ORIGINAL ARTICLE

# Tobacco Smoking Trajectory and Associated Ethnic Differences Among Adolescent Smokers Seeking Cessation Treatment

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*Purpose:* **To examine smoking trajectories in a clinical sample of adolescent smokers seeking cessation treatment, including: (a) smoking onset (initial, daily) and time intervals from initial to daily smoking and from daily smoking to treatment request, (b) associations between current level of tobacco dependence and smoking history, and (c) differences in smoking trajectory between African-American and non-African-American youth.**

*Methods:* **Four hundred and thirty-two adolescent smokers (aged 13–17 years, 61.8% female, 32% African-American) responding to various media advertisement completed a telephone interview as part of pre-eligibility screening for a smoking cessation trial. Smoking trajectory data included age at onset of initial and daily smoking, intervals between those time points, and cigarettes smoked per day (CPD). Tobacco dependence was assessed using the Fagerström Test for Nicotine Dependence (FTND). Data were analyzed using regression models and multiple analyses of covariance.**

*Results:* **Initial smoking occurred at a mean age of less than 12 years and daily smoking at age 13 years. Earlier onset of daily smoking was associated with higher FTND scores and longer duration from daily smoking to treatment request. For the entire sample, the time interval from initial to daily smoking was 1.14 years. When the sample was divided into early (before age 14 years) and later (at or after age 14 years) initiators, early initiators showed a slower progression from initial to daily smoking compared with late initiators (16 months vs. 6 months). Compared with non-African-American teen smokers, African-American youth reported a 1-year delay in onset of both initial and daily smoking.**

*Conclusions:* **Early age of daily smoking and short time interval from initial to daily smoking highlight a brief window of opportunity to prevent the development of tobacco addiction and its consequences. Ethnic differences in smoking trajectory uncovered in this report call for ethnically tailored interventions to reduce youth smoking. © *Society for Adolescent Medicine, 2004***

KEY WORDS:
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Many adolescents start smoking cigarettes despite public health efforts to dissuade youth from experimenting with tobacco [1], the leading preventable cause of morbidity and mortality in the United States. Although one-third to one-half of adolescents who try cigarettes later became regular or dependent smokers, close to two-thirds of them report having tried to quit [1–3]. Ample evidence supports the effectiveness of adult tobacco dependence treatment programs [4], but few cessation programs are available to accommodate the needs of adolescent smok-

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ers before smoking behavior becomes a refractory disorder [5–7]. This deficit is compounded by limited knowledge of the temporal duration of various stages of smoking behavior (smoking trajectory). Because more than one-half of the adolescent smokers who quit remain abstinent as young adults [8], early cessation treatment has significant importance. Data on smoking trajectory would facilitate the optimal timing for implementing developmentally appropriate prevention and early cessation interventions. This report examines the various time points and intervals along the smoking trajectory in a sample of adolescent smokers who request assistance for cessation, a group whose higher health risks need to be recognized because of their dependence-related consumption. Although various definitions of smoking "trajectory" may exist [9], our focus is based on a linear progression along the smoking trajectory, which refers to three time points and two intervals. Time points include the age at onset of first cigarette, age at onset of daily smoking, and age at onset of treatment request (professional assistance to quit smoking). Time intervals include initial to daily smoking and daily smoking to treatment request.

Several lines of evidence indicate that early age of smoking onset (first cigarette) predicts long-term smoking. For example, Chassin et al reported that the "early-stable" group of smokers (those with a younger age of smoking onset) attained a high rate of smoking 11–20 cigarettes a day by age 15 years and remained stable smokers through the 10-year course of the longitudinal study [10]. Smokers who started before age 14 years [11] or 16 years [12] were likely to smoke more cigarettes in adulthood. Additionally, age of smoking onset was associated with a higher level of tobacco dependence and a lower number of quit attempts [12–14]. Therefore, it is likely that there is a relationship between early smoking onset and substantial smoking history in cessation-seeking adolescent smokers.

Whereas the initiation of smoking has been studied for its significance, less is known about the temporal progression from smoking onset to daily smoking. Cross-sectional data suggest that about 30% of experimenters progress to "established" (i.e., daily) smoking within 5 years, and an identifiable subgroup show relatively higher risk of such progression [15]. Breslau et al reported a 3-year interval from first cigarette to daily smoking in a young adult cohort and this duration was independent of the number of cigarettes consumed [16]. Data characterizing the duration from daily smoking to cessation treatment are also scant [12,17]. Determining the time frame from initial to daily smoking would seem crucial for intervening to prevent the development of dependent smoking [18,19].

In addition to studies in the general smoking population, age of smoking onset seems to vary among ethnic groups. Among non-treatment-seeking populations (both adult and adolescent smokers), African-American smokers were found to initiate smoking at a later age and to smoke fewer cigarettes per day compared with non-African-American smokers [20–23]. Later onset of smoking among African-American youth was also reported from a cessation treatment-seeking population [24]. However, once African-American teens began smoking, almost half of them developed addictive smoking, particularly in those who began smoking before age 17 years [25]. Thus, elucidating differences in the time course of smoking trajectory in a cessation-seeking sample may advance the knowledge leading to ethnically tailored treatment interventions to address tobacco-attributable health disparities [26].

Within a sample of adolescent smokers seeking assistance for cessation, this study had three objectives: (a) to examine reported age of onset of initial and daily smoking and intervals between key time points in the smoking trajectory, (b) to explore the association between current level of tobacco dependence and time course of smoking, and (c) to examine ethnic differences (African-American versus non-African-American) in smoking trajectory in this cessation-seeking sample.

## *Methods*

This report was based on data obtained from telephone interviews that screened participants for eligibility for a combined nicotine replacement and counseling cessation study for adolescent smokers who were motivated to quit smoking. The screening protocol was approved by the National Institute on Drug Abuse (NIDA) Institutional Review Board (IRB) with a waiver of informed consent.

### Subjects

From September 1, 1999 to September 30, 2001, a convenience sample of 432 adolescent participants between the ages of 13 and 17 years were recruited from the Baltimore area via several means of advertisement, including newspaper, radio, television, and word of mouth. One hundred thirty-eight participants were African-American, 282 were Caucasian, 4

Native American, 1 Asian, and 7 Hispanic. The latter four groups were collapsed into a non-African-American group. There were 88 (63.8%) females in the African-American group and 179 (60.9%) in the non-African-American group.

### Procedures

Participants telephoned to inquire about the eligibility to participate in the treatment study and completed an internally developed structured telephone interview, lasting approximately 15 to 20 minutes. At the beginning of each interview, interviewers obtained permission from participants to record their information. Data collected included demographic information (age, gender, ethnicity), medical, psychiatric, and medication histories, motivation to quit (integer scale of 10, 10 being the highest), and smoking-related histories.

### Measures

Smoking-related histories included age of onset of first cigarette, age of daily smoking, number of cigarettes consumed (weekdays and weekend), previous cessation attempts (number of times and duration), and current level of nicotine dependence. For data on the age of onset of smoking initiation, callers were asked, "How old were you when you smoked your first whole cigarette?" For data on age of onset of daily smoking, callers were asked, "At what age did you begin smoking daily?" The number of cigarettes smoked per day (CPD) was calculated by summing of weekly consumption and dividing by number of days of a week. Intervals of time points (e.g., from initial to daily smoking, from daily smoking to treatment request) were calculated by subtracting length of time, rounded off to the nearest year. Because of use of age in years rather than dates, for those who reported time points during the same year of age, intervals were calculated as zero. Participants who began to smoke before age 14 years were defined as "early initiators," and those who started at or later than age 14 years were categorized as "later initiators."

Tobacco dependence was assessed using the six-item Fagerström Test for Nicotine Dependence (FTND) [27]. FTND scores range from 0 to 10; suggested interpretations of FTND scores is as follows: 1–2 = very low dependence; 3–4 = low dependence; 5 = medium dependence; 6–7 = high dependence; 8–10 = very high dependence [28]. The FTND have been found to have good test–retest reliability (Cronbach alpha 0.64) and higher internal consistency than FTQ in several studies [29–31].

**Table 1.** Smoking Trajectory of Adolescents Seeking Cessation Treatment

| Variable | Mean ± SD |
|---|---|
| Age at first cigarette (years) | 11.9 ± 2.0 |
| Age at daily smoking (years) | 13.0 ± 1.7 |
| Age at treatment request (years) | 15.6 ± 1.5 |
| First cigarette to daily smoking (years) | 1.1 ± 1.2 |
| Daily smoking to treatment request (years) | 2.7 ± 1.6 |
| Fagerström Test for Nicotine Dependence (FTND) | 5.9 ± 2.2 |
| Cigarette smoked per day (CPD) | 14.5 ± 7.9 |

### Data Analysis

Before tabulation, we removed the personal identifiers (unlinked) of participants found ineligible for the treatment protocol. Because subsequent analyses were performed on such unlinked data, the current screening study was separately approved with an exemption by Institutional Review Board, the National Institutes of Health, Office of Human Subject Research (OHSR).

Frequencies were compared using Chi-square tests. The age at enrollment was significantly different in African-American and non-African-American adolescents, thus this variable was included in all analyses as a covariate. Standard multiple regression analysis was used to test the association of FTND with trajectory variables. Continuous variables were compared by multivariate analysis of variance (MANCOVA) followed by univariate analysis of variance to test specific variables for significant differences. Backward conditional logistic regression was used to determine which trajectory variables were independently associated with ethnicity. Relationships among variables were estimated by stepwise multiple linear regression. Data are presented as means [± Standard Deviation (SD) or frequencies (%)] unless otherwise indicated. Differences were considered significant at the $p < .05$ levels. SPSS version 10.0 (Chicago, IL) was used for all data analyses.

## *Results*

### Sample Smoking Characteristics

The time course of progression through various phases of the smoking cycle in our sample of cessation seekers is illustrated in Table 1. No gender

**Table 2.** Differences in Time Intervals of Smoking Stages in Early and Late Initiators

| Variable | Early Initiator (<14 years) (Mean ± SD) | Late Initiator (≥14 years) (Mean ± SD) | F Value | *p* Value |
|---|---|---|---|---|
| First cigarette to daily smoking (years) | 1.3 ± 1.3 | 0.45 ± 0.7 | 35.4 | <.0001 |
| Daily smoking to treatment request (years) | 2.9 ± 1.7 | 1.6 ± 0.8 | 46.8 | <.0001 |
| First cigarette to treatment request (years) | 4.2 ± 2.0 | 2.0 ± 0.9 | 90.0 | <.0001 |

differences were found among any of the smoking trajectory variables.

### Nicotine Dependence and Smoking Trajectory

Pearson correlation analyses showed that higher CPD was associated with a longer interval from first cigarette to seeking treatment ($r = 0.322$, $p < .0001$) and time from daily use to treatment request ($r = 0.322$, $p < .0001$). CPD did not, however, correlate with interval from first cigarette to daily smoking ($r = 0.05$, $p = .32$).

In the overall sample, the age of first cigarette use bore no relationship to current FTND scores. However, age of onset of *daily* smoking was associated with FTND score such that subjects who had an earlier onset of daily smoking had higher FTND scores (beta = 0.494, SE = 0.06, $t = -7.88$, $p < .0001$). FTND score was also positively associated with age at seeking cessation treatment request such that older participants at enrollment had higher FTND scores (beta = 0.467, SE = 0.07, $t = 6.3$, $p < .0001$). FTND score was not associated with interval from age of first cigarette to daily smoking, but was associated with interval from daily smoking to age at treatment request (beta = 0.48, SE = 0.06, $t = 8.35$, $p < .0001$) such that participants who had higher FTND scores had a longer duration from daily smoking to treatment request.

After controlling for age at treatment request, early initiators (before age 14 years) currently consumed significantly more cigarettes (Mean ± SE 15.4 ± 0.5 vs. 10.0 ± 0.9, $F_{1,424} = 23.7$, $p = .005$) and had higher FTND scores (Mean ± SE 6.2 ± 0.1 vs. 4.7 ± 0.2, $F_{1,424} = 30.4$, $p < .0001$) compared with late initiators. However, differences between these groups became nonsignificant for both CPD and FTND after adjusting for the years of smoking, suggesting that dependence level and CPD are related to the duration of smoking.

As shown in Table 2, early initiators had a significantly longer interval from first cigarette smoked to daily smoking and from daily smoking to treatment request.

### Ethnic Differences in Smoking Trajectory

African-American adolescents ($n = 126$, 30%) (12 African-American participants were excluded from the original sample owing to lack of age of onset of smoking) exhibited a later onset of first cigarette smoked and daily smoking than non-African-Americans (Table 3). When data were adjusted for age and gender, African-American teens had shorter intervals from any one stage to another. However, backward logistic regression analysis showed that the only trajectory variable associated with the ethnic difference was the age of the first cigarette (odds ratio: 0.736, 95% CI: 0.65 to 0.83, African-American group being the reference group, $p < .0001$, i.e., African-American teens had a later onset of smoking initiation compared with non-African-American participants).

**Table 3.** Ethnic Differences in Smoking Trajectory and Tobacco Dependence[a]

| Variable | African-American (n = 126) | Non-African-American (n = 279) | *p* Value |
|---|---|---|---|
| Age at first cigarette (years) | 12.6 ± 0.17 | 11.5 ± 0.12 | .0001 |
| Age at daily smoking onset (years) | 13.6 ± 0.15 | 12.8 ± 0.10 | .0001 |
| First cigarette to daily smoking (years) | 0.95 ± 0.11 | 1.2 ± 0.7 | .031 |
| Daily smoking to treatment request (years) | 2.4 ± 1.6 | 2.8 ± 1.6 | .018 |
| First cigarette to treatment (years) | 3.3 ± 0.18 | 4.0 ± 0.12 | .001 |
| Cigarettes smoked per day | 10.7 ± 0.7 | 15.9 ± 0.5 | .0001 |
| Fagerström Test for Nicotine Dependence (FTND) | 5.2 ± 0.2 | 6.2 ± 0.1 | .0001 |

[a] Data are age-adjusted Means ± SE.

African-American adolescents smoked significantly fewer cigarettes than non-African-American teens ($F_{1,424} = 31.9$, $p < .0001$) and had lower FTND scores ($F_{1,424} = 20.4$, $p < .0001$) than their counterparts. When the comparison of FTND was adjusted for CPD, the difference in FTND was no longer significant.

Although African-American adolescents reported lower CPD than non-African-American youth, African-Americans who began to smoke before age 14 years had greater mean daily cigarette consumption than those who initiated smoking after age 14 (Mean $\pm$ SD 12.4 $\pm$ 7.7 vs. 9.6 $\pm$ 9.0, $F_{1,136} = 3.70$, $p = 0.57$).

## *Discussion*

In our sample of adolescent smokers seeking assistance for cessation, smoking onset occurred on average just before age 12 years and daily smoking around age 13 years. Earlier onset of daily smoking was associated with a higher level of tobacco dependence and longer duration from daily smoking to age of treatment request. Early initiators had a longer interval from first cigarette to daily smoking than later initiators. Early initiators endorsed a similar level of tobacco dependence as later initiators when adjusted for years of smoking meaning that years of smoking is an important factor in predicting dependence. Compared with non-African-American youth, African-American smokers reported a later onset of first cigarette and daily smoking.

### Age of Initial and Daily Smoking

Our clinical population reported an earlier age of smoking initiation than other previous reports [13,16,32–34]. Although a caution for the generalizability of our data to other young smokers is warranted, the young age of smoking initiation and heavy use of cigarettes support the notion that adolescent smokers in our sample represent a "self-selected" subgroup who start smoking early in life, are highly dependent, and are unlikely to quit [10,14,35].

In this report we used daily smoking as a proxy measure for dependent smoking instead of using definitive values from various scales [36,37] because (a) the simplicity and familiarity of participants' recall of daily smoking enhance accuracy; (b) there is no universally approved scale of dependence for adolescent smokers; (c) daily smoking is representative of compulsive use; and (d) daily smoking signals a lifestyle or identity and a probable social affiliation to a smoking group [38]. The age of onset of daily smoking reported here (13 years old) is similar to one report but substantially younger than findings of other studies of non-treatment-seeking populations [39–41]. Our finding that early daily smoking predicts higher level of nicotine dependence supports the association between daily smoking and tobacco dependence [42]. Whereas some reports suggest that tobacco dependence can develop before daily smoking after a relatively short history of tobacco use, others suggest a 1-year delay from the onset of daily smoking to the development of tobacco dependence [43,44].

### Duration/Progression of Smoking

The mean time interval from initial to daily smoking in our sample (1.14 years) is comparable to findings from one epidemiological study [33] but is substantially shorter than other previous findings of 2- [34] and 3-year intervals reported by Breslau [41]. This seems to point to a relatively short opportunity for offsetting the development of compulsive tobacco use. When our sample was divided into early and later initiators, early initiators progressed to daily smoking in 16 months, whereas the later initiators did so in less than 6 months. One possible explanation for a longer progression time to daily smoking in early initiators are the limited opportunities to smoke owing to parental and social disapproval of smoking at this younger age [16,45]. Additionally, reduced access to cigarettes for younger smokers may further deter the progression to daily smoking [46]. Although in some individuals, less time is needed to escalate from experimental to established smoking [43,47,48], the data showing that late initiators progress to daily smoking quicker than early initiators may be explained by experiencing contextual social influences of teenage lifestyle [38], including diminished parental supervision as a function of age, and increased identity as a social smoker. Recent data suggest that having more close friends who smoke may accelerate the progression from experimental to regular smoking [49]. Moreover, older teens may have easier access to cigarettes through smoking parents or friends who work in stores [50]. We suggest that early interventions occur before attitudinal changes that promote the onset of smoking and other risk behaviors; such as before age 10 years [51,52].

### Correlates of Smoking Trajectory and Tobacco Dependence

Adjusted for age at study enrollment, early initiators appear to have a higher level of tobacco dependence measured by FTND scores and a higher rate of daily cigarette consumption. Such difference diminishes after the years of smoking were taken into account, indicating that considerations of multiple factors are needed when assessing tobacco dependence, probably length of exposition being a main factor to become dependent. As an overall sample, the longer time interval from daily smoking to time of seeking cessation treatment is associated with higher CPD and level of tobacco dependence. This finding echoes previous analyses that in both adolescent and adult smokers, heavy smokers tend to make less effort to quit smoking [17,53,54]. Fewer treatment trials among young smokers have resulted in limited information for cessation assistance to adolescent smokers [55]. This situation might have contributed to a delay in seeking cessation treatment after the onset of daily smoking.

### Ethnic Differences

Consistent with several previous reports, African-American youth in our sample reported a later onset of first cigarette smoked compared with non-African-American teens (12.64 years vs. 11.55 years, respectively) [1,20,24,32,56]. In addition, African-American teens reported later onset of daily smoking (13.59 years) compared with non-African-American youth (12.78 years). Parental restrictions and less societal acceptance for cigarette smoking in the African-American population might partially explain these findings [22,57,58]. Detailed analyses showed no difference in trajectory intervals between African-American and non-African-American participants, indicating similar progression from initial to daily smoking and from daily smoking to time of treatment request in both groups. Moreover, African-American youth showed similar tobacco dependence as non-African-American participants, as reported elsewhere [26].

## *Limitations*

Our findings should not be generalized to all adolescent smokers we used a self-selected sample of motivated cessation seekers. Because interview data were based upon recollection, our data are subject to recall bias. However, available evidence has shown that self-reported information on smoking initiation and substance use by both adults and children are sufficiently reliable for reporting retrospective data [59,60]. Nonetheless, prospective studies of adolescent smokers would offer stronger evidence of the time course of smoking trajectories. Socioeconomic status and educational level, which are shown to be associated with smoking initiation [32,61], as well as influence of peer smoking on progression [49] were not obtained during the brief screening interview.

## *Conclusions*

The current study identified the characteristics of smoking trajectory in a clinical sample of tobacco cessation-seeking adolescents. Our sample reported an early age of smoking onset and rapid progression from initial to daily smoking. These findings suggest that there is a relatively brief window of opportunity for intervention, thus underscoring the need for providing appropriate and prompt interventions to prevent the development of tobacco addiction. Moreover, ethnic differences in smoking trajectory uncovered here, namely later onset of initial and daily smoking, may help to design ethnically tailored smoking cessation interventions.

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