

# On the Measurement of Nicotine Dependence in Adolescence: Comparisons of the mFTQ and a DSM-IV–Based Scale

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**Objective** To compare nicotine-dependent smokers identified by the modified Fagerström Tolerance Questionnaire (mFTQ) and a scale based on the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV), in a multiethnic adolescent sample. **Methods** A school survey was conducted on 6th- to 10th-grade students ( $N = 15,007$ ) in a large urban public school system. **Results** The two scales formed two distinct factors. The concordance between the two classifications of nicotine dependence was low. The DSM identified a much larger number of nicotine-dependent smokers than the mFTQ, mostly because smokers met dependence criteria at much lower levels of cigarettes consumed, especially when they were depressed. Rates of dependence were higher among whites than minority-group members, especially African Americans. Control for level of cigarette consumption attenuated or eliminated ethnic differences. **Conclusions** This investigation provides some understanding of youths defined as dependent by each scale but cannot by itself indicate which scale better measures dependence. Differences in dependence rates among ethnic groups are accounted for mostly by quantity of cigarettes smoked.

**Key words** adolescence; nicotine dependence; mFTQ; DSM-IV nicotine dependence; depressive symptoms; ethnicity.

The measurement of nicotine dependence, in particular among adolescents, is a major unresolved issue in the field of tobacco research (Colby, Tiffany, Shiffman, & Niaura, 2000). Of the five instruments currently available, two have been used frequently. These include instruments based on the definitions in the *Diagnostic and Statistical Manual of Mental Disorders*, third (revised) or fourth edition (DSM-III-R or DSM-IV) of the American Psychiatric Association ([APA] 1987, 1994; Anthony, Warner, & Kessler, 1994; Breslau, Fenn, & Peterson, 1993; Breslau, Johnson, Hiripi, & Kessler, 2001; Breslau, Kilbey, & Andreski, 1994; Kandel & Chen, 2000; Nelson & Wittchen, 1998) and alternate versions of the Fagerström

Tolerance Questionnaire (FTQ) (Fagerström & Schneider, 1989), revised as the Fagerström Test for Nicotine Dependence (FTND) (Heatherton, Kozlowski, Frecker, & Fagerström, 1991). Adolescent versions of the instruments have been developed for nonclinical settings for the DSM (Harrison, Fulkerson, & Beebe, 1998; Clark, Niaura, Abrams, & Colby, n.d.; Clemente Jiménez et al., 2003) and the modified Fagerström (mFTQ) (Prokhorov et al., 2001; Prokhorov, Koehly, Pallonen, & Hudmon, 1998; Rojas, Killen, Haydel, & Robinson, 1998). More recent instruments are the Nicotine Dependence Syndrome Scale (NDSS) (SAMHSA, 2002; Shiffman, Waters, & Hickcox, 2004), the Hooked on Nicotine

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Checklist (HONC) (DiFranza et al., 2000; O'Loughlin et al., 2003), and the Wisconsin Inventory of Smoking Dependence Motives (WISDM-68) (Piper et al., 2002). Each instrument appears to measure unique as well as common characteristics of dependence. The 6-item Fagerström emphasizes behavioral aspects of dependence, such as length of time to first cigarette of the day and number of cigarettes smoked per day, although it may also indirectly tap into psychological aspects of tobacco dependence (Dijkstra & Tromp, 2002). The 7-criteria DSM measures the physiological symptoms of tolerance and withdrawal, as well as the physical and psychological consequences of tobacco use; the HONC includes 10 items designed to measure loss of "full autonomy over tobacco use"; the NDSS measures five factors: drive, priority, tolerance, stereotypy, and continuity. The latest version, applicable to both adults and adolescents, includes 19 items. The 68-item WISDM-68, targeted to adults, contains 13 subscales to measure distinct motives for tobacco use, including cognitive enhancement, tolerance, loss of control, and craving. The HONC is the only instrument specifically developed for adolescents.

Scales of nicotine dependence may serve different purposes, from identifying individuals suitable for treatment to identifying cases in epidemiological investigations. There are important differences in the desired properties of instruments designed for clinical purposes and for epidemiological studies. Instruments in clinical settings require optimal prognostic performance (for predicting response to treatment and relapses). Epidemiological investigations, on the other hand, estimate proportions of a phenomenon of interest for descriptive and analytical purposes. Clinicians and researchers alike may ask which scale is the most appropriate. Except for Hughes, Gust, and Pechacek (1987), the various scales have been compared only very recently. For the most part, these comparisons have focused on the DSM and the original FTQ or FTND among young adults in the general population (Breslau & Johnson, 2000) and clinical samples of adult smokers (Marks, Pomerleau, & Pomerleau, 1998; Moolchan et al., 2002) or adolescent smokers (Cohen, Myers, & Kelly, 2002) comorbid for other substance use disorders. The concordance on dependence identified by the two scales is uniformly low ( $\kappa$  about .2), a conclusion reached earlier by Hughes et al. (1987). Breslau and Johnson (2000) concluded that "the common feature shared by both classification systems is tolerance, measured by number of cigarettes smoked" (p. 1124). These authors found that the DSM better predicted depressive episodes, while the FTND better predicted cessation of smoking.

The major aim of this article is to gain an understanding of the nature of the two scales and of the adolescent smokers identified as dependent by each. In particular, we explore the role of extensiveness of smoking and depression in scale-specific definitions of dependence. A secondary aim is to examine how the scales perform in different adolescent subgroups—in particular, different racial/ethnic groups.

## Methods

### Sample and Data Collection

As part of a prospective longitudinal investigation of the transition from experimental smoking to nicotine dependence, we implemented a two-stage research design to select equal numbers of adolescents among the three major ethnic groups: non-Hispanic whites, non-Hispanic African Americans, and Hispanics. First we surveyed 6th to 10th graders ( $N = 15,763$ ) sampled from 43 middle and senior high schools in the Chicago Public Schools (CPS) during January–May 2003. The enrollment in the grades sampled was 10.1% white, 51.9% African American, 34.6% Hispanic, 3.3% Asian, and 0.2% other. Excluded were largely Hispanic high schools, which included 64.0% of the Hispanic enrollment in these five grades, and certain nontraditional schools. Schools with large numbers of non-Hispanic white students were oversampled to provide an approximately balanced sample of the three race/ethnicity groups. Passive parental consent was obtained. All procedures for obtaining parental consent and youth assent were approved by the institutional review boards of the New York State Psychiatric Institute and Columbia University. The completion rate for the survey was 83.1%; 8.2% of students were absent, 7.1% represented parental or child refusals, and 1.6% were unaccounted for. The grade distribution was 18.9% 6th grade, 17.3% 7th grade, 18.9% 8th grade, 22.8% 9th grade, and 20.6% 10th grade; 1.6% were ungraded or missing grade; 47.8% were male, 52.0% female; 0.2% were missing gender. The ethnic distribution was 24.4% non-Hispanic white, 27.3% non-Hispanic African American, 38.8% Hispanic, 6.4% Asian, and 1.6% other; 1.6% were missing ethnicity. The aggregated unweighted sample is not representative of 6th to 10th graders in the CPS.

Students answered a 20-minute self-administered questionnaire. The instrument included items smoking and depressive symptoms (Gadow et al., 2002) and two measures of nicotine dependence: the 7-item mFTQ, an adolescent version of the FTQ (Prokhorov et al., 1998), and a slightly revised version of the 14-item DSM scale developed by Clark et al. (n.d.). Adapted from the

Composite International Diagnostic Interview (World Health Organization, 1997), the scale measures the seven DSM-IV dependence criteria (APA, 1994). An item about craving, which is not part of the DSM-IV nosology, was also included.

### **Measurement of Nicotine Dependence**

The original mFTQ scale queries symptoms of dependence related to current smoking of cigarettes. In order to identify youths who had ever experienced any of the dependence symptoms and to obtain a measure of lifetime dependence, the scale was revised to make it possible for students who had not smoked within the last 30 days to report symptoms for the most recent month that they smoked (Appendix A). The response categories to the questions about number of cigarettes smoked daily and time to first cigarette of the day were more detailed than in the original mFTQ but were coded as per the mFTQ. The 14-item DSM scale asked for symptoms ever experienced with the use of any tobacco product (Appendix B) to assess the seven dependence DSM criteria. The clustering of symptoms over a specific time period was not ascertained. Respondents were given the option of specifying that they “never smoked or only smoked once or twice” (in answer to the mFTQ) or “never used tobacco or only used once or twice” (in answer to the DSM) for each question. Those who endorsed these responses were scored as not having experienced the symptom. A higher proportion chose the category “never smoked/never used tobacco or only smoked/only used tobacco once or twice” in answer to the mFTQ than the DSM items (Galanti, Kandel, Schaffran, Post, & Griesler, 2004). Thus, 55.0% of all lifetime smokers gave that answer to the mFTQ questions about “which cigarette is hardest to give up” and 54.0% did so in answer to “smoked more during the first two hours of the day.” By contrast, the highest proportion of such answers in response to the DSM items was 40.0%. Youths who had used cigarettes were retained in the analysis of the DSM to permit comparison with the mFTQ. A youth was defined as dependent when the score was 4 on the mFTQ, the midpoint of moderate dependence (Prokhorov et al., 2001), or when 3 or more out of the 7 criteria on the DSM-IV–based measure were endorsed.

A four-category variable was created that jointly classified smokers on both scales, i.e., uniquely positive on one scale, positive on both, or positive on neither.

### **Measurement of Other Covariates**

*Quantity smoked* was based on a question that asked respondents how many cigarettes they had smoked daily

in the last 30 days or the last month in which they had smoked. The precoded eight-categories responses included: smoked only once or twice, less than 1 cigarette, 1 cigarette, 2–5 cigarettes, 6–15, 16–25, 26–35, and 36+ cigarettes. A continuous version was created by taking the midpoint of each category: 0.0, 0.5, 1.0, 3.5, 10.5, 20.5, 30.5, 40.0. A logged version was used in the multivariate models to reduce the skewness of the distribution.

*The depression scale* (Gadow et al., 2002) measures DSM-IV criteria for major depressive disorder and dysthymia (APA, 1994). The item about suicide ideation was removed from the 13-item scale because of human subject concerns (see Appendix C). For each item, youths rated their behavior or feelings in the last 30 days on a 4-point scale (0 = never, 1 = sometimes, 2 = often, 3 = very often). A continuous score of each youth's mean depression symptoms was created (range, 0–3).

### **Analyses**

The analytical sample consisted of 15,007 students. Excluded ( $N = 756$ ) were students without valid data for gender ( $n = 25$ ), ethnicity ( $n = 244$ ), grade in school ( $n = 244$ ), or lifetime cigarette use ( $n = 521$ ); some adolescents were missing data on multiple characteristics. The analyses of patterns of cigarette use and nicotine dependence were restricted to 3,901 lifetime cigarette smokers, who represented 93.6% of lifetime tobacco users. Asians and others were combined in the analyses.

Several statistical procedures were implemented to assess the structure of the two scales and their association. Principal-component factor analyses were implemented with the DSM criteria and mFTQ items. Unrotated solutions were obtained for each scale separately and simultaneously. An eigenvalue greater than 1 was used to determine the number of factors. Descriptive and multivariate analyses were conducted to assess the rates and correlates of dependence. Logistic regression models were estimated to predict dependence on each scale. In addition, a multinomial logistic regression model identified correlates of each dependence measure in a single model. The joint distribution of DSM and mFTQ dependence was regressed on number of cigarettes smoked, depression, the product interaction between number of cigarettes smoked and depression, and other control variables (gender, grade in school, and race/ethnicity). The four categories of the cross-classification of DSM and mFTQ dependence defined the categories of the multinomial. Adolescents who were dependent only on the mFTQ were identified as the reference category. We were interested primarily in the relationship between the

prevalence of each measure of dependence and the predictor variables. As the prevalence estimates are not a linear combination of the parametric estimates in the logistic model, we characterized the relationships by inspecting the model-based predicted values of each dependence measure for low (2.5 cigarettes per day) and high (12.5 cigarettes per day) cigarette use, as well as for low (50th percentile) and high (90th percentile) depression. The interaction between cigarette use and depression was characterized by describing the relationship between dependence and depression at different levels of cigarette use. The analyses were unweighted, since the weights would cause volatility in the estimates.

## Results

### Rates of Smoking Behaviors

Twenty-six percent of students had ever smoked cigarettes. The rates increased from 12.3% in 6th grade to 19.8% in 7th to 30.0% in 8th, and stabilized thereafter to 30.5% in 9th and 34.8% in 10th grade. These youths were light smokers. Half (51.0%) of the lifetime smokers smoked only 1 or 2 days; 21.7% smoked 3–9 days; 14.6% smoked 10–99 days; and 12.7% smoked at least 100 days. Among those who smoked more than once or twice, only 9.9% smoked 6 or more cigarettes per day in the most current month that they smoked (3.9% smoked 16 or more cigarettes per day); 32.1% smoked less than a whole cigarette a day; 24.9% smoked a whole cigarette; 33.1% smoked between 2 to 5 cigarettes per day.

### Scale Characteristics and Association

In separate principal-components factor analyses, the symptoms from each scale loaded on a single factor, which accounted for 50.0% of the variance in the DSM and 38.0% in the mFTQ. When all symptoms were factor analyzed, a clear two-factor solution emerged: Factor 1, composed of all the DSM criteria and mFTQ items, and

Factor 2, composed of 5 of the 6 mFTQ items. Factor 1 explained 37.0% of the variance and Factor 2 10.0%. The factor loadings ranged from .50 to .73 for 12 items, with 2 items loading at .35 and .38. On Factor 2, the loadings of 5 mFTQ items ranged from .37 to .48; 1 item did not load (refraining from smoking where it is forbidden), and 1 item (how often inhale) loaded negatively (–.25); the loadings for 6 of the 7 DSM criteria were all negative (ranging from –.08 to –.36). Neglecting activities because of smoking did not load. The internal reliabilities of the scales, composed of 7 DSM criteria and 7 mFTQ items, were slightly higher for the DSM ( $\alpha = .83$ ) than the mFTQ ( $\alpha = .72$ ), as were the mean item-total correlation (DSM = .58, mFTQ = .43) and mean inter-item correlation (DSM = .41, mFTQ = .26). The correlation between the two continuous scales was higher than their concordance as dichotomous measures of dependence (Pearson  $r = .67$ , kappa = .34 among lifetime smokers, and .56 and .29, respectively, among last-30-days smokers).

### Prevalence of Dependence

The rates of dependence among lifetime smokers were approximately three times higher on the DSM than on the mFTQ (DSM = 23.9%, mFTQ = 8.6%). The differences were relatively greater among lifetime smokers than current daily smokers, defined as smoking at least 20 of the last 30 days. Among daily smokers, 86.8% were dependent according to the DSM and 62.6% according to the mFTQ.

Rates of dependence increased as the daily number of cigarettes smoked increased, and were uniformly higher on the DSM than on the mFTQ (Table I). Very few youths who smoked fewer than 2–5 cigarettes per day met criteria for dependence on the mFTQ. By contrast, almost a third of those who smoked only 1 cigarette per day met DSM criteria; 60.0% did so among those who consumed between 2 to 5 cigarettes per day. The differences bet-

**Table I.** Rates of DSM and mFTQ Dependence by Number of Cigarettes Smoked per Day Last 30 Days/Last Month Smoked Among Lifetime Smokers (6th–10th Graders)

Dependence Among Lifetime Smokers <sup>a</sup>	Number of Cigarettes Smoked per Day, %						Total
	DNA <sup>b</sup>	<1	1	2–5	6–15	16+	
DSM dependent	4.3	17.3	31.0	60.0	81.4	84.4	24.1
Total N	(1688)	(623)	(471)	(638)	(118)	(77)	(3615)
mFTQ dependent	0.3	4.5	4.6	18.9	58.5	84.8	8.6
Total N	(1724)	(644)	(497)	(668)	(118)	(79)	(3730)
Ratio DSM/mFTQ	10.8	3.8	6.7	3.2	1.4	0.99	2.8

DSM-IV = *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed.; mFTQ = modified Fagerström Tolerance Questionnaire.

<sup>a</sup>Difference in rates for DSM and mFTQ dependence at each category significant at  $p < .001$  except for 16+ cigarettes (McNemar's test).

<sup>b</sup>Does not apply: Eversmoked 1–2 times.

ween the two scales disappeared at daily consumption of 16 cigarettes and over. Surprisingly, some (4.3%) lifetime smokers who smoked only once or twice met DSM criteria.

The cross-tabulation of the two scales revealed that very few lifetime smokers were positive on the mFTQ but negative on the DSM (1.7%), whereas many youths were positive on the DSM but negative on the mFTQ (17.2%); 6.9% were classified as dependent according to both DSM and mFTQ criteria, and 74.2% were dependent on neither.

### Types of Symptoms Endorsed

Each symptom was examined among five groups: those classified as dependent on each scale and the three subgroups identified by the joint distribution of each scale, i.e., dependent on both scales, dependent on the DSM only, or dependent on the mFTQ only (Table II). The craving item was examined although it is not a DSM criterion.

Three DSM symptoms were endorsed more than any other DSM or mFTQ symptom by the overwhelming majority of dependent smokers on each scale: tolerance, withdrawal, and impaired control. However, a much higher proportion of the mFTQ than DSM dependents endorsed each mFTQ item. On five of the seven items, this proportion was at least twice as high among the former than the latter group. Smokers positive on the three DSM symptoms captured 64.0% of all those who were DSM dependent and 58.9% of those mFTQ dependent.

The cross-classification of dependence on each scale further refined these patterns of response. With three exceptions, a higher percentage of youths who met criteria on both scales rather than on a single one endorsed the dependence symptoms and the craving item. The three exceptions reflected the urgency of smoking upon waking, the first cigarette in the morning being the hardest to give up, and smoking during the first 2 hours

**Table II.** Prevalence of DSM and mFTQ Symptoms Among Those Defined as Dependent on Each Scale and by Combined mFTQ/DSM Dependence Among Lifetime Cigarette Smokers (6th–10th Graders)

Symptoms Endorsed	All mFTQ, %	All DSM, %	Pattern of Dependence		
			mFTQ = 1, DSM = 0, %	mFTQ = 0, DSM = 1, %	mFTQ = 1, DSM = 1, %
<b>DSM criteria</b>					
Tolerance	81.7	86.4	41.1	84.7	90.6
Withdrawal	80.0	86.9	27.8	85.1	91.2
Impaired control	81.1	88.5	25.0	86.8	92.3
Unsuccessful attempts to quit	61.2	55.2	5.3	47.6	74.0
Great deal of time spent using	47.9	41.7	5.1	35.1	58.1
Neglect important activities	36.7	29.7	1.7	23.6	45.1
Use despite problems	47.6	41.7	3.6	35.5	57.7
Craving	60.4	52.1	20.0	45.0	70.2
<b>mFTQ symptoms</b>					
How soon smokes after waking up in the morning					
Within 30 minutes	65.7	23.5	68.3	6.1	65.9
How difficult not to smoke where it is forbidden					
Very/somewhat difficult	70.8	39.4	66.7	26.6	70.8
Which cigarette hardest to give up					
First in the morning	53.5	20.3	59.3	6.9	52.4
Number cigarettes smoked per day on days smoked					
6–15	21.6	11.0	18.3	6.5	22.4
16–25	10.3	3.8	10.0	1.1	10.4
26+	10.7	3.7	6.7	.3	12.0
Smokes more during first 2 hours of the day	38.8	15.3	50.0	6.8	35.9
Smokes if ill in bed most of the day					
Always/quite often	58.7	21.1	46.7	4.7	61.4
How often inhale					
Always	79.9	54.1	68.3	42.8	82.8
Total N ≥	(296)	(839)	(52)	(592)	(241)

DSM-IV = *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed.; mFTQ = modified Fagerström Tolerance Questionnaire.



of the day. The mFTQ items received the lowest endorsement of those who were dependent exclusively according to the DSM. Only 6.1% of this group reported smoking within the first 30 minutes of waking compared with 68.3% of those who were dependent only on the mFTQ. The overwhelming majority of those dependent on the DSM and mFTQ or only on the DSM, but only a minority of those classified as dependent only on the mFTQ, experienced tolerance, withdrawal, and impaired control. The mFTQ item on number of cigarettes smoked daily was most informative. Those who were positive on only one scale, but especially the DSM, were much lighter smokers than any other group. Only 1.4% of those who were positive on only the DSM and 16.7% of those positive on only the mFTQ reported that they smoked at least three quarters of a pack of cigarettes (16 or more) per day compared with 22.4% of those positive on both scales. (The last two percentages are not statistically different.)

### Multivariate Models

Logistic regressions were estimated to assess the association of frequency of daily smoking and depression with dependence on each scale. Gender, grade in school, and race/ethnicity were included as control variables (Table III). A multinomial logistic regression was estimated to assess the association of covariates with mutually exclusive patterns of dependence defined by the joint distribution of the two dependence scales. Interaction terms between frequency of consumption and each covariate were also estimated. It was not possible with existing

programs to estimate simultaneously the marginals and the joint patterns; effects on the marginals (prevalences) were obtained by summing over predicted frequencies in the joint table.

Daily quantity smoked was by far the strongest covariate of dependence for each scale. (The same association remained when quantity smoked was removed from the mFTQ and an ordinary least square regression was estimated on a continuous score based on the remaining five items.) Depressive symptoms were associated with dependence, even after controlling for other covariates for each scale.

The mFTQ and DSM dependence scales are correlated. Thus, to specify the relationship of amount smoked daily and depression with the prevalences of each scale, a multinomial regression estimated the effects of each covariate on the joint distribution of the two scales (Table IV). Three parameters were estimated. These included the odds ratio for being mFTQ dependent only compared with the odds for being: (1) dependent on DSM only, (2) dependent on both scales, (3) not dependent on either scale. Adolescents who were mFTQ but not DSM dependent were the reference category to test the difference in the direct effects of each covariate on the difference in prevalence of the two measures of dependence. Adjusted effects of daily quantity smoked and depression were highly significant.

The interaction between number of cigarettes smoked and depression was significant for each of the three parameters in the multinomial logistic regression. For adolescents smoking few cigarettes per day (2.5 as

**Table III.** Logistic Regressions Predicting DSM-IV and mFTQ Dependence Among Lifetime Smokers (6th–10th Graders) ( $N \geq 3422$ )

Predictors	DSM Dependence		mFTQ Dependence	
	UOR (CI)	AOR (CI)	UOR (CI)	AOR (CI)
Daily quantity smoked <sup>a</sup>	5.3*** (4.7–6.1)	5.7*** (4.9–6.6)	6.0*** (5.1–7.0)	6.2*** (5.2–7.4)
Depressive symptoms	2.4*** (2.1–2.7)	2.4*** (2.0–2.8)	2.1*** (1.8–2.5)	1.6*** (1.3–2.0)
Race/ethnicity (vs. white)				
African American	0.5*** (0.4–0.6)	0.7* (0.5–0.9)	0.5*** (0.4–0.7)	0.9 (0.6–1.5)
Hispanic	0.8* (0.7–0.9)	1.1 (0.9–1.4)	0.6*** (0.5–0.8)	0.8 (0.5–1.1)
Other	0.8 (0.6–1.2)	0.9 (0.6–1.4)	0.8 (0.5–1.3)	0.8 (0.4–1.6)
Gender (vs. male)				
Female	1.1 (0.9–1.2)	1.1 (0.9–1.3)	0.7*** (0.5–0.8)	0.8 (0.6–1.2)
Grade in school (vs. 6th)				
7th	0.8 (0.6–1.1)	0.8 (0.5–1.2)	0.7 (0.4–1.2)	1.0 (0.5–2.0)
8th	1.1 (0.8–1.6)	0.9 (0.6–1.4)	0.9 (0.6–1.5)	0.7 (0.4–1.4)
9th	1.1 (0.8–1.4)	0.7 (0.5–1.0)	1.3 (0.8–2.1)	1.1 (0.6–2.2)
10th	1.4* (1.0–1.8)	0.8 (0.5–1.1)	1.4 (0.9–2.2)	0.9 (0.5–1.8)

DSM-IV = *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed.; mFTQ = modified Fagerström Tolerance Questionnaire; UOR = unadjusted odds ratio; AOR = adjusted odds ratio.

<sup>a</sup>Logarithm of continuous variable coded at midpoint value of each category.

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

**Table IV.** Multinomial Logistic Regression Predicting Unique and Joint Dependence on the DSM-IV and mFTQ Scales Among Lifetime Smokers (6th–10th Graders) (*N* = 3396)<sup>a</sup>

	Unadjusted Model						Adjusted Model					
	DSM Only		mFTQ & DSM		Not Dependent		DSM Only		mFTQ & DSM		Not Dependent	
Predictors	UOR	(CI)	UOR	(CI)	UOR	(CI)	AOR	(CI)	AOR	(CI)	AOR	(CI)
Daily quantity smoked <sup>b</sup>	0.5***	(0.4–0.7)	1.5**	(1.1–2.0)	0.09***	(0.07–0.12)	0.8	(0.5–1.3)	2.2***	(1.4–3.6)	0.1**	(0.1–0.2)*
Depressive symptoms	3.0***	(1.7–5.1)	4.5***	(2.5–7.9)	1.4	(0.8–2.4)	8.2***	(3.1–21.5)	11.2***	(4.1–30.7)	3.7**	(1.4–9.5)
Daily quantity smoked <sup>a</sup> × depressive symptoms							0.5**	(0.3–0.8)	0.5**	(0.4–0.8)	0.5**	(0.3–0.8)
Specific number smoked												
2.5 cigarettes/day							4.4		6.3		1.8	
12.5 cigarettes/day							1.4		2.3		0.5	

DSM-IV = *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed.; mFTQ = modified Fagerström Tolerance Questionnaire; UOR = unadjusted odds ratio; AOR = adjusted odds ratio.

<sup>a</sup>Gender, race/ethnicity, and grade in school were controlled; reference group is dependent only on mFTQ.

<sup>b</sup>Logarithm of continuous variable coded at midpoint value of each category.

\**p* < .05, \*\**p* < .01, \*\*\**p* < .001.

an example, see bottom of Table IV), for each unit increase in depression there was a 4.4-fold increase in adolescents with DSM-only dependence, a 6.3-fold increase in adolescents with both dependencies, and a 1.8-fold increase in the number of adolescents with neither dependency compared with adolescents dependent on the mFTQ only. The net effect of these changes was a substantial increase in the number of adolescents who were DSM dependent as depression increased. For adolescents smoking many cigarettes per day (12.5 as an example, see bottom of Table IV), for each unit increase in depression there was a 1.4-fold increase in adolescents with DSM-only dependence, a 2.3-fold increase in adolescents with both dependencies, and a 2.0-fold (reciprocal of 0.5 in Table IV) decrease in the number of adolescents with neither dependency compared with adolescents dependent on the mFTQ only.

The net effect of these changes was a slight increase in the number of adolescents who were DSM dependent as depression increased among adolescents heavily smoking.

The pattern of the interaction between amount smoked and depression is better illustrated in Table V. Rates of dependence for each scale were much higher (approximately 40% to 50% in absolute percentages) for adolescents smoking many cigarettes compared with those smoking few cigarettes. Rates of mFTQ dependence were slightly sensitive (approximately 5% in absolute percentages) to differences in levels of depression in adolescents. The interaction was clearly evident for the rates of DSM dependence. For adolescents who were smoking many cigarettes, there was a very modest (approximately 7–8%) difference in rates of dependence between adolescents with average depression and those

**Table V.** Predicted Unique and Joint Dependence on the DSM-IV and mFTQ Scales by Daily Quantity Smoked and Depression Among Lifetime Smokers (6th–10th Graders) (*N* = 3996)<sup>a</sup>

Daily Quantity of Cigarettes Smoked	Depression Level	mFTQ = 0, DSM = 0, %	mFTQ = 1, DSM = 0, %	mFTQ = 0, DSM = 1, %	mFTQ = 1, DSM = 1, %	All mFT, %	All DSM, %	Total <i>N</i>
2.5	Median	55.2	4.4	31.6	8.8	13.2	40.0	(2721)
2.5	90th <sup>b</sup>	36.7	1.7	44.6	17.0	18.7	61.6	(495)
12.5	Median	3.4	12.4	32.9	51.3	63.7	84.2	(124)
12.5	90th <sup>b</sup>	1.2	7.5	27.2	64.1	71.6	91.3	(56)

DSM-IV = *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed.; mFTQ = modified Fagerström Tolerance Questionnaire.

<sup>a</sup>Gender, grade in school, and ethnicity were controlled.

<sup>b</sup>90th percentile.

[Source: TND00708, pg. 4/22/04]

with high levels of depression. Remarkably, this same difference was substantial (approximately 20%) for adolescents who were not smoking very many cigarettes.

### **Subgroup Differences: Gender and Ethnicity**

There were small differences in patterns of smoking by gender but large ones by ethnicity (Appendix I). While rates of smoking were weakly but significantly higher among females than males, a higher proportion of males than females smoked six or more cigarettes a day, and were dependent by the mFTQ.

Rates of lifetime smoking were higher among whites (28.8%) and Hispanics (30.2%) than African Americans (20.4%). Furthermore, whites smoked more cigarettes per day than smokers of minority groups, especially African Americans, and had the highest rates of dependence on the two dependence scales. However, the patterns among minority-group members differed by scale. Almost twice as many whites as African Americans met criteria on the DSM; rates for Hispanics were close to those for whites. On the mFTQ, rates were similar for African Americans and Hispanics.

There were few differences in symptoms across ethnic groups among those defined as dependent by either scale. Pattern of consumption was an exception. Dependent whites and Hispanics smoked more cigarettes per day than African Americans. Thus, 24.1% of whites and 21.5% of Hispanics positive on the mFTQ smoked at least 16 cigarettes per day compared with 13.5% of African Americans. While African Americans appeared to be lighter smokers and generally endorsed fewer dependence items than whites or Hispanics, higher proportions of minority-group members reported smoking more during the first 2 hours of the day than the remaining part of the day. The relationships between frequency of daily cigarette use and rates of dependence on either scale were comparable among the ethnic groups and for each gender (data not presented).

In a multivariate model predicting DSM dependence, with the sole inclusion of daily quantity smoked, the odds ratio became nonsignificant for Hispanics and was slightly reduced in significance for African Americans (declined from .5,  $p < .001$  to .7,  $p < .01$ ). When predicting mFTQ dependence, both minority-group coefficients became nonsignificant. Interactive terms between race/ethnicity and quantity smoked were not significant. With the inclusion of depression, the association between being African American and DSM dependence was further reduced.

While univariate gender effects differed in the DSM and mFTQ models, with control for other covariates,

gender was no longer significant for the mFTQ. For neither scale was grade in school significant.

### **Discussion**

The DSM and mFTQ dependence scales are distinct measures. A similar conclusion was reached by investigators who examined the DSM and the FTND, a variant of the FTQ (Breslau & Johnson, 2000; Moolchan et al., 2002). The scales have low concordance as dichotomies and moderate correlations as continuous scores. Tolerance, withdrawal, and impaired control were reported with equal frequency by those who were dependent on each scale. These symptoms, two of which are physiological manifestations of dependence (Breslau & Johnson, 2000), are equally common and appear to constitute the core of dependence, although they are not explicitly measured in the mFTQ.

The DSM scale identifies many more dependent youths than the mFTQ. The rates are almost three times higher among lifetime smokers and almost one and a half times higher among daily smokers. It is unlikely that the differences in rates are due to differences in the format of the questions. To approximate the lifetime frame of experience embodied in the DSM, we modified the administration of the mFTQ to ask adolescents about symptoms experienced in the last 30 days or the most recent month that they had smoked. The difference in dependence rates between the two scales still persisted, albeit attenuated, among those who were current daily smokers. Furthermore, we would expect the impact of the varying time frame to be smaller among the young adolescents in the study than among adults, because the lifetime period of smoking for adolescents is much shorter than for adults.

The differences in rates are partially explained by differences in the levels of cigarette consumption and depressive symptoms at which youths meet criteria for dependence on each scale. Youths are unlikely to be identified as dependent by the mFTQ when they smoke fewer than 6–15 cigarettes daily. By contrast, one third of those who smoke as little as 1 cigarette per day are identified by the DSM as being dependent. At the highest level of daily consumption, rates of dependence are comparable. Light smokers, especially if depressed, are more likely to be identified as being dependent by the DSM than the mFTQ. The DSM may identify a psychological component common to dependence and depression. At low levels of consumption, the DSM identifies smokers as dependent when they are depressed. As noted by Breslau and Johnson (2000), the association between depression and DSM dependence may result



from the association of some DSM behavioral symptoms with depression, anxiety, and nicotine dependence. The DSM better predicted depression, while the FTND better predicted quitting smoking. Similarly, Moolchan et al. (2002) found that the DSM was more strongly related than the FTND to psychiatric morbidity in an adult sample in treatment for smoking. In the present sample, the association of depressive symptoms with dependence was in the same direction for the DSM or the mFTQ. However, examination of the joint distribution of the two scales revealed that the association differed by daily quantity smoked. Depressive symptoms had a stronger association with the DSM than the mFTQ.

Comparison of the crude rates of dependence among different investigators is difficult because of differences in time frame (lifetime, last year, or current), persons included in the denominator (entire population samples, lifetime smokers, last-year smokers, smokers in treatment programs), or age (see also Colby et al., 2000). The crude DSM rate of 24.1% is comparable to rates reported by other studies. Lifetime DSM-IV rates among smokers in a German study were 12.0% at ages 14–15, 23.5% at ages 16–17, 25.9% at ages 18–21, and 27.7% at ages 22–24 (based on data presented in Nelson and Wittchen, 1998). Based on the DSM-III-R, Anthony et al. (1994) reported a rate of 23.6% for lifetime smokers aged 15–24 in the National Comorbidity Study, and Breslau et al. (1993) 27.0% for lifetime smokers aged 20–29.

Using the same measure for high-risk adolescents and adult smokers, Prokhorov, Pallonen, Fava, Ding, and Niaura (1996) found that the rate on the mFTQ was 2.5 times higher among adults than adolescents. This difference in rates may reflect differences in levels of consumption and in patterns of dependence associated with age, and needs to be explored further. The two scales, but especially the mFTQ and other Fagerström-related scales, may be differentially sensitive among adolescents compared with adults. In a sample of young adult daily smokers aged 20–29, Breslau and Johnson (2000) found that the rates of dependence were only slightly lower on the FTND than the DSM-III-R, and Moolchan et al. (2002) observed similar rates among adults in treatment. Restriction to daily smokers or individuals in treatment may have reduced variability in those identified as dependent by each scale. Thus, in the present sample, the rates were identical among youths who smoked at least 16 cigarettes a day. The inclusion of a measure of consumption in the index of dependence in the mFTQ creates conceptual and statistical difficulties in understanding variations in the risk for becoming dependent. The risk varies among individuals who smoke the same number of cigarettes.

Furthermore, it includes a criterion that may be an outcome as well as a determinant of dependence.

Dependent youths who smoke very little must be explained. This pattern, however, may be consonant with the neurobiology of nicotine. Mansvelder, Keath, and McGehee (2002) reported that a single nicotine exposure increased dopamine levels in the mesolimbic reward systems for hours. Di Franza (2003) proposed that the neurobiology of nicotine could explain very rapid development of loss of autonomy and dependence in adolescence after a single cigarette exposure, although some neurobiologists disagree with this interpretation (Koob, 2003). However, misclassification of symptoms is also a possible explanation. Some items in the dependence scales may be misunderstood by adolescents, especially those with low levels of use (Nichter, Nichter, Thompson, Shiffman, & Moscicki, 2002). Furthermore, Nichter et al. (2002) found that some youths reported explicitly that being dependent was unrelated to extensiveness of smoking. In addition, the absence of information on duration and clustering of symptoms in the DSM may have contributed to increasing its sensitivity but decreasing its specificity.

Demographic correlates of dependence vary somewhat depending on the assessment but appear to be explained partially by differences in extensiveness of smoking. The rates of dependence are similar for males and females on the DSM but higher among males than females on the mFTQ. The difference on the mFTQ appears to be partially linked to gender differences in intensity of smoking. Rates are higher among whites than minority-group members on both scales, but higher among Hispanics than African Americans on the DSM. Higher rates of dependence among whites than minority-group members have been consistently reported by other investigators for adolescents (Moolchan, Berlin, Robinson, & Cadet, 2003) and adults (Breslau, Kilbey, & Andreski, 1991; Breslau et al., 2001; Kandel & Chen, 2000; Moolchan et al., 2002). The relationship of extensiveness of smoking with dependence is similar among groups. While dependent whites smoke more cigarettes per day than African Americans, at each level of extensiveness of smoking, the same percentage of youths of different ethnicities meet criteria for dependence on each scale. With control for extensiveness of smoking, ethnic differences are very much attenuated or disappear altogether (see also Moolchan et al., 2003). Thus, ethnic differences in adolescence appear to be due to the fact that minority-group adolescents smoke less than whites, not that they report fewer symptoms of dependence at the same quantities of cigarettes smoked. In this respect, the results of this analysis diverge from those reported

for adults on a national sample (Kandel & Chen, 2000). Lighter smoking and lower sensitivity to nicotine among adults appeared to explain the lower rates of nicotine dependence among African Americans compared with whites. Furthermore, ethnic differences in rates of nicotine metabolism and uptake of nicotine from cigarettes among adult smokers may account in part for ethnic differences in rates of nicotine dependence. African Americans, who metabolize nicotine more slowly than whites (Perez-Stable, Herrera, Jacob, & Benowitz, 1998), would be expected to report symptoms of dependence at lower levels of tobacco consumption.

This detailed comparison of two scales of nicotine dependence in a school sample of adolescents provides some understanding of the patterns of behavior that are captured by each scale, as well as potential differences between adolescent and adult smokers. The two scales correlate very highly with consumption levels, yet the concordance between the scales is weak. Each captures a different aspect of dependence: a behavioral component in the case of the mFTQ, an affective component in the case of the DSM. The psychological component may partially explain why the DSM identifies a much larger percentage of smokers as being dependent than the mFTQ. The difference in rates of dependence on each scale may be greater in adolescence than in adulthood, with the mFTQ identifying a relatively smaller percentage as dependent in adolescence compared with adulthood. The findings still do not answer the basic questions of how well the scales measure dependence and whether one scale is superior to the other.

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#### Appendix I. Patterns of Smoking and Nicotine Dependence, by Gender and Race/Ethnicity (6<sup>th</sup>-10<sup>th</sup> Graders)

Smoking Patterns	Male %	Female %	White %	African American %	Hispanic %	Other %	Total %
Among All Adolescents:							
Ever smoked	24.8 <sup>a</sup>	27.1 <sup>b</sup>	28.8 <sup>a</sup>	20.4 <sup>b</sup>	30.2 <sup>a,c</sup>	15.7 <sup>d</sup>	26.0
Total N	(7,119)	(7,888)	(3,755)	(4,096)	(5,932)	(1,224)	(15,007)
Among Those Who Smoked More Than 1 or 2 Times:							
Number Cigs per Day							
<1 whole cigarette	29.8 <sup>a</sup>	34.2 <sup>b</sup>	26.2 <sup>a</sup>	41.2 <sup>b</sup>	33.5 <sup>c</sup>	23.7 <sup>a</sup>	32.1
1 whole cigarette	25.1 <sup>a</sup>	24.7 <sup>b</sup>	22.0 <sup>a</sup>	24.3 <sup>a,b</sup>	26.8 <sup>b</sup>	26.9 <sup>a,b</sup>	24.9
2-5 cigarettes	31.2	34.7	38.4 <sup>a</sup>	26.5 <sup>b</sup>	31.5 <sup>b,c</sup>	37.6 <sup>a,c</sup>	33.1
6-15 cigarettes	7.8 <sup>a</sup>	4.6 <sup>b</sup>	8.0 <sup>a</sup>	5.5 <sup>a,b</sup>	4.7 <sup>b</sup>	8.6 <sup>a,b</sup>	6.1
16-25 cigarettes	2.9 <sup>a</sup>	1.3 <sup>b</sup>	3.6 <sup>a</sup>	1.4 <sup>b</sup>	1.2 <sup>b,c</sup>	2.2 <sup>a,b,c</sup>	2.0
26+ cigarettes	3.3 <sup>a</sup>	0.6 <sup>b</sup>	1.7	1.1	2.3	1.1	1.8
Total N ≥	(940)	(1,107)	(640)	(362)	(952)	(93)	(2,047)
Among Lifetime Smokers:							
DSM Dependent	23.7	24.0	28.6 <sup>a</sup>	15.7 <sup>b</sup>	24.5 <sup>c</sup>	25.3 <sup>a,c</sup>	23.9
Total N	(1,627)	(2,033)	(1,044)	(770)	(1,676)	(170)	(3,660)
mFTQ Dependent	10.3 <sup>a</sup>	7.1 <sup>b</sup>	11.7 <sup>a</sup>	6.6 <sup>b</sup>	7.3 <sup>b</sup>	9.3 <sup>a,b</sup>	8.5
Total N	(1,668)	(2,077)	(1,058)	(786)	(1,718)	(183)	(3,745)

<sup>a-d</sup>Means significantly different from each other at  $p < .05$ .

[Source: TND00374, TND00384, TND00387; TND00613 – do not print]

#### Appendix A. Modified Fagerström Tolerance Questionnaire (mFTQ) (Prokhorov et al., 1998)

The next questions are about your cigarette smoking. Answer the following questions for the last 30 days or the most recent month you have smoked. Coding indicated in parentheses.

On the days that you smoke(d), how many cigarettes do/did you smoke per day?

- (0) I have never smoked cigarettes or have only smoked once or twice.
- (0) Less than a whole cigarette per day
- (0) 1 whole cigarette per day
- (0) 2–5 cigarettes per day
- (0) 6–15 cigarettes per day (about half a pack)
- (1) 16–25 cigarettes per day (about 1 pack)

- (2) 26–35 cigarettes per day (about 1 and a half packs)
- (2) More than 35 cigarettes per day

How often do/did you take in smoke or inhale when you smoke(d)?

- (0) I have never smoked cigarettes or have only smoked once or twice.
- (2) Always
- (1) Quite often
- (1) Seldom
- (0) Never

How soon after waking up in the morning do/did you smoke your first cigarette?

- (0) I have never smoked cigarettes or have only smoked once or twice.
- (1) Within the first 5 minutes

- (1) Between 6 and 30 minutes
- (0) Between 31 and 60 minutes
- (0) Between 1 and 2 hours
- (0) More than 2 hours

Which cigarette is/was the hardest to give up?

- (0) I have never smoked cigarettes or have only smoked once or twice.
- (1) First cigarette in the morning
- (0) Any other cigarette before noon
- (0) Any other cigarette in the afternoon
- (0) Any other cigarette in the evening

Do/did you find it difficult not to smoke inside places where it is forbidden (for example, inside school, church, library, movies, etc.)?

- (0) I have never smoked cigarettes or have only smoked once or twice.
- (1) Yes, very difficult
- (1) Yes, somewhat difficult
- (0) No, not usually difficult
- (0) No, not at all difficult

Do/did you smoke even if you are/were so ill that you are/were in bed most of the day?

- (0) I have never smoked cigarettes or have only smoked once or twice.
- (1) Yes, always
- (1) Yes, quite often
- (0) No, not usually
- (0) No, never

Do/did you smoke more during the first 2 hours of the day or more during the rest of the day?

- (0) I have never smoked cigarettes or have only smoked once or twice.
- (1) More during the first 2 hours of the day
- (0) More during the rest of the day

### **Appendix B. Nicotine Dependence Measure of the *Diagnostic and Statistical Manual of Mental Disorders, 4th ed.* (based on Clark, Niaura, Abrams, & Colby, n.d.), and Craving Item**

The next questions are about some problems or experiences you may have ever had because of using tobacco. If you have ever used more than one tobacco product, please answer for the one tobacco product you have used MOST FREQUENTLY.

Select the product for which you will be answering. Choose *only one* answer.

- 1 I have never used tobacco or have only used once or twice.
- 2 Cigarettes
- 3 Cigars with *tobacco* in them or little cigars
- 4 *Tobacco* in a pipe
- 5 Bidis (small brown cigarettes in a leaf)
- 6 Kreteks (or clove cigarettes)
- 7 Chewing tobacco, snuff, or dip

(Coding for all subsequent items are: 0 = I have never used tobacco or have only used once or twice; 0 = No; 1 = Yes.)

Over time, did you find that you could smoke or use tobacco more without feeling nauseated or dizzy? (Tolerance)

Compared with when you first started smoking or using tobacco, did you need to use tobacco more in order to get the same effect? (Tolerance)

Did you ever have times when you stopped, cut down, or went without smoking or using tobacco and then experienced **physical problems** (for example, muscle aches, restlessness, increased appetite or weight gain, increased heart rate, nausea, or not sleeping well)? (Withdrawal)

Did you ever have times when you stopped, cut down, or went without smoking or using tobacco and then experienced **emotional problems** (for example, feeling irritable, depressed, angry, anxious, or stressed, or having difficulty concentrating)? (Withdrawal)

Did you ever have times when you smoked or used tobacco to KEEP from experiencing physical or emotional problems? (Withdrawal)

Did you have times when you smoked or used tobacco even though you PROMISED yourself you wouldn't? (Impaired control)

Were there ever times when you smoked or used tobacco more frequently or for MORE DAYS IN A ROW than you intended? (Impaired control)

Were there times when you tried to stop or cut down on your smoking or tobacco use and found that you were not able to do so? (Unsuccessful attempts to quit)

Did you ever have periods of several days or more when you chain-smoked, that is, started another cigarette as soon as you had finished one, or started another dip, chew, or cigar as soon as you had finished one? (Great deal of time spent using)

Did you ever have a period of a month or more when you gave up or greatly reduced important activities—like sports, school, or time spent with friends and family so you could use tobacco? (Neglect of important activities)



Did tobacco ever cause you any physical problems like coughing, difficulty breathing, or problems with your heart? (Screen for next item)

Did you continue to smoke or use tobacco even though you knew that using tobacco was causing you physical problems or making them worse? (Use despite problems)

Did tobacco use ever cause you any emotional problems like irritability, anxiety, difficulty concentrating, or depression? (Screen for next item)

Did you continue to smoke or use tobacco even though you knew that using tobacco was causing you emotional problems or making them worse? (Use despite problems)

#### Craving Item

Was there ever a time when you often had such a strong desire to smoke or use tobacco that you couldn't keep yourself from using tobacco, or found it difficult to think of anything else?

### **Appendix C. Depression Scale (Gadow et al., 2002)**

Choose which rating best describes your overall behavior or feelings in the last 30 days.

During the last 30 days . . .

(Coded 0 = never; 1 = sometimes; 2 = often; 3 = very often)

I have felt grouchy or cranky.

I have had trouble falling asleep or staying asleep.

I have felt unhappy or sad.

I have not felt like doing anything.

I have not liked myself.

I have felt tired, like I don't have any energy to do things.

I have felt bad, that I can't do things as well as other people.

I have felt that things never work out right for me.

I have eaten a lot.

I have slept a lot.

I have had trouble concentrating.

I have skipped meals and eaten very little.

I think about death or suicide. (Item not included in present scale)