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Examining the psychometric properties and predictive validity of a youth-specific version of the Nicotine Dependence Syndrome Scale (NDSS) among teens with varying levels of smoking

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Abstract

Current conceptualizations of nicotine dependence suggest assessing its multidimensional structure, especially for understanding how dependence develops in teen smokers. It is unknown if a multidimensional structure holds for teens with varying levels of smoking. The psychometric properties and predictive validity of the youth-specific, multidimensional Nicotine Dependence Syndrome Scale (NDSS) was assessed among 526 teens (55.5% female; 74.3% Caucasian) who reported smoking in the past 30 days. NDSS and smoking measures were obtained at baseline and six months. Confirmatory factor analysis supported the NDSS-Total (NDSS-T, $\alpha=.94$) and five factors for the sample: Drive ($\alpha=.92$), Tolerance ($\alpha=.85$), Priority ($\alpha=.83$), Stereotypy ($\alpha=.73$), and Continuity ($\alpha=.64$). NDSS-T, Drive, Tolerance, and Priority were predictors of subsequent amount smoked ($p<.01$). Drive, Tolerance, and Continuity predicted subsequent cessation ($p<.05$). Though the youth-specific NDSS has good psychometric properties, tests of predictive validity for subsequent smoking and cessation behavior suggest only certain dimensions of dependence, particularly Drive and Tolerance, appear to be salient in this sample. Further studies should assess the multidimensional nature of nicotine dependence among teens with varying levels of smoking.

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Keywords

nicotine dependence; teens; smokers; NDSS; assessment

I. Introduction

Teen smokers have difficulty quitting and maintaining abstinence (Choi et al., 2002), which is considered an indicator of nicotine dependence (DSM-IV, APA, 2000). Though features of nicotine dependence have been documented in teen smokers (Prokhorov et al., 1996), several important questions remain including what constitutes dependence and how it develops and progresses in teens (Shadel et al., 2000).

Current conceptualizations of nicotine dependence in adults suggest that it is viewed as a syndrome, consisting of several core features including craving, compulsion to smoke, and withdrawal (Shadel et al., 2000). In an effort to create a measure that captured the core, multidimensional constructs of dependence, Shiffman and colleagues (2004) developed the Nicotine Dependence Syndrome Scale (NDSS). The dimensions of the NDSS, derived by factor analysis of data from treatment seeking, adult heavy smokers, consist of five scales: Drive (craving, withdrawal, and subjective compulsions to smoke), Tolerance (reduced sensitivity to the effects of smoking), Continuity (regularity of smoking rate), Stereotypy (invariance of smoking), and Priority (preference for smoking over other reinforcers). A summary scale, the NDSS-Total (NDSS-T), that consisted of items from each dimension was also found.

The syndrome conceptualization of nicotine dependence used for adults is being adopted for teens (Shadel et al., 2000). Measures of nicotine dependence often used for teens either are not conceptualized as multidimensional or they often assess only limited aspects of dependence, such as nicotine dosing and compulsivity to use nicotine (Colby et al., 2000). A youth-specific version of the NDSS has been developed to address those concerns (Nichter et al., 2002). To date, the psychometric properties of this measure have not yet been tested among teen smokers with varying levels of smoking. The present study used the youth-specific NDSS to examine whether a multidimensional conceptualization of dependence replicates in a sample of teens who reported smoking at least one cigarette in the past 30 days (past 30 day users) prior to baseline assessment. An important question in the field is when in the smoking uptake continuum dependence develops. We chose to examine the youth-specific NDSS among this sample because it would allow for the assessment of dependence symptoms among teens that smoke at low-levels, but are current smokers (as defined by past 30 day smoking). Given concerns that nicotine dependence may develop well before the establishment of daily smoking (O'Loughlin et al., 2003), it is important to examine how adolescents who smoke less frequently perform on measures of dependence and which dimensions of dependence emerge in this sample. This longitudinal study also examined the ability of NDSS dimensions to predict prospectively subsequent smoking and quitting behavior in this sample.

2. Methods

2.1. Participants

Data were from two longitudinal samples: a sample of high school students enrolled in teen smoking cessation programs and a sample of 8th and 10th graders enrolled in a natural history study of smoking (non-treatment) who at baseline assessment indicated having smoked in the past 30 days. Only students who reported smoking 1 cigarette during the past 30 days at baseline were included in this study, yielding a final sample of 526 students

(100% of the cessation sample and 34% of natural history of smoking sample). Data for this study were collected from both samples at baseline and 6 months via self-administered questionnaires. Demographic and smoking characteristics for the sample are presented in Table 1. Both studies and procedures were approved by the University of Illinois at Chicago's Institutional Review Board.

2.2. Measures

The samples used identical measures to assess smoking behavior and dependence at the baseline and follow-up administrations. Smoking was assessed by two measures: 1) a 7-day smoking calendar to calculate the number of days students smoked (7-day smoking) and the number of cigarettes smoked per day on the days smoked (amount smoked); and 2) past 30-day smoking, both the number of days smoked (30-day smoking, responses from 1=0 days to 9=all 30 days) and amount smoked in past 30 days, (responses from 1=0 cigarettes to 11=more than 20 cigarettes per day). Dependence was assessed by the 26-item youth-specific NDSS (responses from 1=not true at all to 4=very true, Nichter et al., 2002). The NDSS scale and subscale scores were obtained by averaging responses to all items and higher scores reflected higher levels of dependence.

2.3. Analytic approach

Confirmatory factor analysis (CFA) determined if the youth-specific NDSS had the same underlying, multidimensional structure as the adult-based NDSS. The internal consistency and test-retest reliability of the measure were examined. Predictive validity was determined by examining if the youth-specific NDSS predicted number of days smoked and amount smoked at 6-month follow-up. Finally, the ability of the measure to predict smoking cessation/abstinence (defined as no smoking during the past 30 days) at 6-month follow-up was examined. Baseline smoking, demographics, and cessation group participation were controlled for in each regression.

3. Results

3.1. Factor structure of NDSS

The structure of the NDSS-T ($\chi^2=553.01$, $df=108$, $p<.001$, $CFI=.94$, $TLI=.98$, $RMSEA=.09$) and subscales ($\chi^2=451.59$, $df=109$, $p<.001$, $CFI=.95$, $TLI=.99$, $RMSEA=.08$) had good fit to the data (Hu and Bentler, 1999)¹.

3.2. Reliability and stability of overall NDSS scale and its subscales

Each subscale exceeded the recommended value of 0.70 (Nunnally, 1978) for reliability, except Continuity. The test-retest reliability for the NDSS-T and the five subscales were all significantly correlated ($p<.05$) (Table 2).

3.3. Predicting smoking rates at follow-up

To examine the ability of the five subscales and the NDSS-T to predict future smoking (and considering the problem of multicollinearity), we conducted separate regressions for each of the five subscales and the NDSS-T. Only baseline smoking ($\beta=0.65$, $t=15.62$, $R^2=.39$, $p<.001$) significantly predicted the number of days smoked at 6 months. For the amount smoked at 6 months, NDSS-T ($\beta=0.21$, $t=3.59$, $R^2=.56$, $p<.001$), Drive ($\beta=0.18$, $t=3.33$, $R^2=.52$, $p<.001$), Tolerance ($\beta=0.20$, $t=3.61$, $R^2=.52$, $p<.001$), and Priority ($\beta=0.12$, $t=2.56$,

¹Post-hoc analyses found the structure also replicated in infrequent (NDSS-T: $CFI=.96$, $RMSEA=.08$; subscales: $CFI=.97$, $RMSEA=.07$) and daily smokers (NDSS-T: $CFI=.95$, $RMSEA=.08$; subscales: $CFI=.96$, $RMSEA=.08$).

$R^2=.50$, $p=.01$) were all significant predictors beyond baseline smoking ($\beta=0.65$, $t=14.76$, $R^2=.49$, $p<.001$)².

3.4. Predicting smoking abstinence at follow-up for Cessation program participants

Over a third (37.7%) of the cessation program participants reported no smoking in the past 30 days (smoking abstinence) at 6 month follow-up. Separate logistic regressions, considering each scale alone without the others but including baseline smoking, were conducted to determine if the NDSS-T or the five subscales predicted smoking abstinence at follow-up in cessation program participants only. Drive ($\beta=0.46$, $R^2=.19$, $p<.05$), Tolerance ($\beta=0.36$, $R^2=.18$, $p=.05$) and Continuity ($\beta=0.41$, $R^2=.18$, $p<.01$) predicted smoking cessation, above and beyond amount smoked at baseline ($\beta=0.35$, $R^2=.16$, $p<.001$)³. Compared to continuing smokers, quitters had significantly lower mean scores on the Drive (smokers mean=2.39, SD=0.89 and quitters mean=1.24, SD=0.65, $p<.001$), Tolerance (smokers mean=2.65, SD=0.87 and quitters mean=1.43, SD=0.63, $p<.001$), and Continuity (smokers mean=2.52, SD=0.72 and quitters mean=1.51, SD=0.73, $p<.001$) subscales at 6 month follow-up.

4. Discussion

We examined the psychometric properties of the youth-specific NDSS in a sample of teens with varying levels of smoking. Though the psychometric tests provided support for the multidimensional structure of the measure, tests of predictive validity revealed that only certain dimensions of the youth-specific NDSS are relevant for subsequent smoking and quitting behavior in our sample. In addition to having the strongest internal consistencies among all subscales, both Drive and Tolerance were predictors of subsequent smoking and quitting behavior. Post-hoc analyses confirmed this finding, suggesting that declines in these subscale scores over time predicted reductions in smoking behavior as well as smoking abstinence. This may perhaps imply that for teens who smoke at infrequent, varying levels, only dimensions related to the physiological aspects of smoking (e.g., craving, withdrawal, reduce sensitivity to nicotine) are more prominent. That Priority and Continuity emerged as predictors of subsequent smoking and quitting behavior, respectively, suggests that though these dimensions are important, they are not yet salient for both behaviors in this sample. Stereotypy failed to predict amount smoked and quitting behavior in our sample, despite predicting these behaviors in teen daily smokers (Clark et al., 2005) and adult heavy smokers (Shiffman et al., 2004). Taken together, these findings perhaps imply that these dimensions become more prominent predictors of smoking and quitting behaviors as teens develop more regular and established patterns of smoking.

Neither the NDSS-T nor any of its subscales predicted the number of days smoked in our sample. There are several possible explanations for this finding. The measure of number of days smoked may be flawed because of a ceiling effect. Though our sample included teens with varying levels of smoking, the majority had not progressed to daily smoking. The measure of number of days smoked may have lack statistical variability for our sample of teen smokers, and may have limited the possibility of finding effects. Sledjeski and colleagues (2007) reported that smoking frequency (a measure similar to our number of days smoked) was associated with dimensions of the adult NDSS among college non-daily

²Post-hoc analyses examined if change in the NDSS-T and the 3 subscales (calculated by subtracting baseline score from 6 month score) predicted change in smoking behavior at 6 months. Change in the NDSS-T ($\beta=0.35$, $t=6.27$, $R^2=.18$, $p<.001$), Drive ($\beta=0.31$, $t=5.83$, $R^2=.16$, $p<.001$), Tolerance ($\beta=0.33$, $t=6.52$, $R^2=.18$, $p<.001$), and Priority ($\beta=0.21$, $t=3.96$, $R^2=.12$, $p<.001$) subscales predicted smoking at 6 months.

³Post-hoc analyses suggested that change in the Drive ($\beta=1.35$, $R^2=.27$, $p<.001$), Tolerance ($\beta=1.16$, $R^2=.29$, $p<.001$), and Continuity ($\beta=0.89$, $R^2=.27$, $p<.001$) subscales predicted cessation at 6 months.

smokers. Our findings may suggest that in *teens* with varying levels of smoking, a variety of situational factors (e.g., limited access to cigarettes; ability to smoke only on weekends, Mermelstein, 2003) may influence the number of days smoked, which in turn may limit the ability to detect a relationship to dependence.

Limitations to the present study include: the inability to examine racial/ethnic differences that may be important in the development of dependence, and a relatively short follow-up period that may not be long enough to assess changes in dependence in youth.

In conclusion, the youth-specific NDSS had acceptable psychometric properties in a sample of teens ranging from infrequent smokers to more frequent and daily smokers. Substantively only certain dimensions of dependence, namely Drive and Tolerance (as captured by this measure), appear to be salient at very early stages of smoking, however. The multidimensional structure of the youth-specific NDSS may require further study to explore if other dimensions emerge as predictors of both smoking and quitting behavior in other samples of teen smokers.

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Table 1

Demographic data and smoking measures for teens with varying levels of smoking

	BASELINE % (N=527)	FOLLOW-UP % (N=460)
Grade		---
8 th	15.6	---
9 th	7.0	---
10 th	37.9	---
11 th	18.9	---
12 th	20.6	---
Sex (% female)	55.5	---
Race		
African-American	9.1	---
Caucasian	74.3	---
Latino	9.9	---
Other/Biracial	6.7	---
7-day smoking—number of days smoked		
0 day	16.9	44.8
1 day	6.3	7.4
2 days	4.5	4.8
3 days	2.8	2.2
4 days	4.3	3.0
5 days	5.9	3.0
6 days	11.4	5.0
7 days	47.9	29.8
7-day smoking—number of cigs smoked/day		
0 cigs/day	16.9	31.5
1 cig/day	13.6	6.1
2-5 cigs/day	26.4	9.6
6-10 cigs/day	21.7	4.1
11 cigs/day	21.4	48.7
30-day smoking—number of days smoked		
0 day	0	30.3
1-5 days	23.6	22.5
6-10 days	7.2	5.6
11-20 days	9.1	8.2
21-29 days	17.5	10.7
30 days	42.6	22.7
30-day smoking—number of cigs smoked on days smoked		
1 cig/day	24.7	57.7

	BASELINE % (N=527)	FOLLOW-UP % (N=460)
2-5 cigs/day	29.2	18.8
6-10 cigs/day	23.1	23.4
11 cigs/day	23.0	0
Number of prior quit attempts		
None	33.5	---
Once	22.9	---
2-3 times	30.6	---
4 or more	13.0	---

Table 2

Youth-specific NDSS scores and reliability for teen smokers with varying levels of smoking

NDSS DIMENSION	# ITEMS	MEAN	SD	α (CI, 95%)	TEST-RETEST RELIABILITY
NDSS-T	24	2.33	0.79	0.94(0.93-0.95)	0.72 ^{**}
Drive	7	2.42	1.01	0.92(0.91-0.93)	0.67 ^{**}
Tolerance	5	2.66	0.95	0.85(0.83-0.87)	0.65 ^{**}
Priority	6	2.44	0.97	0.83(0.81-0.85)	0.65 ^{**}
Stereotypy	3	2.33	0.85	0.73(0.69-0.77)	0.43 ^{**}
Continuity	3	2.43	0.81	0.64(0.58-0.69)	0.46 ^{**}
mFTQ	7	1.68	0.65	0.85(0.83-0.87)	0.79 ^{**}

*
 $p \leq .05$ **
 $p \leq .01$