What Predicts Early Smoking Milestones?

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ABSTRACT. Objective: As many cigarette smokers begin experimenting before age 16, prevention efforts require a comprehensive understanding of smoking predictors during adolescence. Research has made many advances in understanding the predictors of smoking initiation, yet more precision is still needed to determine whether the patterns of prediction differ across early smoking milestones. The purpose of this study was to use a sample of young adolescents to examine the predictors of two key milestones in smoking initiation: first puff and first cigarette. **Method:** Data came from an ongoing, prospective project examining psychosocial factors related to adolescent substance use. At Time 1 (T1), the sample was 1,023 Rhode Island middle school students (ages 10–15 years; M = 12.2). T1 measures included empirically supported risk and protective factors, as well as current smoking. Follow-up surveys assessed smoking behavior over the ensuing year (T2 smoking). **Results:** Cigarette availability was the most robust predictor of smoking milestones, increasing the likelihood of both first puff and first cigarette in cross-sectional and prospective analyses. Multivariable analyses also showed specificity, where some factors were only associated with one time point (e.g., age and T1 puff and cigarette), whereas others were only associated with one milestone (e.g., parental monitoring and whole cigarette at both time points). **Conclusions:** This study found different patterns of predictors for two early smoking milestones. Such findings are the first to suggest that puff and whole cigarette are distinct smoking milestones and reaffirm arguments that researchers should distinguish the various stages of smoking initiation when examining the broader period of onset/initiation. (*J. Stud. Alcohol Drugs, 76,* 256–266, 2015)

DESPITE DECLINES IN THE PREVALENCE of cigarette smoking over the past decades, approximately 20% of adults in the United States are current smokers, contributing to some 443,000 smoking-related deaths annually (Centers for Disease Control and Prevention [CDC], 2008, 2009). The rate at which smoking prevalence is declining has diminished in recent years (CDC, 2011b), leading to concerns that continued reductions in prevalence (including continued cessation among current smokers) will be increasingly difficult (Augustson & Marcus, 2004; Chaiton et al., 2008). If current patterns continue, approximately 6.4 million youths in the United States will die prematurely from tobacco-related diseases (CDC, 2006). Prevention is, therefore, a critical component of the endeavor to reduce smoking prevalence (CDC, 2011a). Yet a focus on prevention necessitates a fine-grained understanding of the risk and protective factors for early smoking initiation—including explicit clarity for what is meant by both "early smoking" and "smoking initiation."

Individuals who initiate smoking early

Approximately 16% of eighth graders in the United States have smoked cigarettes in their lifetime (Johnston et al., 2013), with many experimenting prior to grade 5 (Andrews et al., 2003; Combs et al., 2012). White, Hispanic/Latino, and Native American adolescents have particularly high rates of early initiation (Garrett et al., 2011; Trinidad et al., 2004). Furthermore, longitudinal research indicates that, at least among primarily White samples, early-onset smoking is related to higher rates of nicotine dependence in later adulthood (Buchmann et al., 2013; Hu et al., 2006) as well as smoking-related morbidity and mortality (Fagerström, 2002; Huxley et al., 2012).

So what constitutes "early" in the context of cigarette smoking? Although definitions vary, most reports cluster around ages 12–15 years (see Morrell et al., 2011, for a review and critical discussion). To capture the entire period of early smoking initiation, an investigation into risk and protective factors requires examining youth several years earlier. Therefore, the present study uses data from an ongoing, longitudinal project that began when adolescents were ages 11–14 years.

Distinguishing early smoking milestones

A substantial amount of research indicates that the natural course of smoking tends to progress along several stages or "milestones." For example, O'Loughlin and colleagues (1998) found that over a 1-year period, one sixth of the never-smokers in their adolescent sample transitioned to ever-smokers, whereas one third of their ever-smokers continued smoking. Stage models of smoking adoption (e.g., Leventhal & Cleary, 1980; Prokhorov et al., 2002) suggest this progression from experimentation to regular use can unfold gradually over a series of years. More recently, Gervais et al. (2006) showed the progression of cigarette use milestones (e.g., inhalation, full cigarette,

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regular smoking) is related to the progression of symptoms of nicotine dependence. Further, their findings suggested that nicotine dependence symptoms developed early, even during experimentation.

Despite the attention to smoking progression, there is no single, agreed-upon definition for smoking onset/initiation within the tobacco literature. Rather, there is tremendous variety in operational definitions, including first try, first puff, smoking one or two puffs, first cigarette, first whole cigarette, and starting smoking regularly (Freedman et al., 2012; Hu et al., 2012; Mayhew et al., 2000). Distinguishing among the various definitions of smoking initiation is important because both research and theory suggest that there are meaningful differences in the biological, affective, and cognitive factors underlying the various types of smoking milestones (DiFranza et al., 2000; Gilpin et al., 2001; Moolchan et al., 2007). Indeed, numerous studies have demonstrated that the pattern of factors predicting initiation are not the same as those predicting continued cigarette use (e.g., O'Loughlin et al., 2009; Stein et al., 1996). As one example, Flay and colleagues (1998) found that although many factors predicted both trying smoking and regular smoking, other factors predict just one milestone: high family conflict, for instance, distinguished never-smokers from regular users but not never-smokers from triers. Previous research has also found differences between those reporting their first cigarette compared with those reporting just a puff in the physiological and social consequences experienced from smoking (Brady et al., 2008, found 62% of their whole-cigarette group reported feeling relaxed, compared with 27% of their puff group). Thus, it is likely that factors predicting first puff are not entirely the same as those predicting first whole cigarette. Failing to distinguish between these two early initiation milestones may contribute to inconsistent reports in the literature about unique predictors of initiation (Mayhew et al., 2000).

More specific terminology is also necessary to answer questions about the sequence of early smoking progression. Specifically, to what extent does having a first puff predict escalation to trying a whole cigarette? Numerous studies provide information about transitions from an early milestone to a late milestone (e.g., Zhan, 2012), such as the transition between first cigarette to regular use (Ridenour et al., 2006; Sartor et al. 2010). Yet a fine-grained focus on the initiation period is lacking: To our knowledge, no studies have heretofore examined transitions between the two early milestones of first puff to first whole cigarette.

Risk and protective factors for early smoking milestones

We sought to understand the predictors of early smoking milestones using a multivariable approach grounded in theories about levels of influence (e.g., the Theory of Triadic Influence; Flay, 1999) and based on findings attained from several fields of study. For instance, beyond highlighting differences across age, developmental perspectives on health-risk behaviors emphasize the role of socialization by parents, peers, and school (Arnett, 1992; Bogenschneider et al., 1998; Graber & Brooks-Gunn, 1999). Psychosocial theories also emphasize how pathways from environmental to individual-level factors influence health-risk decision making, pointing to the detrimental influence of stress, negative mood, and deviance on subsequent smoking (Gibbons et al., 2010; Pascoe & Richman, 2009; Wills et al., 1995). Sociological perspectives highlight the role of background factors, such as race/ethnicity, socioeconomic status (SES), and gender (Pampel & Rogers, 2004). Furthermore, theories developed specifically to explain and predict substance-related behaviors have identified the importance of substance availability for initiation (Pokorny et al., 2004; Robinson et al., 1997). Together, these various theories indicate three broad levels of influence on adolescent smoking: background or demographic factors (age, gender, race/ethnicity, population density, and SES), contextual factors (cigarette availability, school, peers, and parents), and individual factors (stress, mood, self-control, and deviance).

Overview

The goal of the present study was to use a young adolescent sample to examine concurrent and prospective predictors of two key early smoking milestones: first puff and first cigarette. Analyses were somewhat exploratory, as we expected these two milestones are distinct but did not have specific hypotheses regarding different patterns of correlates and predictors. Our approach was based on several fields of research that point to three major levels of influence: demographic, contextual, and individual. Recognizing the importance of testing multiple risk and protective factors in the context of one another, we focused our approach on multivariable analyses.

Method

Participants

All procedures were approved by the Brown University Institutional Review Board. Data came from an ongoing, prospective project examining individual and contextual factors related to adolescent substance use (see Jackson et al., 2014). At Time 1 (T1), the sample was composed of 1,023 students in six Rhode Island middle schools (one urban, two rural, three suburban) and included roughly equal numbers of sixth, seventh, and eighth graders. The sample was 48% male and primarily non-Hispanic White (72%). The mean age was 12.2 years (range: 10–15, SD = 0.98). Based on school-level Rhode Island data (Information Works, 2009), our sample was largely representative of the schools from

which they were drawn; the sample was more racially diverse than the school populations but less disadvantaged.

Data were also collected from one parent of the adolescent (the "responding parent"; 86% were the biological mother). In terms of family SES, 44% of responding parents reported having a college degree, nearly half of the families had an annual income less than $50,000 (ranging from less than $5,000 to greater than $150,000), and 34% reported that their child was eligible for the federally sponsored reduced-price or free-lunch program. (Income amounts are in U.S. dollars.) These sample demographics are largely consistent with the overall Rhode Island population (U.S. Census Bureau, 2013).

Adolescents who had missing data for more than one third of the variables of interest ($n = 4$) were excluded from analyses, yielding a sample of 1,019 youths who answered all or most questions pertaining to the study aims. Data were collected from 929 parents. Compared with students whose parents did not participate, students with participating parents were more likely to be non-Hispanic White ($p = .04$); there was no difference by age or gender.

Procedure

Using rosters from the six Rhode Island schools, we mailed consent forms and information about the study to each student's home; faculty distributed a second set of packets in class. All interested students whose parents provided written informed consent were eligible to enroll. We provided classroom incentives for signed and returned consent forms regardless of whether parental consent to participate was granted. Across the schools, an average of 39% of students returned a consent form; of those returning forms, 35% of parents declined to have their child participate in the study, whereas 65% returned consent forms allowing for study participation.

The sample comprised five cohorts (each cohort contained one school, with the exception of Cohort 1, which included two schools); cohorts were enrolled 6 months apart, beginning in autumn 2009. Schools were selected to represent different population densities and relative affluence but were not randomly selected; schools intentionally differed with regard to subsidized lunch status (range: 6%–56%) and racial/ethnic diversity (prevalence of White, non-Hispanic ranging from 51% to 89%). At T1, baseline information was collected as part of an initial orientation session, during which project staff provided a detailed review of the project and students completed a 45-minute computer-administered survey. Students were also provided with a unique user ID and created a password for future online surveys.

Subsequent data collection for adolescents included semiannual (every 6 months) online surveys. These approximately 45-minute surveys could be completed from any location with Internet access. During orientation, emphasis was placed on finding a private location to take the survey. All participants were given multiple alerts and reminders (via mail, email, text, phone) when a survey was available. Students received a $20 gift card for each completed survey. Responding parents were mailed a 30-minute paper-and-pencil survey 1 month after the orientation; 89% of parents completed this survey and received a $30 grocery store gift card.

To assess the onset of smoking over a 1-year interval, the present study used data from the first two semiannual follow-up surveys; smoking results from these follow-ups were used to create a single Time 2 (T2) measure (see *Measures* section for details). The percentage of students completing at least one of these two semiannual surveys was 96% (92% of the original sample completed the 6-month, and 88% completed the 12-month). The 4% of students who were nonresponders did not differ from responders on age or having smoked a cigarette by T1 but were somewhat more likely to be male, of a racial/ethnic minority, and to have puffed a cigarette at T1 (Pearson's χ^2 range: 5.5–14, ps < .02).

Measures (assessed at T1, unless otherwise indicated)

Demographic factors. Students reported their date of birth (used to calculate age) and gender. There were two questions about race/ethnicity: "Are you Hispanic or Latino?" (yes, no) and "What is your race?" (American Indian or Alaskan Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, White, or other). Responses were used to create a single race/ethnicity item (coded as non-Hispanic White, Black, Hispanic, and other for this study). Population density (rural, suburban, urban) was coded based on middle school location.

Family income and parental education were used as proxies for SES. Responding parents reported annual household income (1–9 scale; 1 = *less than $5,000* and 9 = $*150,000 or more*). They also reported whether their child qualified for a free or reduced-price lunch at school (coded as yes, no). For education, parents reported the highest level of education they received (1–5 scale; 1 = *less than high school* and 5 = *postgraduate degree*).

Environmental-level factors. The availability of cigarettes was measured with a binary item: "If you wanted to get some cigarettes, could you get some?" (yes, no).

School engagement was measured using a set of 12 Likert-scale items assessing enjoyment and the perceived importance of schoolwork and school, and one item assessing academic performance (how often receive good grades, like A's or B's); items for this scale were taken from the Monitoring the Future study (Bachman et al., 2005). Table 1 provides all scale reliabilities.

Peer deviance was measured using a list of behaviors derived from several sources (Arthur et al., 2000; National Longitudinal Study of Adolescent Health, 1999; Zucker et al., 1994). Students were asked if any of their close friends

TABLE 1. Predictors used for the logistic regression analyses, designated as either larger factor constructs or single items. Measures are provided for all predictors. Standardized factor loadings or scale alphas are provided when relevant.

Predictor	Factor construct or single item?	Measures (loading on factor construct[a])	Scale α
Demographics			
Age	Item	What is your date of birth?	
Gender	Item	What is your gender?	
Race/ethnicity	Item	Are you Hispanic or Latino? What is your race? (Please select all that apply)	
Socioeconomic status	Construct	Household income (-.87) Free or reduced lunch (.92) Parental education (.81)	
Environment			
Availability of cigarettes	Item	If you wanted to get some cigarettes, could you get some?	
School engagement	Item	Enjoyment and perceived importance of school work and school, and one item assessing academic performance	.79
Peer deviance	Construct	Peer problematic behavior (.82) In the past 6 months, have any of your friends smoked cigarettes? (.82) Peer other substance use (.85) Extreme peer orientation (48)	.80 .73 .68
Peer support	Item	Emotional support and companionship	.84
Peer conflict	Construct	Conflict (.83) Antagonism (.85) Criticism (.79)	.54 .64 .67
Parental monitoring	Construct	Child disclosure (.84) Parental solicitation (.82) Parental control (.78)	.76 .81 .85
Parental support[b]	Item	Emotional support and companionship	.85–.86
Parental conflict[b]	Item	Conflict, antagonism, and criticism	.91–.91
Either parent smokes	Item	Do you now smoke daily, occasionally, or not at all? Does your partner (or other adult caretaker in the household) now smoke daily, occasionally, or not at all?	
Responding parent ever smoked	Item	Have you ever smoked cigarettes or other kinds of tobacco?	
Individual differences			
Stress	Construct	Stress from: school (.72), friends (.64), future (.65), parents/family (.68), job (.55), money (.65)	.73
Positive mood	Construct	Negative affect (-.81) Positive affect (.81)	.81 .89
Poor self-control	Construct	Sensation seeking (.74) Positive urgency (.88) Negative urgency (.88)	.82 .85 .84
Deviance	Construct	Delinquency (.82) Physical aggression (.93) Nonphysical aggression (.92) Count of items endorsed one or more times (.92)	.80 .84 .82

Notes: Factor constructs were created for instances of high multicollinearity among items. [a]Factor loadings are for the (unrotated) component matrix; [b]the higher of the two parents' scores (mother or father) was selected for analyses; internal reliability ratings are provided for both mother and father, respectively.

had done each behavior in the past 12 months (yes, no). We summed items for peer problematic behavior (13 items; e.g., shoplifting) separately from items for peer substance use (five items; e.g., being drunk). Peer cigarette use was kept as a separate, single item. In addition, four items assessed students' extreme peer orientation (i.e., willingness to sacrifice talents, school performance, and parents' rules to be popular and have friends; 1–7 Likert scale; Fuligni & Eccles, 1993).

Peer support was measured with the emotional support and companionship subscales of the Network of Relationships Inventory–Relationship Qualities Version (NRI-RQV; Buhrmester & Furman, 2008), asking about the adolescents' best friend (six 1–5 Likert-type items).

Peer conflict was measured with the conflict, antagonism, and criticism subscales of the NRI-RQV, which asked about the frequency of adolescents' conflict with their best friend (e.g., how much they argue with each other; nine 1–5 Likert-type items).

Parent-reported monitoring was measured using the Sources of Parental Knowledge Scale (Kerr & Stattin, 2000), which includes three five-item subscales: child disclosure (children telling parents about their activities without prompting), parental solicitation (parents asking about their child's activities), and parental control (parents limiting their child's engagement in unknown activities through rules and restrictions).

Parental support was measured with the emotional support and companionship scales of the NRI-RQV, which asked adolescents about a self-identified mother figure and father figure. Using the approach of previous studies to mitigate differences between single- and two-parent families (Demuth & Brown, 2004; Musick & Meier, 2012), the higher of the two scores (mother or father) was used as the measure of parental support (six 1–5 Likert-type items).

Parental conflict was measured with the conflict, antagonism, and criticism scales of the NRI-RQV for both parents, again using the higher of the two scores (mother or father) as the measure of parental conflict (nine 1–5 Likert-type items).

The parent survey assessed current smoking status for the responding parent and a secondary caregiver; responses to these items were combined to index either parent smoking (dichotomized as yes, at least one parents smokes or no, neither smokes). Responding parents also reported whether they had ever smoked cigarettes/tobacco (yes, no).

Individual-level factors. Experiences with life stress were assessed with six items corresponding to six domains measured in the Adolescent Hassles Inventory (Bobo et al., 1986): school, parents/family, the future, friends, jobs, and money.

To assess mood, we selected the five positive and five negative traits with the highest factor loadings in the Positive and Negative Affect Schedule for Children (Laurent et al., 1999). Students were asked how often in the past 2 weeks they felt each emotion (e.g., upset, joyful). The positive and negative items created two subscales.

Poor self-control was assessed with three domains from the UPPS+P Impulsive Behavior Scale (Lynam et al., 2006): sensation seeking (an interest in novel and exciting activities; six items), positive urgency, and negative urgency (the tendency to act rashly in response to high positive or negative affect, respectively; six items each). All items on this scale are 1–4 Likert-type items.

Deviance was measured using students' reported frequency of past-30-day problem behavior in the areas of delinquency, physical aggression, and nonphysical aggression using a set of 20 items taken from Farrell et al. (1992). The remaining six items from Farrell et al.'s scale concerned substance use and were dropped. To account for the scope (and not just the frequency) of problem behaviors, we also included a measure of the sum of items endorsed one or more times.

Smoking milestones (T1 and T2). Smoking behavior assessment used measures from the Smoking Uptake Continuum Scale (Choi et al., 2001). For puff behavior, we asked: "Have you ever tried or experimented with cigarette smoking, even a few puffs/drags?" (yes, no). For cigarette behavior, we asked: "Have you ever smoked a whole cigarette?" (yes, no). T1 reports measured baseline ever use. Results from the semiannual follow-up surveys were merged to create T2 measures of use; T1 and T2 reports were then compared to determine who made a T1–T2 transition (i.e., who progressed from never having a puff at T1 to having a puff by T2, and who progressed from never having a full cigarette at T1 to having a full cigarette by T2). Students also reported the sources by which they obtained cigarettes (options were parents; boyfriend/girlfriend; close friend; somebody I know from school; somebody I work with; siblings, cousin, or other family member; or other—more than one option could be selected).

Analyses

Our analyses began by examining descriptive statistics. We were interested in the two early smoking milestones of first puff and first cigarette at two periods: T1 (at M_{age} 12.2; cross-sectional) and the ensuing year (through age 13.2; prospective). Analyses capitalized on the distinct advantages of cross-sectional and prospective examinations: cross-sectional modeling used data from the full sample; prospective modeling permitted unambiguous examination of onset over a 1-year interval.

We had four early smoking outcomes: (a) T1 first puff, (b) T1 first cigarette, (c) T1–T2 transition to first puff, and (d) T1–T2 transition to first cigarette. Data from the full sample were used to examine the T1 first puff and first cigarette outcomes. For the transition outcomes, to examine *initiation* of first puff and first whole cigarette, only adolescents who had reported no puff at T1 (n = 894) or no whole cigarette at T1 (n = 941) were included in the analyses.

Our analyses next turned to regressions to examine factors associated with early smoking outcomes. We began with univariate logistic regressions. Next, to simultaneously test the effects of multiple risk and protective factors, we turned to multivariable logistic regressions. For each multivariable regression, predictors were entered in steps: Step 1 entered demographic items, Step 2 entered contextual-level constructs, and Step 3 entered individual-level constructs. For the T1–T2 transition to first cigarette, the additional predictor of T1 first puff was included at Step 4. The nonusing group always served as the reference group.

Table 2. Demographics and smoking environment of the sample at Time 1 (N = 1,019)

Factor	M (SD) or n (%)
Age	12.2 (0.98)
Male	488 (47.9%)
Race/ethnicity	
Non-Hispanic White	731 (71.7%)
Black	40 (3.9%)
Hispanic	123 (12.1%)
Other	117 (11.5%)
Availability of cigarettes	194 (19.0%)
Have friends who smoke	56 (5.5%)
Either parent smokes now	279 (27.4%)
Responding parent ever smoked	500 (49.1%)
T1 ever had a puff	90 (8.8%)
T1 ever had a cigarette	38 (3.7%)

Note: T1 = Time 1.

Data reduction

To avoid overfitting and multicollinearity, we condensed predictors by creating factor scores. Using exploratory factor analysis with varimax rotation in SPSS, we created regression factor scores for the following constructs: SES, peer deviance, peer conflict, parental monitoring, stress, mood, self-control, and deviance. The remaining parenting variables (peer support, parental support, parental conflict, and smoking) and demographics (age, gender, race/ethnicity, and density) were kept as single items; cigarette availability, parental smoking, and school engagement were also kept as single items because they did not load well onto other factor constructs. Table 1 lists these predictors and provides the standardized factor loadings of each item onto its construct.

Missing data

To minimize the loss of cases, multiple imputation was used to impute missing data. To test the robustness of our findings to different approaches for handling missing data, we also examined whether results differed when analyses were run using the non-imputed data. Findings from these tests are summarized in our "sensitivity analysis" section below; this section also provides further information on missing data.

Results

Descriptive statistics

Table 2 presents T1 sample demographics and smoking-related environmental factors (an intercorrelation table is available on request from the first author). At T1, 90 adolescents (9%) reported having ever at least puffed a cigarette, and 38 (4%) reported having ever smoked a whole cigarette. The most frequently cited sources of cigarettes were friends (62%) and someone from school (44%). Over the subsequent year, 45 adolescents transitioned from not having a puff at T1 to having their first puff by T2. There were 32 adolescents who transitioned from not having a whole cigarette at T1 to having their first cigarette by T2 (28% of those who reported only having had a puff at T1 transitioned to having a whole cigarette by T2). Overall, 31% of students had a parent currently smoking, 6% had a close friend who smoked cigarettes within the past year, and 19% reported that cigarettes were available to them.

Predicting early smoking milestones

Univariate analyses: T1 smoking and smoking transitions over 1 year (T1–T2). Univariate logistic regressions indicated T1 puff and T1 whole cigarette were associated with nearly all factors; odds ratios [ORs] (95% confidence intervals [CIs]) ranged from 0.14 [0.11, 0.17] to 22.1 [9.57, 51.0]; a table providing ORs and CIs is available on request from the first author. Similar patterns occurred for predictors of the prospective, T1–T2 transition analyses, although some effects were specific to one milestone: For example, age was not prospectively predictive of puff, and poor self-control was not prospectively predictive of whole cigarette. For both cross-sectional and prospective analyses, T1 availability had among the highest ORs for both milestones (ORs > 3); for the T1–T2 transition to whole cigarette, T1 puff was also a very strong predictor (OR = 17.6, 95% CI [8.0, 38.6]).

Multivariable analyses: T1 smoking. Multivariable logistic regressions indicated that in the final step, T1 puff was associated with both environmental and individual difference factors: older age, low SES, availability of cigarettes, high peer deviance, and lower self-control (Nagelkerke's R^2 for the nonimputed data = .57; see Table 3 for ORs and CIs; Figure 1 displays all outcomes). T1 cigarette was associated with older age, low SES, availability of cigarettes, high peer deviance, low monitoring, and high adolescent deviance (Nagelkerke's R^2 = .55). For both T1 milestones, availability of cigarettes was the strongest factor in the model (ORs > 4), whereas gender and race/ethnicity were not significant.

Multivariable analyses: Smoking transitions over 1 year (T1–T2). Similar to the cross-sectional analyses, availability of cigarettes was among the strongest predictors for T1–T2 transitions to both puff and cigarette (Nagelkerke's R^2 = .23 and .36, respectively). Also similar to the cross-sectional findings, low parental monitoring predicted the cigarette outcome (but not the puff outcome). A puff by T1 was the strongest predictor of cigarette transition (OR = 4.8), although the effect of cigarette availability was also large (OR = 3.1). Gender, race/ethnicity, and the individual difference factors were not significant predictors of either transition.

Sensitivity analyses

Before imputation, complete data for all predictors were available for 81% of the sample. The most common missing

TABLE 3. Odds ratios at the final step of the four multivariable logistic regressions

	Time 1 (cross-sectional)				Time 2 (transitions over 1 year)			
	First puff (90 who ever had a puff vs. 929 who had not)		First cigarette (38 who ever had a cigarette vs. 981 who had not)		First puff (45 who transitioned to first puff vs. 849 never-puffers[a])		First cigarette (32 who transitioned to first cigarette vs. 909 never-full-cigarette-smokers[b])	
Factor (ref.)	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]	OR	[95% CI]
Demographics								
Age	1.51**	[1.11, 2.14]	2.41**	[1.45, 4.01]	1.02	[0.71, 1.47]	1.03	[0.66, 1.61]
Gender, male	0.89	[0.44, 1.79]	1.03	[0.37, 2.83]	1.38	[0.68, 2.84]	1.02	[0.40, 2.58]
Race/ethnicity (ref.: non-Hispanic White)								
Black	1.34	[0.37, 4.85]	0.35	[0.03, 4.39]	0.24	[0.02, 2.70]	1.23	[0.20, 7.69]
Hispanic	1.16	[0.45, 2.98]	0.31	[0.06, 1.61]	0.81	[0.28, 2.34]	0.68	[0.17, 2.75]
Other	1.98	[0.86, 4.58]	1.88	[0.62, 5.70]	1.19	[0.43, 3.28]	0.70	[0.17, 3.00]
Socioeconomic status	0.53*	[0.33, 0.86]	0.52*	[0.28, 0.96]	0.69	[0.45, 1.05]	0.66	[0.38, 1.14]
Density (ref: suburban)								
Rural	1.57	[0.64, 3.83]	2.51	[0.72, 7.98]	1.62	[0.66, 4.00]	0.96	[0.54, 1.71]
Urban	1.74	[0.76, 3.96]	1.72	[0.52, 5.62]	2.22	[0.94, 5.24]	1.13	[0.37, 3.44]
Environment								
Availability of cigarettes (ref: no)	4.62***	[2.36, 9.05]	8.33***	[2.80, 24.79]	3.00**	[1.38, 6.54]	3.13*	[1.23, 7.96]
School engagement	0.54	[0.27, 1.08]	1.12	[0.42, 3.00]	1.42	[0.58, 3.46]	0.88	[0.36, 2.17]
Peer deviance	1.90***	[1.47, 2.45]	1.42*	[1.07, 1.90]	1.49*	[1.06, 2.11]	1.24	[0.88, 1.74]
Peer support	1.23	[0.87, 1.74]	0.98	[0.58, 1.66]	0.99	[0.67, 1.45]	1.08	[0.69, 1.70]
Peer conflict	1.12	[0.86, 1.44]	0.83	[0.55, 1.27]	1.02	[0.73, 1.43]	0.95	[0.64, 1.42]
Parental monitoring	0.75	[0.54, 1.05]	0.55*	[0.34, 0.90]	0.79	[0.53, 1.17]	0.57*	[0.36, 0.90]
Parental support	0.70	[0.49, 1.00]	1.23	[0.73, 2.10]	1.24	[0.82, 1.86]	1.05	[0.65, 1.70]
Parental conflict	1.25	[0.88, 1.80]	0.87	[0.52, 1.46]	0.89	[0.56, 1.40]	1.30	[0.83, 2.05]
Either parent smokes (ref: no)	1.15	[0.55, 2.44]	1.41	[0.48, 4.11]	1.22	[0.56, 2.67]	0.93	[0.34, 2.50]
Responding parent ever smoked (ref: no)	1.35	[0.63, 2.88]	1.16	[0.37, 3.64]	1.41	[0.65, 3.07]	2.03	[0.70, 5.95]
Individual differences								
Stress	1.02	[0.71, 1.46]	1.17	[0.70, 2.00]	0.95	[0.63, 1.43]	1.10	[0.70, 1.73]
Positive mood	1.06	[0.74, 1.50]	1.17	[0.69, 1.80]	1.02	[0.69, 1.50]	0.66	[0.39, 1.11]
Poor self-control	0.57**	[0.41, 0.80]	0.65	[0.42, 1.03]	1.01	[0.71, 1.44]	0.93	[0.60, 1.43]
Deviance	1.14	[0.86, 1.50]	1.49*	[1.05, 2.12]	1.36	[0.96, 1.94]	1.04	[0.70, 1.54]
T1 ever had a puff (ref: no)							4.81*	[1.54, 14.97]

Notes: Ref. = reference group; T1 = Time 1. [a]Because of our focus on the *transition* from no-puff to puff, this analysis excluded the 90 youths who reported a puff at T1; an additional 35 were excluded because of missing data; [b]because of our focus on the *transition* from no-cigarette to cigarette, this analysis excluded the 38 youths who reported a cigarette at T1; an additional 40 were excluded due to missing data.
*$p < .05$; **$p < .01$; ***$p < .001$.

predictors were based on parent-reported items (SES and parental smoking). Less than 1% of the sample had more than three predictors imputed, and none had more than five imputed. Regressions were re-run using the nonimputed data. For all four logistic regressions, availability remained significant when analyses were re-run using the nonimputed data (a table with results from the nonimputed data is available on request from the first author).

Discussion

Because many cigarette smokers begin experimenting before age 13 (Andrews et al., 2003; Combs et al., 2012) and nearly all current smokers initiate before age 18 (U.S. Department of Health & Human Services, 2012), prevention efforts require specificity in understanding the predictors of early smoking milestones during early adolescence. In this study, we examined first puff and first cigarette milestones among a large sample of middle school students by investigating the associated demographic, contextual, and individual-level factors. Our approach was based on stage models of smoking adoption (Leventhal & Cleary, 1980; Prokhorov et al., 2002), which suggested that each distinct stage (or milestone) of progression could have its own correspondingly distinct predictors. Consistent with this stage model approach to the very early steps in smoking progression, T1 first puff was a powerful predictor of cigarette transition over the course of a year (T1–T2). Indeed, 28% of those who reported only having had a puff at T1 transitioned to having a whole cigarette 1 year later (actual rates may be even higher, as attrition lost a disproportionate number of students who were ever-puffers at T1).

At T1 (M_{age} = 12.2 years), 9% of the adolescents had at least puffed a cigarette and 4% had smoked a whole ciga-

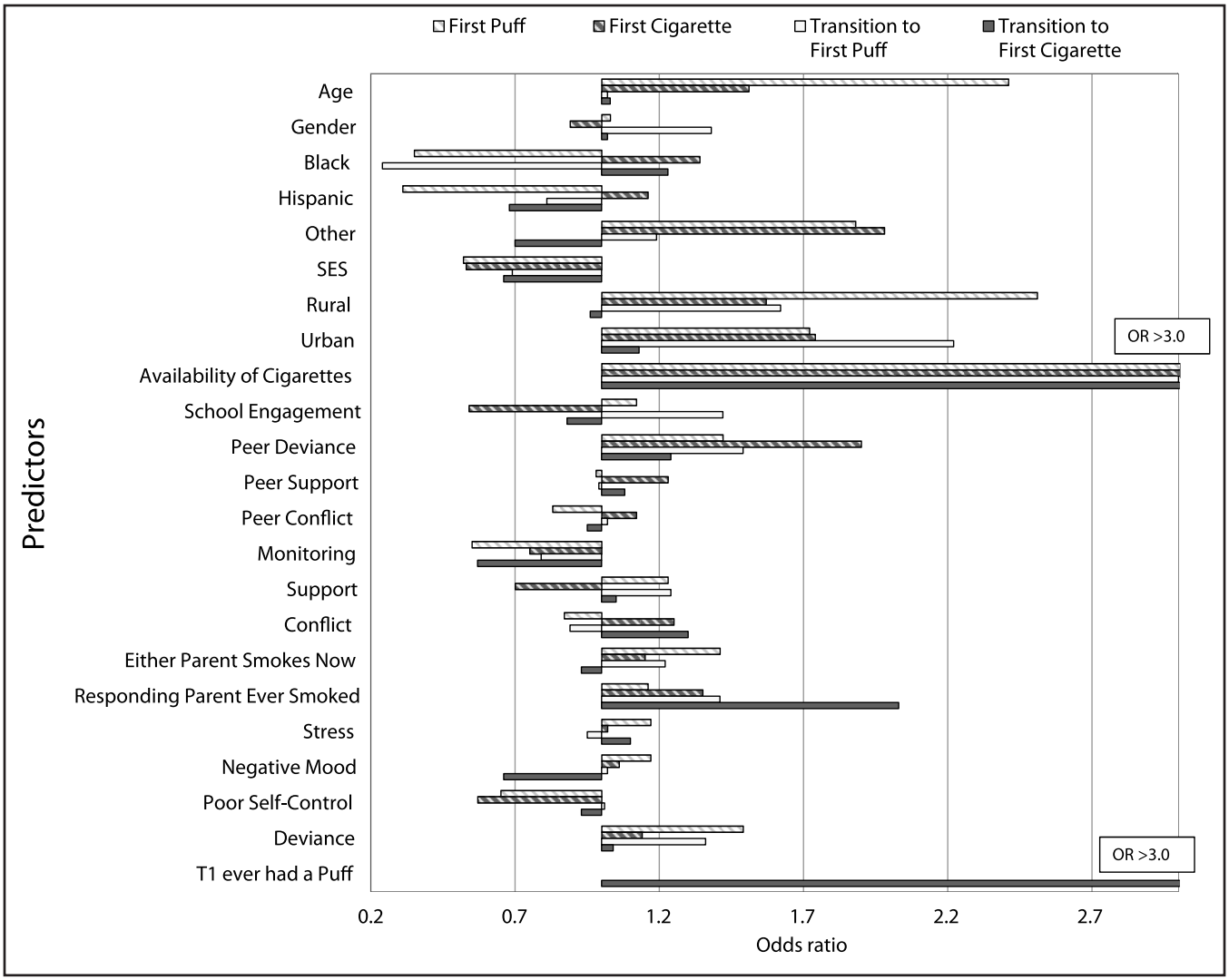

FIGURE 1. Odds ratios of the risk factors for smoking milestones (based on the final step of the four multivariable logistic regressions). SES = socioeconomic status; T1 = Time 1; OR = odds ratio.

rette. These rates are slightly lower but still comparable to rates reported for similar adolescent samples (DiFranza et al., 2007; Johnston et al., 2013), including those from Rhode Island (Information Works, 2009). Nearly all predictors were significant in the univariate logistic regressions. Fewer predictors were significant in the multivariable logistic regressions, supporting arguments for the use of comprehensive models that examine factors in the context of one another (O'Loughlin et al., 2009). For example, Calkins and Fox (2002) argue that because multiple factors contribute to development, the role of a single variable cannot be fully understood in isolation.

Multivariate findings also supported our supposition that there are not identical factors predicting both milestones. For instance, poor self-control was only related to T1 first puff, and deviance was only related to T1 first cigarette. Such nuances have implications for prevention. For example, that parental monitoring was predictive of first cigarette but not first puff suggests that the protective role of monitoring may occur further along in the continuum of smoking uptake. Consequently, interventions that target parental monitoring may be most impactful for youths who have just recently begun experimenting with smoking. Likewise, work targeting peer-related factors may be the most beneficial for preventing use by never-smokers, as peer deviance predicted transitions to first puff but not transitions to first cigarette.

Our findings suggest greater environmental, compared to individual-difference influences on early milestones. In particular, and as demonstrated by past substance use research (Pokorny et al., 2004; Robinson et al., 1997), cigarette availability appears to be a key predictor of early smoking milestones. It was consistently among the strongest predictors of both puff and whole cigarette, both concurrently and prospectively (including the multivariable analyses that ac-

counted for the effects of other predictors). The prospective analyses, which are suggestive of directionality, support the idea that the association between availability and smoking is not simply because youth with experience notice cigarettes more or seek them out in the environment (also in support of this notion, in additional analyses we found that neither T1 first puff nor T1 first cigarette were predictive of T1–T2 changes in perceived availability of cigarettes).

As the natural course of smoking progression does not occur independent of other health-risk behaviors, we did not control for other substance use. Adolescent research indicates that there is often substantial overlap in the patterns of predictors across different types of substance use outcomes (Barnes et al., 2005; Griffin et al., 2003). Consequently, the present results may extend to other substances, such as alcohol or alternative tobacco products.

The pattern of predictors we observed for puff and whole cigarette milestones may not extend to additional smoking stages. This is consistent with the finding of Pokorny and colleagues (2004) that, although cigarette availability predicted puff, it did not predict continued use. It is also consistent with behavior genetics work demonstrating that environmental influences play a more substantial role in the initiation of cigarette use than in later stages of smoking behavior (Stallings et al., 1999; True et al., 1997). Likewise, that age and SES were predictive of smoking milestones at T1 but were not predictive of transitions over the following year (T1–T2) suggests that predictors may vary over developmental periods, according to what is normative behavior. Linking early milestones to later outcomes will be of interest, but can only be accomplished in this sample as the project progresses and participants grow older.

Limitations and future directions

One important limitation to note is that our parent data were based on the reports of only one parent, thus missing vital information from other parents or caregivers. Our sample was also 72% non-Hispanic White, with the second largest racial/ethnic group at 12% Hispanic/Latino. These proportions of racial/ethnic minorities in our sample were sufficient to examine main effects (of which little to no differences were detected); however, further research needs to examine more nuanced questions about the relationships between predictors and early smoking milestones across racial/ethnic groups.

There was a relatively low parental consent rate for students' participation in the study, and even lower rates of participation by parents. The larger study from which these data were drawn included fine-grained monthly surveys for a 2-year period, and it is likely that our lower-than-expected consent was due to the study's intensity and focus on substance use in early adolescence. Rather than reflecting refusal, parental nonresponse to active consent procedures appears to reflect the inconvenience of responding or inattention to the request (Frissell et al., 2004). We have no evidence of differential participation based on school, ethnic, or socioeconomic composition, and we have no reason to believe the pattern of associations found in the present study would be different in other samples. Nevertheless, it is possible that important differences exist between the current sample and students who declined to participate (i.e., the sample was not truly representative) or parents who declined to participate (i.e., data were not missing completely at random). As with other school-based studies, replication with other samples is a necessary next step. Further research will also need to replicate our obtained patterns for what factors were and were not significant, as it is possible that results were influenced by idiosyncrasies in our data (e.g., power, restricted ranges).

Conclusions

Overall, this study is the first to provide compelling evidence that puff and whole cigarette may be distinct smoking milestones. Results indicate different patterns of predictors for the two early milestones and also suggest that puff is a strong predictor of transition to first whole cigarette. Such findings reaffirm arguments that tobacco researchers should distinguish the various stages of smoking initiation. More precision in these definitions stands to benefit future research on the predictors of early cigarette use as well as related research mapping the course of early dependence.

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