Published in final edited form as:
Nicotine Tob Res. 2008 July ; 10(7): 1185–1190. doi:10.1080/14622200802163118.

Ecological momentary assessment of adolescent smoking cessation: A feasibility study

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Abstract

Attempts to quit smoking by adolescents typically fail, even when aided by psychosocial and pharmacological treatments. Gaining a better understanding of the process of smoking cessation and relapse in this population could lead to improved treatments and increases in cessation rates. Ecological momentary assessment (EMA) has been used to describe the relapse process among adults, but not among adolescents. This study examined the feasibility of using EMA to examine relapse among adolescent smokers. Participants (*N*=13) used a hand-held computer for 3 weeks to report on their smoking behavior, affect state, and exposure to smoking cues during a quit attempt (7 days prequit, 14 days postquit). All of the participants recorded a quit attempt and at least one lapse during the monitoring interval. Compliance with the protocol was generally high but decreased slightly over time. As with adults, evidence indicated that lapses were associated with craving, negative affect, and smoking cues. These data support the feasibility and potential value of using EMA with adolescent smokers.

Introduction

Although adolescents frequently report making attempts to quit smoking (e.g., Stanton, McClelland, Elwood, Ferry, & Silva, 1996), their attempts almost always end in relapse. Approximately 90%–95% of adolescents who make an unaided attempt to quit smoking will relapse (Mermelstein, 2003; Sussman, 2002). Even with the provision of psychosocial or pharmacological treatments, the relapse rates are unacceptably high and typically exceed the failure rates observed among adult smokers (Grimshaw & Stanton, 2006).

One of the limitations of developing treatments for adolescent smokers is that we know very little about the natural history of a quit attempt in this population (Mermelstein, 2003). This makes it difficult to tailor psychosocial or pharmacological treatments to this unique group. For example, understanding the contexts associated with lapses among this population (Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996) could allow for tailoring of treatments to the unique vulnerabilities of adolescents. Additionally, the timing of intervention delivery could be matched to the needs of adolescents: If relapse happens very quickly, it would be useful to concentrate the intervention around the quit date. In sum, gaining a better understanding of cessation and relapse among adolescent smokers could lead to improved interventions for this population.

Ecological momentary assessment (EMA) methods have been used to capture detailed information about adult smoking cessation and relapse (e.g., Gwaltney, Shiffman, Balabanis,

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& Paty, 2005). EMA involves asking smokers to report about their experiences in real-time multiple times per day, using a hand-held computer. EMA for relatively short intervals (up to 1 week at a time) has been used with adolescent smokers to better understand the onset and progression of smoking (Mermelstein, Flay, Hedeker, & Shiffman, 2003) and the relationship between smoking and mood states and psychiatric disorders (Whalen, Jamner, Henker, & Delfino, 2001). However, EMA has not been used to examine the relapse process with adolescents. Although previous work demonstrates that adolescents can successfully self-monitor for relatively short periods of time, their ability to use EMA in the manner required to study relapse (monitoring for several continuous weeks, entering critical events like the onset of the quit attempt and the occurrence of lapses) has not been established. Accordingly, the primary goal of this study was to examine the feasibility of using EMA to study adolescent smoking cessation. We assessed compliance with an EMA protocol among a small sample of adolescents who were making an unaided attempt to quit smoking. We also used the data to explore high-risk situations for lapsing among this sample.

Method

Participants

A total of 13 participants (5 females, 8 males) were recruited through a local high school, radio advertisements, and a previous noncessation smoking study. Recruitment at the school involved setting up a display table in the cafeteria for 2 days. Of the 24 students who expressed interest in the study, 14 were reached for screening, 11 were eligible, and 7 participated. (Of the four eligible students who did not participate, two agreed to participate but could not be enrolled before the end of the study, one could not participate for disciplinary reasons, and one did not attend the first session.) The radio advertisements were run for 2 weeks and yielded seven calls. Of these callers, four were eligible and three participated (the fourth agreed to participate but did not attend the first session). We contacted three of six referrals from the noncessation study. Two of these adolescents were eligible, and both participated. One pilot study participant was referred to the study by another participant. Active parental consent was required. Recruitment, enrollment, and data collection were completed from January to March 2007, when school was in session.

Adolescents who were aged 14–18 years (M=17.4, SD=0.8), expressed a desire to quit smoking in the next 30 days, reported smoking on at least 25 days out of the last 30, and reported smoking over 100 cigarettes in their lifetime were eligible. Participants who planned to use any form of pharmacotherapy while quitting were excluded. Participants were paid US$170 for completion of the entire monitoring protocol. Nine of the participants were White; three reported mixed ethnicity (data missing for one participant).

Procedure

On the first study day, participants were trained individually in the use of a hand-held computer, the Teen Experience Diary (TED; implemented on the PalmPilot Tungsten E2). Participants self-monitored for 3 consecutive weeks (7 days prequit, 14 days postquit) and met with the research staff on five occasions during this interval (typically days 1, 2, 7, 14, and 21). Self-reported smoking status (smoked in past 24 hr) and exhaled carbon monoxide (CO) were collected at each session, and data from the TED were uploaded to a laptop computer. At each session, the staff member asked the participant about his or her ability to use the features of the TED and to comply with the monitoring protocol. The staff member worked with the participant to resolve any problems. After the session, the researcher reviewed the TED data and contacted the participant again if any problems were observed.

Upon enrollment, participants selected a target quit date, at the request of the research staff. This date was typically scheduled to occur on day 8 of the monitoring protocol. The quit attempt was initiated when the participant selected an "I've Quit" button on the TED menu. The TED administered five kinds of assessments:

Cigarette assessments—Cigarette assessments were completed every time the participant smoked a cigarette prior to initiating the quit attempt.

Nonsmoking assessments—Participants were audibly prompted by the TED at random times within 3.5-hr intervals between 8 a.m. and 10 p.m. to complete an assessment (total of four possible nonsmoking assessments per day).

I've Quit—Participants were instructed to initiate the quit attempt at a time of their choosing on the target quit day and make the corresponding entry on the TED.

Temptations—Occasions when the participant felt like smoking or came to the brink of smoking but did not were labeled as "temptations to smoke." Participants were instructed to make an entry on the TED at the end of each temptation.

Lapses—Any instance of smoking following the I've Quit entry was recorded on the TED and considered a lapse. Participants were instructed to make an entry on the TED following any smoking episode (even a puff).

The TED included features designed to allow it to fit in with the participant's daily schedule, including school attendance. A "suspend" function allowed the participant to turn off the TED for up to 10 hr. This allowed participants to eliminate the audible prompts (see below) during times when they would have been inappropriate, such as during a test or in church. The suspend function also was used when participants slept. Participants were instructed to end the suspend when they were able to resume self-monitoring. Participants were not expected to use suspend in school at times when the audible prompts would not be problematic. Participants were provided with letters describing the study that could be shown to schoolteachers and administrators.

EMA assessment content

In each assessment, participants answered items that addressed the following: (a) cigarette craving, (b) affect state, (c) social context, and (d) whether smoking cues were present. Items measuring affect state included happy, stressed, relaxed, bored, irritable, energetic, and sad. Craving (0=none at all; 10=extremely high) and affect items (0=NO!!; 10=YES!!) used 11-point response scales. Social context was assessed by asking participants if they were alone (Yes or No). Smoking cues were assessed by asking participants if others were smoking around them (Yes or No) and if cigarettes were available (Yes or No).

Debriefing

During the final session, participants indicated whether or not they entered all events in real time.

Data analyses

The primary goal of the study was to demonstrate the feasibility of examining adolescent relapse with EMA. Evaluation focused on (a) compliance with the nonsmoking assessments (number and percentage of nonsmoking assessments that were completed), (b) time trends in cigarette entries and completion of nonsmoking assessments (examined with generalized estimating equations; Zeger, Liang, & Albert, 1988), (c) entry of I've Quit records, and (d)

entry of lapses and temptations in real time. Real-time cigarette entries were compared with CO readings and retrospective self-reports of smoking.

A secondary goal of the study was to explore contexts associated with smoking lapses among adolescents. We focused on first lapses, because of their relative importance. A case-control strategy was used (Shiffman et al., 1996), in which the first lapse assessment was compared with the "I've Quit" assessment to isolate processes associated with lapsing. Average scores for affect and craving items were calculated for both assessments, as were the percentage of participants endorsing being alone or in the presence of smoking cues. Because of the small sample size, we did not attempt to determine the statistical significance of the differences between the assessments. Instead, an effect size was calculated, using Cohen's (1988) formulas for the difference between means (*d*; craving and affect variables) and the difference between proportions (*h*; social context and cues).

Results

Overall

Out of 13 participants, 11 (85%) completed the entire monitoring protocol. One subject was discontinued after 11 days because of an emergent medical problem that was unrelated to the study. One participant dropped out of the study after 7 days for an unknown reason. Across all participants, at least one data point was entered on 239 of 249 days (96%). Data were missing on the remaining 10 days because of software malfunctions.

Compliance with monitoring protocol

Nonsmoking assessments—Participants completed 618 nonsmoking assessments during the monitoring interval, or an average of 2.48 ± 0.81 per day (out of four possible assessments). Overall, participants responded to 75% (range=53%–94%) of the audible nonsmoking assessment prompts. Compliance with the nonsmoking assessments did not change significantly over time (GEE parameter estimate=−.006, *SE*=.005).

Prequit cigarette assessments—Participants entered a total of 551 cigarettes during the prequit monitoring period. On average, participants entered 6.1 ± 3.5 cigarettes per day. The average number of cigarettes reported per day at screening was 10.3 ± 4.9. The number of cigarettes reported each day decreased significantly over the 7-day prequit interval (parameter estimate=−.74, *SE*=.20, $p<.001$). In other words, the number of cigarettes entered declined by almost three-quarters of a cigarette with each passing day (Figure 1). Nevertheless, in the debriefing questionnaire, 11 out of 12 (91.7%) participants reported entering every cigarette that they smoked during the prequit interval.

Key event recording

I've Quit records—All 12 of the participants who remained in the study through the target quit date made an I've Quit entry on the TED. All of these entries were on the target quit date. The I've Quit record was entered, on average, at 4:51 p.m. (range=7:04 a.m. to 11:32 p.m.; *Mdn*=6:05 p.m.). Of the 12 participants, 9 (75%) reported smoking at least one cigarette on the quit day (range=1–10) prior to making the I've Quit entry.

Lapses—All 12 participants who made an I've Quit entry also entered at least one lapse during the postquit monitoring period. The average number of lapses entered was 13.0 ± 12.4 (range=2–41). On average, first lapses occurred 27 hr and 39 min (*Mdn*=15 hr, 59 min) after the I've Quit record. The range of latencies between quit and lapse was 1 hr and 9 min to 144 hr and 8 min. Of 12 participants, 8 reported on the debriefing questionnaire that they entered every lapse in real time. The remaining participants reported that they entered the vast majority

of lapses but that they failed to enter some episodes when they were not "in the mood" or were with friends.

Temptations—All 12 participants who made an I've Quit entry also entered at least one temptation during the postquit monitoring period. The average number of temptations entered was 5.2 ± 2.7 (range=1–10). On average, first temptation entries occurred 19 hr and 13 min after the I've Quit record (*Mdn*=14 hr and 16 min). The range of latencies between quit and temptation was 17 min to 47 hr. In 8 out of 12 participants, at least one temptation preceded the first lapse report. Responses on the debriefing questionnaire regarding compliance with real-time entry of temptations matched the responses regarding compliance with lapse entries.

Verifying smoking entries

At the beginning of each session with the subject, CO was measured and the participant was asked if he or she had smoked in the past 24 hr. Participants reported at least one cigarette (either a prequit cigarette or a postquit lapse) in real time on 100% of days where CO levels were greater than 5 ppm (abstinence cutoff) or they retrospectively reported smoking in the past 24 hr. On days where zero cigarettes were entered in the previous 24 hr (n=5), CO readings were always under 5 ppm. Number of cigarettes entered in real time in the 24 hr prior to the visit was positively associated with CO level (r=.43, p<.01).

Lapse characteristics

First lapses were marked by increased craving and increased negative affect, particularly irritability and feeling "stressed" (Figure 2a). Quit attempts were more likely to occur when the subject was alone, whereas first lapses were more likely in the presence of other smokers and when cigarettes were available (Figure 2b).

Discussion

The present study established the feasibility of using EMA to study adolescent relapse. However, the study also uncovered areas of concern that should be addressed in future studies. The most encouraging findings were that adolescents who claimed to want to quit smoking (a) were willing to enroll in an EMA study, and (b) actually made a quit attempt and recorded its initiation on the electronic diary. These findings set the foundation for a study of relapse: If adolescents do not reliably make and record their quit attempts, it is impossible to study the relapse process with EMA. Although all participants recorded a quit attempt, many of them reported smoking within a few hours. This raises the question of how to define a true quit attempt (Carpenter & Hughes, 2005; Hughes et al., 2003). In these data, every participant entered a temptation episode during the 21-day monitoring interval, and the majority entered at least one temptation between the quit and first lapse entries. This finding suggests that they were trying to abstain prior to entering a lapse and that this was a real quit attempt.

Compliance with the nonsmoking and cigarette assessments was generally good though a little lower than is typically observed among adults (Shiffman et al., 2002). A biochemical measure of smoke exposure provided support for the validity of the real-time cigarette entries. We observed a decrease in cigarette entries during the prequit interval and a slight decrement in compliance with the nonsmoking assessments during the 3-week monitoring interval. It is unclear whether the decrease in cigarette entries reflects noncompliance or a true decrease in smoking rate leading up to the quit attempt. In a debriefing questionnaire, all but one of the participants reported entering every cigarette that they smoked in real time. In any event, to maintain high rates of responding in this population, it may be helpful to (a) introduce rewards (e.g., cash, gift certificates) contingent upon compliance, (b) increase the number of contacts with the research staff, so that feedback regarding compliance can be provided more frequently,

or (c) decrease the assessment burden (e.g., by randomly sampling cigarettes and lapses for assessment or decreasing the length of the assessments).

These exploratory analyses suggest that craving, negative affect, and smoking cues are associated with lapsing among adolescents. This mirrors results from adult cessation samples (e.g., Shiffman et al., 1996) using EMA. In future EMA studies, it will be important to ensure that nonsmoking assessments are administered in between the quit attempt and first lapse, to more clearly distinguish episodic changes in state and environment (e.g., a “spike” in irritability) from tonic withdrawal processes (relatively static irritability). Making this distinction could have important treatment implications: Episodic changes may be best addressed by coping skills training or “rescue medications,” whereas pharmacotherapies may be the best approach for decreasing withdrawal symptoms.

EMA can provide a detailed portrait of adolescent smoking and relapse, which may inform cessation programs. This pilot study suggests that adolescents are generally able to comply with the monitoring protocol required to examine cessation and relapse, even during school. The data also suggest that, as with adults, dynamic emotional and environmental processes may play an important role in undermining a quit attempt. Large-scale studies should use innovative methods to attain and preserve high rates of compliance when examining these processes in the future.

Acknowledgements

This study was supported by research grant DA021677 to the first author from the National Institute on Drug Abuse. The authors thank Sam Klugman and Julia Pleet for their assistance in data collection. Chad Gwaltney serves as consultant to PRO Consulting and invivodata, inc., which provides electronic diary services for clinical research.

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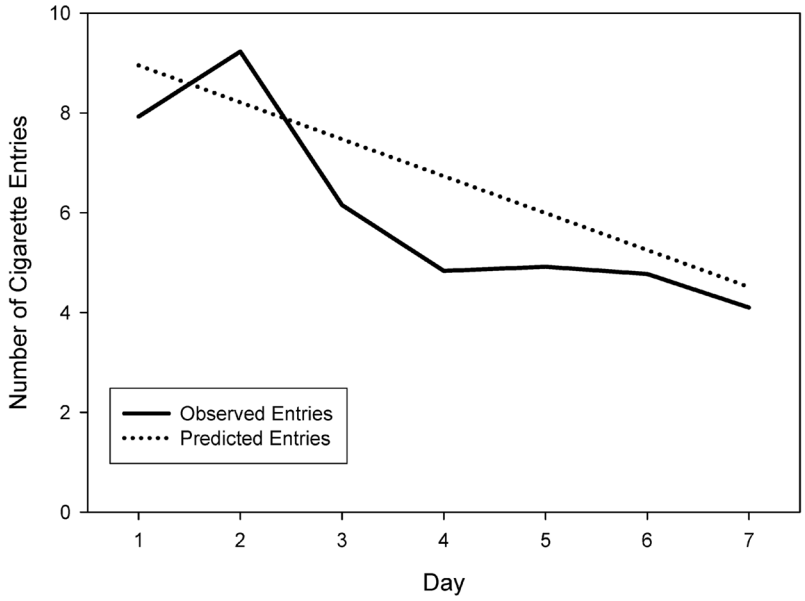

Figure 1.
Cigarette assessment entries during prequit monitoring interval.

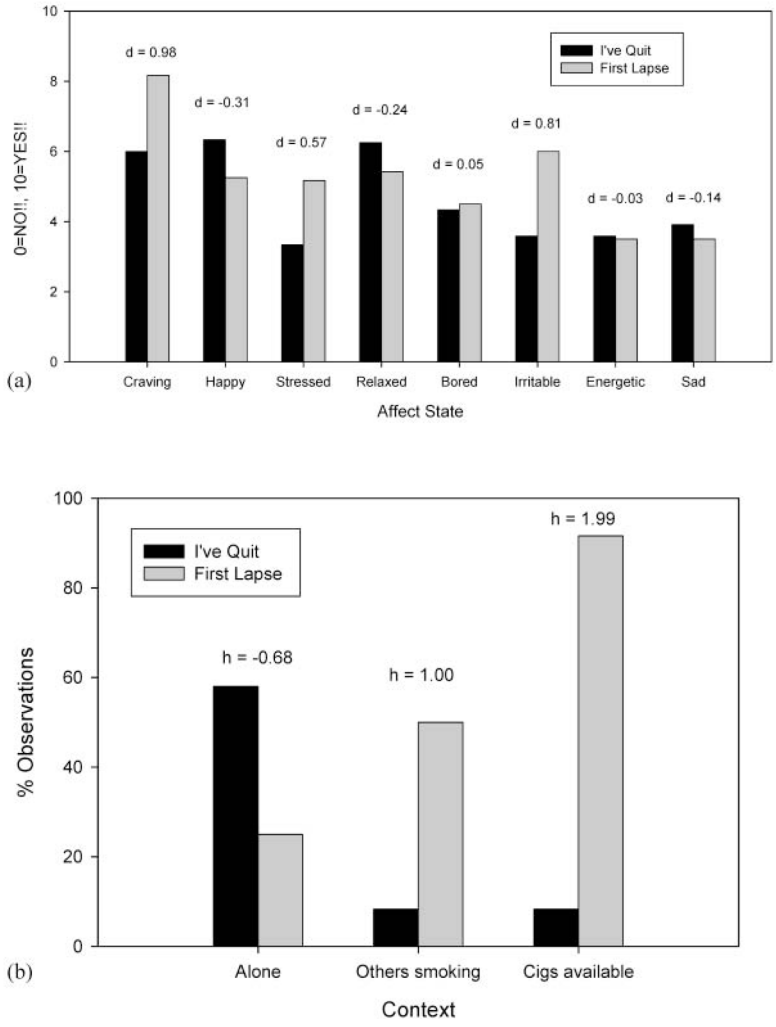

Figure 2.

(a) Affect state and (b) external cues in I've Quit and first lapse assessments. Small *d* and *h*=.20, medium *d* and *h*=.50, large *d* and *h*=.80.