeconomic status.

on the Satorra–Bentler scaled chi-square statistic show that there is good model-data fit. Only affect and effect expectations and gender had statistically significant, direct associations with follow-up smoking status among baseline occasional smokers (see Figure 1). Affect and effect expectations were also related to frequency of baseline smoking among occasional smokers. There were no other significant associations.

Baseline daily smokers. Among baseline daily smokers, father smokes and cigarettes smoked per day were significant predictors of follow-up smoking status in both the unadjusted (father smokes, OR = 2.33, $p = .01$; cigarettes smoked per day, OR = 1.07, $p = .01$) and adjusted analyses (father smokes, OR = 2.16, $p = .03$; cigarettes smoked per day, OR = 1.08, $p = .01$). Three additional variables were significant in the adjusted analyses (age, OR = 0.58, $p = .03$; roommate smokes, OR = 0.42, $p = .03$; affect control by other means, OR = 1.31, $p = .001$). However, only affect control by other means and cigarettes smoked per day continued to be significant after using a Bonferroni correction for familywise error, suggesting that the results may not be robust. Therefore, multivariate analyses were not conducted.

Discussion

In the current study, smoking behavior among college students was fluid over time and particularly so for occasional and daily smokers. Over the course of 4 years, 13% of baseline daily smokers quit smoking completely and 28% reduced the frequency of their smoking from daily to occasional. Moreover, only 35% of the occasional smokers were still occasional smokers at the end of the study—14% had become daily smokers and 51% had quit smoking altogether. Among baseline nonsmokers, 11.5% began smoking on an occasional basis and none became daily smokers. Thus, although there were substantial shifts in smoking behavior over time, 87% of baseline daily smokers and almost 50% of baseline occasional smokers were still smoking after 4 years.

The cross-sectional results at baseline were generally consistent with studies of both adolescents and college students showing that increased involvement with smoking was related to greater peer smoking, more alcohol use, stronger positive smoking outcome expectancies and weaker negative outcome expectancies, stronger affect regulation expectations for smoking and weaker expecta-

tions for affect regulation by other means, greater desire to smoke, greater likelihood of smoking in response to negative affect, and weaker beliefs about the likelihood of being a nonsmoker in the future (Brandon & Baker, 1991; Derzon & Lipsey, 1999; Emmons et al., 1998; Mayhew et al., 2000; Rigotti et al., 2000; USDHHS, 1994; Wechsler et al., 1998). In terms of familial smoking (USDHHS, 1994), only the fathers' smoking status was related to the participants' smoking status at baseline. Smoking behavior at baseline was unrelated to current affect, stress, and demographics.

Of importance, predictors of future smoking behavior differed by baseline smoking status. Longitudinal analyses indicated that there were few significant predictors of smoking behavior at follow-up among the baseline nonsmokers and daily smokers. However, consistent with our previous research in college students, adolescents, and adult smokers (Anderson et al., 2002; Brandon & Baker, 1991; Kenford et al., 2002; Wetter et al., 1992, 1994), positive smoking outcome expectancy factors (Positive Reinforcement, Negative Reinforcement, Appetite/Weight Control) and affect regulation expectations (both by smoking and by other means) were significant predictors of future smoking behavior among occasional smokers, but the single negative outcome expectancy factor was not. These variables predicted future smoking behavior in bivariate analyses, after controlling for demographics and frequency of baseline smoking, after adjustment for multiple comparisons, and when used as indicators of a latent variable reflecting affect and effect expectations in an SEM. The predictive superiority of positive over negative smoking outcome expectancies is consistent with previous studies (Stacy, Widaman, & Marlatt, 1990; Wetter et al., 1994).

The findings among occasional smokers support models of drug motivation positing that expectations regarding the affect regulation properties of both drug-related and non–drug-related behaviors influence drug use (Baker, Morse, & Sherman, 1987; Cooper, Frone, Russell, & Mudar, 1995). Drug use is more likely with increasing expectations about the ability of the drug to reduce negative affect and less likely with increasing expectations about the ability of non–drug-related behaviors to reduce negative affect. Apart from the current results, few studies have examined the predictive power of beliefs about the ability to regulate negative affect via nonpharmacologic means. Combined with our previous work indicating that affect regulation expectations for drug-related and non–drug-related behaviors predict smoking urge and self-administration (Wetter et al., 1992), these data encourage greater research attention directed at the relative contributions of expectations for drug versus nondrug coping. However, our results did not show strong relations between affect regulation expectations and smoking transitions among baseline nonsmokers and daily smokers.

Consistent predictive relations with future smoking behavior were not found for peer smoking, family smoking, affect/stress, and alcohol use. Moreover, after adjusting for multiple comparisions, none of the variables predicted future smoking among nonsmokers, and only affect control by other means and cigarettes per day predicted future smoking behavior among daily smokers. Although the finding for cigarettes per day is consistent with findings from both the adolescent and adult literature (USDHHS, 1994, 2000), a measure of nicotine dependence and years smoking were not significant predictors. The only demographic variable that predicted outcome was gender among occasional smokers. Males were more likely than females to progress in their smoking behavior. However, gender did not predict smoking status at baseline, nor did it predict future smoking behavior for either baseline nonsmokers or daily smokers. Although Derzon and Lipsey's (1999) meta-analysis among adolescents found gender to be one of the weakest predictors of future smoking behavior, the results are congruent with the conclusion of Mayhew et al. (2000) that male gender predicts the transition from experimentation to regular cigarette use.

Current affect or stress did not appear to play a role in smoking behavior among college students, in contrast to the results of a number of studies among both adolescents and adults (Breslau et al., 1998; Orlando et al., 2001; Windle & Windle, 2001). However, most of those studies focused on depressive affect rather than general positive and negative affect as was done in the current study. Thus, differences in the assessment instruments or in the targets of measurement could account for differences between the current results and previous studies. That is, depressive affect, rather than general negative affect per se, may be the component of affect that is related to smoking behavior among college students. Furthermore, given the prepotency of peer smoking and alcohol use in predicting adolescent smoking behavior, the lack of significant predictive effects for these variables, regardless of baseline smoking status, was surprising. The lack of effect for peer smoking among daily smokers is congruent with the conclusion of the Surgeon General's report, noting that the "influence of peers seems to be particularly potent in the stages of smoking that precede regular use" (p. 139, USDHHS, 1994), but the lack of predictive power among nonsmokers and occasional smokers suggests that peer smoking may be less powerful among college students than among adolescents.

The lack of consistent predictive relations between future smoking behavior and numerous theoretically relevant predictors may be attributable to a number of factors. For example, the current study may simply have lacked sufficient power to detect effects either because of small sample sizes or low transition rates, particularly among nonsmokers and daily smokers. Both of these issues affect power, and variability in the outcome measure can also affect the strength of association. Moreover, by partitioning the sample into relatively homogenous smoking groups at baseline, as was necessitated by the numerous interactions between predictors and baseline smoking status found when examining the entire sample, it is likely that the longitudinal associations between the predictors and outcome were attenuated because of a restriction of range. Although most of the assessments have established reliability and validity, predictive relations may also have been constrained by insensitive or distal measurement. Thus, our analyses might be considered conservative, if not biased against finding significant results. Alternatively, the findings may challenge existing theories with respect to their ability to account for smoking behavior among college students, and many constructs may simply be less prognostic during this highly transitional period (e.g., moving out of the family house, living with new people, removal or lessening of parental restrictions).

Study Limitations

The results need to be considered in concert with the study limitations, one of which is generalizability given that the sample

was predominantly White and drawn from a single institution in the upper Midwest. In addition, data were not collected on the proportion of participants invited to participate from various smoking status categories or on response rates to those invitations. Because participants were instructed to report their current smoking patterns at the baseline and follow-up surveys, some participants may have fluctuated among smoking categories between these two time points (e.g., some students may have quit smoking and then relapsed, or initiated smoking and then quit) without those fluctuations being captured by the assessments. Therefore, smoking status among college students may be even more fluid than indicated in the current study. Further research detailing the natural history and predictors of smoking among college students with multiple repeated assessments is needed to address this issue more fully. The lack of biochemical confirmation of smoking status is also a limitation of the study. However, because this was not a treatment study and participants were generally physically isolated from other family members, there should have been little incentive to misreport smoking status. Further, there is considerable evidence for the veracity and validity of self-reported tobacco use in survey research (Velicer, Prochaska, Rossi, & Snow, 1992).

Unfortunately, the current study lacks data on the life circumstances of our sample at follow-up (e.g., are participants still college students, have they dropped out, have they graduated, are they working, are they married). Thus, we cannot address how these factors influence the course of smoking among college students. Another issue that the current study cannot address is the continued course of smoking behavior into adulthood. For example, are those baseline occasional smokers who continue to smoke irregularly at follow-up less prone than others to develop nicotine dependence, representing "chippers" who are likely to continue to smoke at some low level in adulthood (Shiffman, Kassel, Gnys, & Zettler-Segal, 1994), or are they more likely to either quit smoking or progress to daily smoking over time? Because continued tobacco use and intensity of use increase the risk of smoking-related disease, these types of questions have important public health implications.

Conclusions

Although the findings among baseline occasional smokers reinforced the importance of expectations about the functional value of both smoking- and nonsmoking-related coping in determining smoking behavior, the lack of strong predictive relations for numerous theoretically relevant constructs also indicated that much more research is necessary among college students to elucidate numerous questions raised by the current study (e.g., whether certain factors may be more important at some stages of smoking development, what is the natural history of smoking behavior postcollege). It is unclear whether the relative lack of predictors of smoking behavior is due to a general difficulty in predicting smoking behavior across this major life transition, incompletely specified theoretical relations, poor or distal measurement, a lack of power attributable to smaller group sizes, less variability in outcomes, a restriction of range among predictor variables, or to some other factor.

Nevertheless, the findings do have important implications for intervention. First, almost 90% of baseline daily smokers and 50% of occasional smokers will continue to smoke over a 4-year period. However, the smoking behavior of these individuals appears more fluid and mutable than that of adults (e.g., 28% of daily smokers reduced but did not quit smoking). Thus, these individuals may be particularly receptive to interventions, and tobacco control interventions are clearly warranted among the college student population. Moreover, the relatively encompassing or cloistered confines of the college environment would appear to be excellent settings for implementing both policy- and individual-level interventions. Second, because cigarettes per day predicted smoking behavior among daily smokers, the results suggest that in addition to behavioral approaches, pharmacological interventions may need to be considered among daily smokers. Finally, the findings among occasional smokers suggest that interventions must address beliefs about the functional value of smoking and nonsmoking coping. Intervention strategies targeting these mechanisms might include expectancy challenge approaches (Darkes & Goldman, 1998) and the development of more adaptive life skills (Dusenbury & Botvin, 1992).

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