

Assessment of Nicotine Dependence Among Substance Abusing Adolescent Smokers: A Comparison of the DSM-IV Criteria and the Modified Fagerström Tolerance Questionnaire

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Nicotine dependence has been found to be a significant factor in adolescent smoking persistence. However, measures of this construct are primarily adult-derived, limiting their utility as bases for characterizing nicotine dependence and formulating youth intervention strategies. This issue is of particular importance among substance abusing youth who have substantially higher rates of cigarette smoking than do adolescents in the general population. The objectives of this preliminary study were to examine the construct validity of the DSM-IV nicotine dependence criteria and the modified Fagerström Tolerance Questionnaire (mFTQ) and to compare the DSM-IV diagnostic criteria for nicotine dependence with the mFTQ in a sample of 67 adolescent smokers in treatment for substance abuse. Results revealed that more participants were classified as nicotine dependent using DSM-IV criteria than by mFTQ scores. Little evidence was found for construct validity of these measures and convergence between the two measures was low. Findings also suggested that the present measures do not capture optimally broad dimensions of adolescent nicotine dependence.

KEY WORDS: nicotine; dependence; adolescent; smokers.

Findings from the National Household Survey on Drug Abuse (U.S. Department of Health and Human Services, 2000) indicate that despite recent declines in cigarette use, smoking remains prevalent among youth. Although smoking rates among youth in general remain a cause for concern, prevalence is substantially higher among certain subgroups. Substance abusing youth in particular report rates of cigarette smoking that are significantly higher than the general adolescent population (e.g., Myers & Brown, 1997). A study examining adolescents in treatment for substance abuse found that 85% were current cigarette smokers, with 77% smoking daily

and 63% smoking 10 or more cigarettes per day (Myers & Brown, 1994). The prevalence of smoking in this clinical sample is almost three times the rate of smoking among U.S. high school seniors (Johnston, O'Malley, & Bachman, 2000).

Cigarette smoking among adolescent substance abusers commonly persists into early adulthood. For example, in a sample of youth interviewed 2 years following treatment for alcohol and other drug abuse, 75% reported current smoking (Myers & Brown, 1994). In this study respiratory problems were significantly more common among heavier smokers during the posttreatment period, demonstrating the vulnerability of these youth to negative health consequences from smoking. In addition, smoking rates were similar across alcohol and other drug use outcome groups, suggesting that adolescents who maintain abstinence from alcohol and other drugs remain at risk for cigarette-related problems. Similar findings emerged in a more recent study of this sample (Myers & Brown, 1997) in which 80% of smokers at the time of treatment were

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still smoking 4 years later. The severity of this problem is underscored by evidence that tobacco use was the leading cause of mortality for adults following alcoholism treatment (Hurt et al., 1996). Thus, available research demonstrates that youth treated for substance abuse are heavy smokers, that their cigarette use persists into adulthood, and that tobacco-related health problems are evident during adolescence. These data highlight the importance of identifying factors that influence cessation efforts for this high-risk population.

Nicotine dependence is one of the primary factors related to successful smoking cessation in the adult literature (Killen, Fortmann, Kraemer, Varady, & Newman, 1992; Pinto, Abrams, Monti, & Jacobus, 1987). Specifically, it has been demonstrated that adult smokers with lower levels of nicotine dependence were able to achieve long-term smoking cessation largely on their own, with minimal behavioral intervention and no pharmacologic therapy, whereas smokers with higher levels of dependence needed both pharmacologic and behavioral therapy to quit successfully (Killen et al., 1992). Although little is known regarding cessation outcomes for substance abusing or community samples of youth, available evidence points to the role of nicotine dependence in adolescent smoking persistence. For instance, a prospective examination of smoking persistence among adolescents treated for substance abuse revealed that heavier smoking at baseline predicted persistence 4 years following treatment (Myers & Brown, 1997). Similarly, studies of community adolescent samples found that self-reported cessation rates were substantially higher for less frequent smoking youth (Ershler, Leventhal, Fleming, & Glynn, 1989; Sargent, Mott, & Stevens, 1998). These findings suggest that the construct of nicotine dependence and its accurate assessment are of vital significance in planning, measuring, and influencing smoking cessation outcomes in substance abusing youth.

Various methodologies have been applied to the measurement of nicotine dependence. One approach is reflected in the *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed. (DSM-IV; American Psychiatric Association [APA], 1994). According to the DSM-IV, the essential features of nicotine dependence incorporate a combination of cognitive, behavioral, and physiological symptoms that play a role in an individual's continued use of a substance despite significant substance-related problems. Specifically, nicotine dependence comprises (1) diminished responsiveness or the development of tolerance to nicotine effects, (2) nicotine withdrawal symptoms, (3) nicotine being used in larger amounts or over a longer period of time, (4) desire to quit or unsuccessful efforts to quit smoking, (5) a great deal of time spent in smoking-related activities, (6) giving-up or

reducing social, occupational, or recreational activities, and (7) continued nicotine use despite harmful effects (APA, 1994). In this system, a defined threshold must be met (three of seven symptoms) to warrant classification as "nicotine dependent." In addition, the specifier, "with physiological dependence," is indicated when there is evidence of tolerance, withdrawal, or both.

An alternate approach in assessing nicotine dependence is using such measures as the Fagerström Tolerance Questionnaire (FTQ; Fagerström, 1978). Designed as a test of "physical dependence to nicotine," the FTQ has been applied commonly in clinical settings, and used to select the best candidates for nicotine replacement therapy among adults (Fagerström, 1991). The FTQ consists of eight differentially weighted items, which when summed, produce a score indicating degree of physical dependence on a scale of 0 (*minimum*) to 11 (*maximum*).

Both approaches to measurement of nicotine dependence were developed for use with adult smokers, and their utility among youth requires additional exploration (Colby, Tiffany, Shiffman, & Niaura, 2000a). A recent investigation examined a modified version of the FTQ in a sample of adolescents at high-risk for smoking and provided initial evidence for the utility and psychometric validity of this measure (Prokhorov, Pallonen, Fava, Ding, & Niaura, 1996). Despite the widespread use of DSM-IV nicotine dependence and FTQ-derived criteria, few researchers have examined the appropriateness of these measures for adolescent populations. Furthermore, in a comprehensive review of the assessment of nicotine dependence among adolescents, Colby et al. (2000a) identified the need for direct comparisons between alternative measures of dependence to determine their relative strengths and limitations. Because few, if any, published data exist on the measurement of nicotine dependence among substance abusing adolescents, the present study was undertaken as a preliminary effort to examine and compare selected psychometric properties of the two most commonly used measures of this construct and their usefulness in assessing nicotine dependence.

The present work examined the construct validity of the DSM-IV nicotine dependence criteria and a version of the FTQ modified for use among adolescents (mFTQ), and compared the application of the DSM-IV diagnostic criteria for nicotine dependence and the mFTQ in a heavy smoking sample of substance abusing adolescents. Given the absence of a "gold standard" measure of adolescent nicotine dependence, Colby and her colleagues suggested that validation efforts focus on construct validation, or the relation of dependence measures with other variables expected to correlate with the dependence construct

(Colby, Tiffany, Shiffman, & Niaura, 2000b). A review of recent papers addressing nicotine dependence among adolescents (Colby et al., 2000b; Kassel, 2000; Shadel, Shiffman, Niaura, Nichter, & Abrams, 2000) revealed that several domains were proposed consistently as relevant to this construct, including compulsive use of nicotine, repeated exposure to nicotine, ambivalence about quitting smoking, positive reinforcement/sensory satisfaction from smoking, and negative reinforcement/reduction of negative affect from smoking. Based on these recommendations, construct validity of the measures in the present study was assessed in relation to a smoking quantity/frequency index (compulsive use), years since first smoked a cigarette (repeated exposure to nicotine), self-reported ratings of desire to quit smoking (ambivalence), and scores on the positive and negative reinforcement scales of the Smoking Consequences Questionnaire (Brandon & Baker, 1991; representing the domains of sensory satisfaction from smoking and management of negative affect, respectively).

METHOD

Participants

Sixty-seven adolescents were recruited from four outpatient treatment settings, both private and publicly funded, for adolescent abuse of alcohol and drugs other than nicotine in metropolitan San Diego, California. Adolescents were participants in two studies examining a cigarette smoking intervention for substance abusing youth (e.g., Myers, Brown, & Kelly, 2000) and were recruited either to participate in a treatment condition or as no treatment controls. Recruitment was conducted by research staff in small group meetings where study requirements and eligibility criteria were explained. Of the 134 adolescents who were screened, 97 met eligibility criteria for this study. Sixty-nine percent of those meeting eligibility criteria consented to participate. To be included in the project participants had to smoke at least once a week and be between 13 and 18 years of age. Desire to quit smoking was not an inclusion criterion for participants in the present study.

Participants from the sites were approximately 16 years of age ($M = 16.32$, $SD = 1.17$, range = 13–18) and the majority were male (69%). Participants identified themselves as “White” (70%), “Hispanic” (21%), “Asian” (3%), and “Native American” (3%). The majority of participants in the present study met DSM-III-R (APA, 1987) criteria for dependence on alcohol (71%) or marijuana (75%), and 35% met criteria for amphetamine

dependence. Overall, 90% of adolescents in this study met dependence criteria for at least one drug other than alcohol. Participants reported on average 432.5 ($SD = 557.6$) occasions of alcohol use, 585.1 ($SD = 397.0$) occasions of marijuana use, and 188.7 ($SD = 327.3$) times using amphetamines in their lifetime.

Procedure

Informed assent was obtained from participating adolescents, and informed consent for participation was obtained from the adolescents’ parent/legal guardian. Consent and assent were obtained separately and independently for adolescents and parents/legal guardians to avoid any possibility of perceived coercion. Adolescent smokers treated for alcohol and other drug abuse completed a baseline interview that was conducted prior to the onset of smoking treatment and administered by trained research interviewers.

Measures

Demographics

Structured Clinical Interview for Adolescents (Brown, 1987). Background information such as age, ethnicity, and gender was obtained using the Structured Clinical Interview for Adolescents.

Substance Use

Customary Drinking and Drug Use Record (CDDR; Brown, Myers, et al., 1998). The CDDR is a structured interview that assesses alcohol and other drug involvement in four domains: use, withdrawal, psychological/behavioral dependence, and consequences of use. Previous studies suggest the CDDR is both reliable and valid when used with clinical samples of substance abusing youth (Brown, Myers, et al., 1998). Lifetime alcohol and other drug use frequency information from the CDDR was used to describe substance involvement for the present sample.

Cigarette Smoking Characteristics

Time-Line Follow-Back (TLFB; Sobell & Sobell, 1992). The TLFB procedure was adapted for smoking use and was utilized to assess smoking topography (i.e., quantity and frequency) during the 90 days prior to

study intake. To enhance accurate recall of smoking behavior, interviewers used memory cues by reminding participants of the occurrence of significant events or holidays during the past 3 months, and by inquiry into whether any significant events had occurred in their own lives. This information was then entered onto the calendar in order to facilitate memory recall for the temporal topography of smoking behavior. To capture better the topography of adolescent smoking behavior a quantity/frequency index was calculated by multiplying the mean number of cigarettes smoked per smoking day over the past 90 days by the mean number of days smoked per month during the same period. The TLFB is found to have excellent reliability and validity with adult smokers (Brown, Burgess, et al., 1998), and initial reports demonstrate the utility of the TLFB with adolescent alcohol and other drug users (Waldron, 1996).

Nicotine Dependence

Teen Smoking Questionnaire (TSQ; Myers, Brown et al., 2000). The TSQ is a semistructured interview that assesses smoking history (e.g., age at smoking initiation, previous cessation efforts), includes questions regarding motivation for change (e.g., desire for cessation), and incorporates existing measures of tobacco use and nicotine dependence, including the DSM-IV dependence criteria and the mFTQ.

DSM-IV Nicotine Dependence Criteria (APA, 1994). The criteria for nicotine dependence proposed by the DSM-IV were administered as part of a semistructured interview. The diagnostic criteria for nicotine dependence were assessed with 14 items adapted for adolescent cigarette use (see Table I). These items were derived from a previously developed measure with demonstrated validity and reliability for assessment of adolescent alcohol and other drug dependence (the Customary Drinking and Drug Use Record; Brown, Myers, et al., 1998), and amended for tobacco use as appropriate. Adolescents were asked each of the criterion items in succession in specific reference to use of cigarettes and not other forms of tobacco. Responses were scored both on a 5-point Likert scale, ranging from 1 (*never*) to 5 (*most of the time*) and dichotomously (Never or rarely = *no*; sometimes, often, most of the time = *yes*), in accord with DSM-IV practice.

Modified Fagerström Tolerance Questionnaire (mFTQ; Prokhorov et al., 1996). The mFTQ is a seven-item measure that is designed to assess adolescent nicotine dependence and was administered as part of the TSQ interview. This measure was adapted for use with adolescents.

Table I. DSM-IV Nicotine Dependence Interview Items

Question
1. When you smoke your usual amount of cigarettes now, does it give you the same effect as when you began smoking this amount?
2. Do you get dizzy or nauseous when you smoke your usual amount of cigarettes?
3. Do you need more cigarettes to get the same effect as you used to when you started smoking?
4. Do you smoke more cigarettes than usual in the morning after you wake up or after being in a place where you couldn't smoke for a while (e.g., in a class, meetings, etc.)?
5. Do you find that you smoke your cigarette supply faster than you planned (e.g., run out of cigarettes quicker than you thought you would)?
6. Have you wanted or tried to limit, cut down or stop smoking before and not been able to?
7. Do you spend a lot of time getting cigarettes (e.g., going out of your way to a store where you know they will sell to you; trying to find someone who will buy for you)?
8. Do you spend a lot of time smoking cigarettes (e.g., chain smoking; smoking a lot throughout the day)?
9. Have you ever stopped seeing or doing things with certain people because of your cigarette smoking (e.g., have you stopped "hanging out" with certain people because you smoke)?
10. Have you stopped or missed work or changed activities or schedule at work because of your cigarette smoking (e.g., missed work due to an illness related to your smoking or changed your schedule to accommodate your smoking)?
11. Have you stopped or missed school (or classes) or changed your school schedule because of your cigarette smoking (e.g., missed school due to an illness related to your smoking or changed your class schedule to accommodate your smoking)?
12. Have you stopped or cut down on activities like sports, hobbies, recreational activities because of your cigarette smoking (e.g., quit doing sports because smoking made it hard to exercise)?
13. When you smoke your usual amount of cigarettes now, does it give you the same effect as when you began smoking this amount?
14. Have you continued to smoke at times when you were feeling bad (e.g., jittery, anxious, upset stomach) even though cigarettes may have caused it or made it worse)?

Note. Withdrawal symptoms were assessed using a standard DSM-IV format.

The mFTQ has a scoring range of 0–9, with scores of 0–2 reflecting *no nicotine dependence*, scores of 3–5 indicating *moderate nicotine dependence*, and scores of 6–9 indicating *substantial nicotine dependence* (A. V. Prokhorov, personal communication, March 24, 2000). Initial studies demonstrate that the mFTQ has adequate reliability and validity (Prokhorov et al., 1996; Prokhorov, Koehly, Pallonen, & Suchanek Hudmon, 1998).

Smoking Expectancies

Smoking Consequences Questionnaire (SCQ; Brandon & Baker, 1991). Smoking expectancies or

anticipated effects from smoking were assessed using the 50-item SCQ. All participants were asked to complete this measure upon completion of the interview. This self-report measure assesses four factors: negative consequences (e.g., health risks), positive reinforcement/sensory satisfaction (e.g., taste, relaxation), negative reinforcement/negative affect reduction (e.g., reduction of sadness and anxiety), and appetite-weight control. Participants respond to questions using a 10-point Likert scale (0=*completely unlikely*; 9=*completely likely*), with higher scores representing more positive smoking expectancies. The positive and negative reinforcement factor scores were used in the current study.

RESULTS

Smoking Characteristics

Adolescents smoked nearly every day ($M = 26.2$, $SD = 7.5$, range = 1–30) at a rate of just over nine cigarettes per day ($M = 9.2$, $SD = 7.7$, range = 1–36), as shown in Table II. On average, subjects from this sample had their first cigarette when they were 12 years old ($M = 12.0$, $SD = 2.1$, range = 5.7–15.6), progressed to daily smoking in 2.5 years, and had made more than one prior quit attempt ($M = 1.8$, $SD = 3.3$, range = 0–20).

DSM-IV Dependency Criteria

The DSM-IV criteria were conceptualized as a categorical diagnosis and as a sum of the seven criteria. Summary scoring of dependence criteria provides a means of scaling dependence in a continuous fashion, an approach that permits a more direct comparison with mFTQ scale scores. The validity of DSM dependence symptom summary scores has been demonstrated for adolescent alcohol and other drug abuse (Brown, Myers, et al., 1998). Internal consistency of the seven dichotomous DSM-IV items was computed using the Kuder–Richardson 20 (KR20)

Table II. Smoking Intensity and History Among Study Participants ($n = 67$)

Smoking variable	<i>M</i>	<i>SD</i>
Cigarettes/day (past 90 days)	9.2	7.7
Days/month smoked (past 90 days)	26.2	7.5
Age smoked first cigarette	12.0	2.1
Age smoked at least once/week	13.1	2.0
Age smoked at least once/day	13.8	2.0
How long since first cigarette (years)	4.3	2.2
How long a weekly smoker (years)	3.3	2.0
How long a daily smoker (years)	2.5	1.9
Quit attempts (lifetime)	1.8	3.3

coefficient. Results revealed a coefficient of .64. A lower level of internal consistency was observed for these items when scored on a continuous 5-point Likert scale ($\alpha = .53$).

The majority (69%) of adolescents in this sample reported smoking 10 or fewer cigarettes per day; yet, 85% met DSM-IV criteria for nicotine dependence. Of the 85% who met the DSM-IV criteria, the vast majority (79%) also met the diagnosis with physiological dependence. Additionally, 43% of this sample endorsed at least six of the seven dependency criteria. All DSM-IV symptoms were endorsed by a majority of the subjects, as shown in Table III.

Construct validity of the DSM-IV assessment and of the mFTQ was examined in relation to five variables representing the domains of nicotine dependence. The sum of the endorsed DSM-IV symptoms was examined in relation to the smoking quantity/frequency index (compulsive use), years since first smoked a cigarette (repeated exposure to nicotine), self-reported ratings of desire to quit smoking (ambivalence), and scores on the positive and negative reinforcement scales of the SCQ (representing the domains of positive reinforcement and management of negative affect, respectively). The sum of symptoms rather than a categorical approach (dependence/no dependence) was examined due to the disparity in dependence

Table III. Proportion of Subjects Meeting Each DSM-IV Dependency Criterion

DSM-IV criteria for nicotine dependence	Percent of sample meeting criterion
Tolerance	72
Withdrawal	51
Substance taken in larger amounts/over a longer period of time	79
Persistent desire/unsuccessful efforts to cut down or control use	61
Great deal of time spent in activities necessary to obtain/use cigarettes	63
Important social, occupational, or recreational activities given up	52
Continued use despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused by cigarettes	78

Table IV. Proportion of Subjects That Endorsed Each mFTQ Item

mFTQ item	Percent of sample
How many cigarettes a day do you smoke?	81% smoked 1–15 cigarettes per day
Do you inhale?	96% always inhale
How soon after you wake up do you smoke your first cigarette?	54% smoke within 30 min of waking
Which cigarette would you hate to give up?	45% reported first cigarette in the morning
Do you find it difficult to refrain from smoking in places where it is forbidden?	69% reported finding it not difficult
Do you smoke if you are so ill that you are in bed most of the day?	67% reported that they do not
Do you smoke more during the first 2 hr than during the rest of the day?	22% reported smoking more in the first 2 hr of the day

classification groupings and small sample size. Spearman correlations revealed a significant but modest relationship between dependence symptoms and the SCQ negative reinforcement scale ($r = .34$, $p < .05$). However, non-significant relationships were obtained between sum of dependence symptoms and smoking quantity/frequency ($r = .11$, $p = .38$), years since first cigarette ($r = .10$, $p = .44$), desire to quit ($r = .15$, $p = .22$), and sensory satisfaction/positive reinforcement ($r = .23$, $p = .08$). Thus, of the five domains of nicotine dependence examined, a significant relationship was obtained only between the negative reinforcement expectancies and nicotine dependence criteria.

mFTQ Criteria

Internal consistency of the mFTQ was examined in the present sample. Because of the differential scaling of items on this measure, items were standardized prior to assessing internal consistency. Subsequent analysis revealed a Chronbach's alpha coefficient of .55, indicating poor internal consistency. Examination of the individual item–total correlations revealed that the question, “Do you inhale?” appeared to attenuate consistent measurement of this construct (alpha if item deleted = .64). As such, this item was deleted from the summary score used in subsequent analyses. The coefficient alphas obtained from the current adolescent sample was smaller than obtained in other studies using the mFTQ ($\alpha = .75$, Prokhorov et al., 1996; $\alpha = .81$, Prokhorov et al., 1998).

Sixty percent of subjects met criteria for moderate dependence as assessed by the mFTQ. Only a small proportion (18%) received a score of 6 or more, representing substantial nicotine dependence. Over one fifth of the sample (22%) was classified as having “no dependence.” In contrast to findings for the DSM-IV criteria, where most of the endorsed items showed a similar pattern of response to those observed in adult smokers, most of the items on the mFTQ showed a different response pattern when compared to adult smokers (e.g., Heatherton, Kozlowski,

Frecker, & Fagerström, 1991). For example, only 22% reported smoking more in the first 2 h of the day than during the rest of the day (see Table IV).

Construct validity was assessed by examining the relationships between the mFTQ summary score and the five domains of nicotine dependence. To avoid confounding the analysis between the smoking quantity/frequency and the mFTQ score, the smoking quantity item was excluded for this analysis (Prokhorov et al., 1998). Higher quantity/frequency index scores were significantly related to the mFTQ total score ($r = .30$, $p = .013$). In addition, the mFTQ scale scores were significantly related with years since first smoked ($r = .35$, $p = .003$). Nonsignificant relationships, however, were obtained between the mFTQ and desire to quit ($r = -.22$, $p = .07$), sensory satisfaction/positive reinforcement ($r = .13$, $p = .35$), and negative affect reduction ($r = .14$, $p = .31$).

Comparison of the DSM-IV and mFTQ

The intercorrelation of DSM-IV and mFTQ was assessed to examine the convergence of these two measures of nicotine dependence. The observed biserial correlation between a DSM-IV nicotine dependence diagnosis and the dependence categories on the mFTQ was low ($r = .24$). Examination of the continuous measures (i.e., sum of DSM-IV symptoms endorsed and mFTQ score) revealed a similarly low Spearman correlation ($r = .22$). A similar lack of convergence emerged when comparing categorical classification of nicotine dependence. Of 15 individuals classified as “not dependent” based on mFTQ score, 11 (73%) met DSM-IV diagnostic criteria for nicotine dependence. Interestingly, the degree of colinearity worsened rather than improved when examining only those individuals ($n = 53$) who met a DSM-IV diagnosis with the specifier “with physiological dependence.” This is contrary to what should have been observed given that both of these measures are intended to measure physical dependence. Of 15 individuals classified as “not dependent” based on the mFTQ score, 12 (80%) met diagnostic

Table V. Convergent Validity of DSM-IV (With Physiological Dependence) and mFTQ Nicotine Dependence Classification

DSM-IV dependence classification with physiological dependence	mFTQ dependence classification		
	Not dependent	Dependent (moderate or substantial)	Total
Not dependent	40% (4)	60% (6)	100% (10)
Dependent	19% (11)	81% (46)	100% (57)
Total	22% (15)	78% (52)	100% (67)

Note. Of the 67 individuals who participated in this study, 57 met diagnostic criteria for DSM-IV nicotine dependence. Forty-five of the 57 individuals who met diagnostic criteria for DSM-IV nicotine dependence also met the criteria for the specifier "with physiological dependence." The numbers in parentheses represent the number of individuals in each cell.

criteria for DSM-IV nicotine dependence with physiological dependence. This low degree of colinearity is evident in Table V.

DISCUSSION

This preliminary study examined the construct validity of the DSM-IV nicotine dependence criteria and the mFTQ and compared the DSM-IV diagnostic criteria for nicotine dependence to the mFTQ in a heavy smoking sample of substance abusing adolescents. Both the DSM-IV diagnostic criteria for nicotine dependence and the mFTQ showed low internal consistency and few significant relationships with variables representing domains within the nicotine dependence construct. In addition, summary data from these measures demonstrated little convergence with one another. Results indicate that existing methods for measuring nicotine dependence among substance abusing youth yield divergent results and demonstrate limited association with smoking behavior, cognitions and history in the present sample, suggesting limited internal validity. Thus, findings stand in contrast with those obtained in adult smokers and highlight the importance of developing adolescent-specific measures of nicotine dependence. As observed by others (e.g., Colby et al., 2000a), problems in the measurement of adolescent nicotine dependence reflect the limited understanding of and the lack of consensus regarding a definition of this construct.

The low internal consistency observed in this study for both the dichotomous and continuously measured DSM-IV nicotine dependence criteria is consistent with prior research in young adult smokers showing that the DSM construct is represented better by two factors than

a single, general dependence factor (Johnson, Breslau, & Anthony, 1996). The high rate of DSM-IV dependence observed in the present study (85%) is surprising given that half of the adolescents in the current study reported smoking less than seven cigarettes per day. Despite the high rate of dependence diagnoses, little support was obtained for construct validity of this measure. The only significant relationship with the nicotine dependence construct was observed between symptoms of nicotine dependence and negative affect reduction. The limited correspondence between diagnostic classification and the validation variables suggests that the diagnostic criteria do not adequately assess characteristics of nicotine dependence in the present adolescent sample. These results are, however, consistent with previous research indicating that the initial symptoms of nicotine dependence may appear relatively soon following initiation of smoking (DiFranza et al., 2000). Future studies with prospective data are required to evaluate further the accuracy and usefulness of this diagnostic classification.

As with the DSM-IV, the mFTQ scale also showed low internal consistency, a finding that contrasts with previous research for this measure (Prokhorov et al., 1996). Consistent with prior reports (Prokhorov et al., 1996), the present study found that the mFTQ correlated with duration and intensity (quantity/frequency) of smoking, providing support for construct validity. However, no significant relationships were found between the mFTQ scale and the other variables employed to assess the nicotine dependence construct. Differences between this and previous investigations of the mFTQ may reflect the disparate samples examined. The present findings suggest that the mFTQ captures some behavioral aspects of nicotine dependence but does not assess other dimensions of the construct (e.g., Shadel et al., 2000). This interpretation is consistent with the work of Prokhorov et al. (1996) who found the mFTQ to consist of a single factor and thus would not be expected to reflect the multidimensional nature of the nicotine dependence construct.

As with previous studies (Prokhorov et al., 1996), adolescents in the present sample exhibited a different pattern of responses to mFTQ items than those typically reported by adult smokers. Although several individual mFTQ items showed similar patterns of response between the current sample and from adults not currently in treatment for substance abuse (e.g., Heatherington et al., 1991), findings were consonant with those of Prokhorov et al. (1996) in that substantial differences were observed in the number of cigarettes smoked, smoking within the first 30 min after waking, and smoking when ill. Although the mFTQ scoring was amended specifically to consider

adolescent smoking topography, further refinement may improve the utility of this measure. In particular, the original FTQ content retained in the mFTQ may not assess optimally adolescent-specific behavioral indicators of nicotine dependence. For example, the mFTQ item that addresses difficulty refraining in situations where smoking is prohibited was endorsed by only 31% of adolescent subjects. Adolescents may have little difficulty abstaining in situations where smoking is prohibited both because of lower smoking frequency and because they may be subject to more smoking restrictions than adults (and therefore are “trained” not to smoke in many situations). Similarly, only 33% of adolescents reported smoking when ill. It may be that adolescents do not have the opportunity to smoke when ill because of such issues as parental censure or access to cigarettes. Thus, differences observed in item endorsement between adults and adolescents may be more reflective of developmental factors than nicotine dependence per se. These possibilities highlight the need for development of adolescent-derived measures of nicotine dependence.

Little convergence was observed between DSM-IV diagnostic criteria and the mFTQ. Although the majority of the current sample met DSM-IV diagnostic criteria for dependence, the extent of nicotine dependence as assessed by the mFTQ was quite low. However, no significant relationship emerged between mFTQ scores and the sum of DSM-IV dependence criteria. Further, of 15 individuals classified as having no dependence based on mFTQ scores, 11 met DSM-IV criteria with physiological dependence. Thus, there appears to be limited overlap between DSM-IV and mFTQ assessment of nicotine dependence, whether examined as continuous scores or categorically. Unfortunately, the present data do not permit conclusions regarding the relative utility of these two measures. However, the correlation between mFTQ scores and smoking quantity/frequency is consistent with previous findings and suggests this measure does reflect behavioral aspects of smoking.

The present study was preliminary in nature and as such, results are considered in the light of several limitations. The small size and unique nature of the present sample (adolescents treated for substance abuse) may limit generalizability of the present findings. However, given recent attention to the issue of smoking among substance abusing adolescents (e.g., Myers, 1999; Myers et al., 2000), study findings may prove useful for informing assessment strategies in the context of smoking cessation treatment for such youth. In addition, the inclusion of relatively heavy smoking adolescents may have restricted the range of variables of interest. However, this would not explain the lack of convergence between the

two measures. Further, the five variables examined may not address all potential aspects of nicotine dependence, and as such the variables employed may not have adequately captured all the features of the construct. However, the limited relationships obtained suggest that neither the DSM-IV nor mFTQ represents a broad assessment of adolescent nicotine dependence. This finding is surprising in the case of the DSM-IV criteria that are based on a broad definition of dependence. With regard to the mFTQ, this finding is not unexpected given the unidimensional (e.g., physical aspects) nature of the measure. Also, studies with larger samples are needed to examine in more detail the psychometric characteristics of these measures (e.g., factor structure) and the contribution of individual items (e.g., Item Response Theory). Finally, the cross-sectional nature of the study limits conclusions regarding the clinical utility of the measures examined. Prospective studies are necessary to determine the extent to which these approaches to assessment of adolescent nicotine dependence predict future smoking behaviors.

In conclusion, results of the present study highlight the difficulties of measuring nicotine dependence among substance abusing adolescents, and perhaps adolescents more generally. The limited evidence for construct validity and convergence of the measures examined caution against the adoption of adult-derived measures for use with these adolescents. Some of the weaknesses observed in these measures likely reflect uncertainties and high variability in the nature of adolescent smoking behaviors and nicotine dependence. In addition, future measure development would benefit from inclusion of item content that is relevant to and consistent with adolescent experience. Finally, the present results suggest that findings based on DSM-IV and mFTQ assessment of adolescent nicotine dependence be interpreted with caution.

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