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Early Emerging Nicotine Dependence Symptoms in Adolescence Predict Daily Smoking in Young Adulthood

Lisa Dierker,

Wesleyan University, Middletown, CT, U.S

Donald Hedeker,

University of Chicago, Chicago IL, U.S

Jennifer Rose,

Wesleyan University

Arielle Selya, and

University of North Dakota

Robin Mermelstein

University of Illinois, Chicago IL, U.S

Abstract

Purpose—The present study evaluated the predictive validity of individual early emerging nicotine dependence symptoms in adolescence on smoking behavior in young adulthood.

Methods—A total of 492 adolescents who, at baseline, had not smoked more than 100 cigarettes in their lifetime and 123 adolescents who smoked more than 100 cigarettes lifetime, and who participated in the 6-year follow-up assessment were included in the present analyses. Predictive validity of 10 nicotine dependence items administered at baseline was evaluated at the 6 year follow-up when the sample had entered young adulthood (mean age=21.6).

Results—Among adolescents who had smoked fewer than 100 cigarettes, experiencing higher levels of overall nicotine dependence as well as individual symptoms at baseline longitudinally predicted an increase in risk for daily smoking in young adulthood, after controlling for baseline smoking and other tobacco use. For adolescents who had smoked more than 100 cigarettes at baseline, level of nicotine dependence and individual symptom endorsement did not predict smoking behavior in young adulthood.

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Corresponding Author: Lisa Dierker, Psychology Department, 207 High Street, Middletown, CT 06459, ldierker@wesleyan.edu.

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Conclusions—These findings add to accumulating evidence that early emerging dependence symptoms reported at low levels of smoking exposure signal a greater propensity for continued smoking behavior. Screening for these early emerging symptoms among novice adolescent smokers represents an important and unused tool in tobacco control efforts aimed at preventing the development of chronic smoking patterns.

Keywords

Smoking; Nicotine Dependence; Adolescents; Young Adults

1. Introduction

Over the past several decades, public health interventions have been very successful in reducing smoking in the United States by encouraging higher rates of quitting and decreased uptake. This has largely been achieved through “universal” approaches that have increased knowledge of deleterious effects of smoking and exposure to second hand smoke, and influenced major anti-smoking legislation that has increased prices, reduced access and limited smoking in both public and private areas (Nagelhout et al., 2012; Grucza et al., 2013). Given the heavy public health burden associated with smoking, despite substantial environmental restrictions, a “hardening hypothesis” has been posited in which largely hardcore smokers, that is, those with a greater propensity for heavy, dependent smoking, remain in the wake of population-based intervention (Hughes, 2011; Smith et al., 2014). Based on the belief that new smokers who progress beyond initiation and experimentation may possess a propensity for heavy dependent use, recent work has begun to focus on identifying individual differences in patterns of early smoking behavior and emerging dependence symptoms.

To date, there have been 6 prospective studies that have evaluated the development of smoking and nicotine dependence among novice adolescent smokers, and despite their use of different measures of dependence and different lags between follow-up assessment, each has clearly demonstrated that for some youth, symptoms of nicotine dependence emerge soon after smoking initiation, at relatively low levels of smoking exposure and well before the establishment of daily smoking patterns (DiFranza et al., 2000, 2002; O’Loughlin et al., 2003; Audrain-McGovern et al. 2004; DiFranza, Savageau et al. 2007; DiFranza et al. 2007; Kandel et al., 2007; Dierker and Mermelstein, 2010). Although this and other accumulating evidence based on cross-sectional reports of novice smokers have clearly documented individual differences in the number and type of nicotine dependence symptoms experienced (Rose et al., 2010), to date, less evidence is available evaluating whether these early emerging symptoms represent substantial risk for sustained, chronic smoking behavior and if so, whether that risk may be better accounted for by individual differences in smoking exposure (e.g., lifetime cigarettes) than by the presence of nicotine dependence symptoms per se.

In an earlier report based on the present sample, early emerging nicotine dependence symptoms predicted smoking behavior 2-years later, during adolescence, when the sample was still in high school (Dierker and Mermelstein, 2010). The present study extends this work by evaluating the predictive validity of early emerging nicotine dependence symptoms

between baseline assessment and a 6 year follow-up, when the cohort has entered young adulthood.

2. Method

2.1 Participants

The sample was drawn from the Social and Emotional Contexts of Adolescent Smoking Patterns (SECASP) Study, which has been described elsewhere (Dierker and Mermelstein, 2010). All 9th and 10th grade students at 16 Chicago-area high schools completed a brief screener survey of smoking behavior ($N = 12,970$). All students who reported 1) smoking in the past 90 days and smoking <100 cigarettes/lifetime, 2) smoking in the past 30 days and smoking >100 cigarettes/lifetime, or 3) smoking <100 cigarettes/lifetime, but not smoking in the past 90 days, were invited to participate, as were random samples of never-smokers. Of the 3654 students invited, 1263 agreed to participate and completed the baseline measurement wave 2 months after screening. All procedures received approval from the University of Illinois at Chicago IRB. Written informed consent was obtained from the parents or guardians of the adolescents. For assessment following each participant's 18th birthday, informed consent was directly obtained.

Base-line assessment occurred in 2005-2006, and the 6 year follow-up in 2012. Retention at the 6 year follow-up was 84.6% ($N = 1068$). The mean age of this sample when recruited for the study was 15.7 years (s.d. 0.62). Fifty-five percent ($n=521$) were male, 57.4% ($n=540$) White, 15.2% ($n=143$), Black and 18.5% ($n=174$) were Hispanic. Participants and nonparticipants at the 6 year follow-up did not differ by age, race/ethnicity or number of days smoked in the past 30 at baseline. However, nonparticipation was significantly higher among males (19.7%) than females (12.2%), $p = .0002$. Compared to completers at the 6 year follow-up, non-completers reported a greater number of cigarettes smoked per day in the past 30 days at baseline ($M = 0.90$ cigarettes per day, $SD = 2.06$ vs. $M = 0.85$, $SD = 1.45$), $p = .0001$. A total of a) 492 adolescents who had not smoked more than 100 cigarettes in their lifetime at baseline and b) 123 adolescents who smoked more than 100 cigarettes lifetime at baseline, but less than 5 cigarettes per day, and who also participated in the 6-year follow-up assessment were included in the present analyses. Demographic and smoking characteristics for each group are presented in Table 1.

2.2 Measures

2.2.1 Baseline Smoking—Current smoking was assessed with two items at the baseline assessment administered approximately two months following screening. Participants were asked how many days they smoked cigarettes in the past 30 days (frequency) and how many cigarettes they smoked in the past 30 days (quantity). Age of initiation was assessed with the question “How old were you the very first time you smoked even a puff of a cigarette?”, and any lifetime daily smoking was assessed with the question “Have you ever smoked cigarettes on a daily basis? (At least 30 days when you smoked every day or nearly every day)?”

2.2.2 Smoking at 6 year follow-up—These same quantity and frequency questions were used to assess current cigarette smoking at the 6 year follow-up. Number of days smoked in the past 30 was dichotomized to daily (30 days) vs. non daily (less than 30 days) and number of cigarettes smoked in the past 30 days was dichotomized to any smoking in the past 30 days (yes/no).

2.2.3 Nicotine Dependence—Nicotine dependence at baseline was assessed with a shortened version of Nicotine Dependence Syndrome Scale (NDSS; Shiffman et al., 2004), modified for use with adolescents. The full NDSS scale was reduced to 10 items based on psychometric analyses conducted on an adolescent sample (Sterling et al., 2009), retaining those items reflecting mainly Drive and Tolerance from the original NDSS. Research supports the reliability, stability, construct validity, and predictive validity of the NDSS for use with adolescents (Clark et al., 2005; Sledjeski et al., 2007), and the modified version demonstrated strong internal consistency with the current sample (coefficient alpha = .93). Items in the current study were answered on a four-point Likert-type scale, ranging from 0 (not at all true) to 3 (very true). A nicotine dependence total score was obtained by averaging responses to all items. Individual symptoms were included in the analyses, the three response options of “sometimes true” to “very true” were collapsed into a single category to generate a dichotomous variable for symptom endorsement (No – not at all true vs. Yes – any of the three positive responses).

2.2.4 Other Tobacco Use—Other tobacco use at baseline was measured with the questions. During the past 30 days, on how many days did you a) use chewing tobacco, snuff or dip; b) smoke cigars, cigarillos or little cigars; c) smoked bidis or d) smoked kreteks. Reports were dichotomized into any other tobacco use vs. no other tobacco use.

2.3 Analyses

We used SAS 9.2 to conduct logistic regression analyses testing the association between nicotine dependence (both the NDSS total score and endorsement of individual symptoms) measured at baseline and smoking behavior (any past month smoking and past month daily smoking) measured at the 6 year follow-up for each baseline smoking group. Covariates added to the model included baseline smoking exposure indices (i.e. number of days smoked in the past 30 and number of cigarettes smoked in the past 30 days), and other tobacco use in the past 30 days. These covariates were chosen to evaluate the association between nicotine dependence symptoms and future smoking that cannot be accounted for by tobacco exposure. Due to differences in the association between smoking and nicotine dependence previously demonstrated, gender was also included as a covariate in each model (Kandel and Chen, 2000).

3. Results

When examining the bivariate association between smoking behavior at the 6-year follow-up assessment and nicotine dependence symptoms scores at baseline among those smoking fewer than 100 cigarettes when entering the study, logistic regression revealed that those smoking daily at the 6 year follow-up reported higher NDSS total scores at baseline (Mean 5.3, s.d.=6.05) compared to those who were not smoking daily at the 6 year follow-up

(Mean 2.8, s.d.=3.99). The NDSS total score at baseline did not predict any past month smoking. Logistic regression analysis including covariates again showed that higher levels of nicotine dependence predicted daily smoking behavior at the 6-year follow-up and that this association was significant after controlling for baseline smoking (quantity and frequency), other tobacco use and gender (outcome: daily smoking at 6 year follow-up, (Odds Ratio=1.1, Confidence Interval 1.04-1.16). At the symptom level, baseline reports of *willingness to go out in a rainstorm to get cigarettes, better functioning in the morning after having a cigarette, needing to smoke in order to keep from experiencing any discomfort* and *craving* each predicted daily smoking at the 6 year follow-up after controlling for gender, baseline smoking quantity and frequency, and other tobacco use.

When examining corresponding models based on the sample of baseline smokers who had smoked more than 100 cigarettes lifetime, but were smoking less than 5 cigarettes per day, level of nicotine dependence and individual symptom endorsement at baseline were not significantly associated with either daily or any past month smoking at the 6 year follow-up. Building the models to include covariates showed that in many cases the only significant predictor of future smoking for those who had smoked more than 100 cigarettes was baseline smoking frequency (i.e. number of days smoked in the past month). Table 2 presents the final models examining the association between nicotine dependence measured at baseline and current smoking behavior at 6 year follow-up for each smoking group.

4. Discussion

Although smoking initiation typically occurs in adolescence and represents a behavior that has been studied extensively in this population, surprisingly little research has examined the importance of emerging dependence in novice smokers and its potential role in smoking maintenance into young adulthood (Colby et al., 2000; Tiffany et al., 2004; DiFranza et al., 2007). The present study examined the predictive validity of early emerging nicotine dependence symptoms in adolescence on smoking behavior in young adulthood. Findings revealed that for adolescents smoking <100 cigarettes, higher levels of nicotine dependence at baseline as well as individual symptoms of craving, withdrawal, better functioning in the morning after a cigarette and willingness to go out in a rainstorm to get cigarettes predicted daily smoking 6 years later, associations that remained significant over and above the contributions of baseline smoking quantity or frequency. In contrast, among adolescents who had smoked more than 100 cigarettes in their lifetime, smoking frequency rather than nicotine dependence predicted smoking behavior at the 6 year follow-up in young adulthood. Taken together, these findings suggest that measurement of nicotine dependence during the earliest exposures to smoking may be an important, yet unused tool in predicting smoking behavior prior to the development of more established smoking patterns, but that as more regular smoking patterns emerge, smoking behavior during adolescence is the strongest predictor future smoking during young adulthood.

As the first study to demonstrate that dependence symptoms experienced by adolescents who have smoked fewer than 100 cigarettes signal risk for daily smoking behavior during young adulthood, the present results have important implications for tobacco control efforts in that they provide information on who may be more likely to progress to chronic

dependent smoking and who may engage in smoking but not make this transition. Notably, most smoking interventions target the prevention of the first smoking experiences or the treatment of heavily dependent, chronic smokers (Fiore, 2000; Lantz et al., 2000), yet the present findings suggest that smokers reporting symptoms of nicotine dependence during their earliest exposure to nicotine are an important target for intervention. This window of vulnerability – after initial trials, but before smoking escalates to more frequent use—presents a new opportunity for targeted interventions for adolescents, and one that has yet to be explored.

Despite the numerous strengths of this study including recruitment of adolescent smokers across the continuum of smoking behavior, exploration of smoking behaviors below the most commonly used cut point for estimating smoking rates (i.e., below 100 cigarettes smoked lifetime) and follow-up assessments into young adulthood, the present results should be interpreted within the context of limitations. First, the sample was geographically restricted. Second, measurement of nicotine dependence was limited to a shortened version of Nicotine Dependence Syndrome Scale, modified for use with adolescents (Sterling et al., 2009). Further, measures of non-cigarette tobacco use captured an incomplete number of products currently available to U.S. consumers. Additional prospective work employing multiple measures of nicotine dependence are needed to both replicate and extend the present findings by identifying dependence features that consistently predict smoking persistence in this population. Finally, we do not know if these reports of emerging symptoms at low levels of smoking link to more objective measures of physiologic dependence, information that would better allow us to contribute to theory surrounding the development of chronic smoking behavior. However, whether individual differences in nicotine dependence are driven by systematic differences in subjective evaluations of symptoms or by physiologic differences in sensitivity, we have shown that above and beyond smoking quantity and frequency, these differences do forecast future smoking, and as such, are worthwhile targets of intervention.

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•Highlights

- We evaluate the predictive validity of early emerging nicotine dependence symptoms.
- Analyses were conducted on baseline and 6 year follow-up assessments.
- Individual symptoms longitudinally predicted an increase in risk for daily smoking.
- This effect remained after controlling for smoking and other tobacco use.
- Early emerging dependence symptoms in adolescence signal a greater propensity for smoking in young adulthood.

Table 1
Demographic and smoking characteristics by smoking group

Baseline Characteristics ^a	Smokers <100 cigarettes ^b n=492	Smokers > 100 cigarettes ^c n=123
	n (%)	n (%)
Gender: (male)	299 (60.8)	63 (51.2)
Age: mean (s.d.)	15.6 (0.60)	15.8 (0.62)
Ethnicity: (White)	270 (54.9)	89 (72.4)
Any other tobacco use (past 30 days)	155 (31.5)	57 (46.3)
Ever smoked daily (lifetime)	70 (14.2)	97 (78.9)
	Mean (SD)	Mean (SD)
Age of initiation (puff or more) – in years	12.3 (3.08)	11.76 (1.91)
Number of days smoked in past month	3.0 (5.07)	19.0 (11.10)
Number of cigarettes smoked on days smoked in past month	0.8 (1.09)	4.2 (4.08)
Nicotine Dependence Symptom Scale (mean of 10 items on 0-3 scale)	3.4 (4.79)	13.04 (8.28)
<u>6 Year Outcomes</u> ^a		
Positive for past month smoking	309 (62.8)	97 (78.9)
Positive for past month daily smoking	119 (24.2)	60 (48.8)

^aPercentages based on valid responses.

^bBased on the screening phase of the study, youth who indicated smoking in the past 90 days and who have smoked less than 100 cigarettes in their lifetime.

^cBased on the screening phase of the study, youth who have smoked in the past 30 days, have smoked more than 100 cigarettes in their lifetime, but smoke 5 or less cigarettes a day.

Table 2
Association between baseline nicotine dependence symptoms and smoking at the 6 year follow-up by smoking group^a

	Smokers < 100 cigarettes n=492 ^b			Smokers > 100 cigarettes n=123 ^b		
	YES %	NO%	OR (CI) RR (CI)	YES %	NO%	OR (CI) RR (CI)
Compared to when I first started smoking, I need to smoke a lot more now in order to be satisfied.						
Positive for past month smoking at 6 year	69.9	60.8	1.1 (0.71-1.83) 1.0 (0.96-1.12)	80.2	74.1	0.9 (0.27-2.85) 0.9 (0.76-1.16)
Positive for daily past month smoking at 6 years	31.4	21.3	1.1 (0.67-1.89) 1.1 (.87-1.27)	50.0	44.4	0.4 (0.11-1.67) 0.9 (0.74-1.02)
Since I started smoking, I have increased how much I smoke						
Positive for past month smoking at 6 year	68.8	60.0	1.2 (0.77-1.85) 1.1 (0.98-1.14)	81.0	66.7	1.3 (0.36-4.49) 1.1 (0.85-1.2.8)
Positive for daily past month smoking at 6 years	28.7	21.5	1.0 (0.62-1.69) 1.0 (0.86-1.25)	50.5	38.9	0.4 (0.09-1.39) 0.8 (0.56-1.07)
After not smoking for a while, I need to smoke to relieve feelings of restlessness and irritability						
Positive for past month smoking at 6 year	69.3	60.0	1.3 (0.82-1.91) 1.1 (0.97-1.13)	79.8	75.0	0.8 (0.25-2.49) 0.9 (0.81-1.10)
Positive for daily past month smoking at 6 years	29.6	21.4	1.2 (0.73-1.88) 1.1 (0.91-1.29)	50.0	42.9	0.4 (0.14-1.36) 0.9 (0.68-1.17)
After not smoking for a while, I need to smoke in order to keep myself from experiencing any discomfort						
Positive for past month smoking at 6 year	72.1	61.0	1.3 (0.81-2.16) 1.0 (0.97-1.13)	81.9	73.7	1.1 (0.37-3.24) 0.9 (0.80-1.12)
Positive for daily past month smoking at 6 years	36.9	20.5	1.8* (1.07-2.93) 1.2* (1.02-1.45)	54.2	36.8	1.0 (0.38-2.72) 0.9 (0.77-1.22)

		Smokers < 100 cigarettes n=492 ^b			Smokers > 100 cigarettes n=123 ^b		
		I can function much better in the morning after I've had a cigarette					
		YES %	NO %	OR (CI)	YES %	NO %	OR (CI)
Positive for past month smoking at 6 year		84.4	62.0	2.1 (0.76-6.03) 1.1 (0.96-1.15)	86.7	71.4	2.0 (0.59-6.93) 1.1 (0.93-1.25)
Positive for daily past month smoking at 6 years		65.6	21.6	6.2* (2.60-14.77) 1.5* (1.25-1.80)	63.3	34.9	1.4 (0.52-4.00) 1.02 (0.81-1.29)
Whenever I go without a smoke for a few hours, I experience craving							
		YES %	NO %	OR (CI)	YES %	NO %	OR (CI)
Positive for past month smoking at 6 year		71.8	62.5	1.1 (0.62-2.08) 1.1 (0.97-1.33)	83.3	73.9	1.1 (0.35-3.59) 1.1 (0.78-1.15)
Positive for daily past month smoking at 6 years		40.9	22.0	2.0* (1.10-3.67) 1.3* (1.04-1.51)	56.9	37.0	0.8 (0.27-2.20) 0.9 (0.73-1.23)
When I'm craving a cigarette it feels like I'm in the grip of some unknown force that I can't A control							
		YES %	NO %	OR (CI)	YES %	NO %	OR (CI)
Positive for past month smoking at 6 year		71.8	62.1	1.2 (0.66-2.17) 1.0 (0.97-1.12)	77.3	80.7	0.5 (0.16-1.31) 1.0 (0.86-1.09)
Positive for daily past month smoking at 6 years		38.5	22.1	1.6 (0.88-2.84) 1.2 (0.94-1.43)	54.6	42.1	0.9 (0.38-2.13) 0.9 (0.77-1.11)
If there were no cigarettes in the house and there was a big rainstorm, I would still go out of the house and find a cigarette							
		YES %	NO %	OR (CI)	YES %	NO %	OR (CI)
Positive for past month smoking at 6 year		71.9	62.6	1.1 (0.57-2.15) 1.1 (0.96-1.15)	85.0	73.0	1.6 (0.55-4.81) 1.0 (0.87-1.16)
Positive for daily past month smoking at 6 years		43.9	21.9	2.1* (1.12-4.01) 1.3* (1.05-1.54)	56.7	41.3	0.8 (0.34-2.12) 1.0 (0.82-1.17)
In situations where I need to go outside to smoke, it's worth it to be able to smoke a cigarette, even in cold or rainy weather							
		YES %	NO %	OR (CI)	YES %	NO %	OR (CI)

	Smokers < 100 cigarettes n=492 ^b		Smokers > 100 cigarettes n=123 ^b		OR (CI)	OR (CI)
	YES %	NO%	YES %	NO%		
Positive for past month smoking at 6 year	71.8	61.3	83.3 1.1 (0.66-1.88) <i>1.0 (0.96-1.13)</i>	68.4 1.5 (0.45-5.01) <i>1.1 (0.9-1.23)</i>		
Positive for daily past month smoking at 6 years	35.9	20.9	54.8 1.5 (0.85-2.50) <i>1.2 (0.96-1.41)</i>	34.2 0.7 (0.22-2.16) <i>1.0 (0.82-1.22)</i>		
If I'm low on money, I'll spend it on buying cigarettes instead of buying lunch						
	YES %	NO%	OR (CI)	YES %	NO%	OR (CI)
Positive for past month smoking at 6 year	71.4	62.9	1.2 (0.55-2.45) <i>1.0 (0.85-1.09)</i>	80.2	74.1	0.6 (0.18-1.77) <i>1.0 (0.87-1.27)</i>
Positive for daily past month smoking at 6 years	46.9	22.0	0.5 (0.25-1.03) <i>1.2 (0.99-1.55)</i>	50.0	44.4	1.3 (0.50-3.55) <i>1.0 (0.85-1.18)</i>

^a Odds ratios and 95% confidence intervals adjusted for baseline smoking frequency (days smoked in past 30), quantity (number of cigarettes smoked in past week), other tobacco use (any on the past 30 days) and gender.

^b Percentages based on valid responses.