

Measurement properties of a nicotine dependence scale for adolescents

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This paper reports on the measurement properties of a scale intended to measure nicotine dependence in adolescents using data from the American Legacy Longitudinal Tobacco Use Reduction Study. The Nicotine Dependence Scale for Adolescents (NDSA) is a simple linear sum of items associated with behaviors to avoid withdrawal and items associated with experiences of craving. An exploratory factor analysis indicated that the items formed a single scale. The reliability of the scale was assessed by estimating Cronbach's alpha for the scale items. The estimated alpha reliability was .81. The scale's validity was assessed by estimating the correlation between the scale and measures of smoking and quitting behaviors. As hypothesized, the scale was positively correlated with lifetime number of cigarettes smoked ($r = .44, p < .001$), days smoked in the past 30 days ($r = .66, p < .001$), cigarettes smoked per day on days smoked ($r = .61, p < .001$), and number of quit attempts ($r = .10, p < .001$) and negatively correlated with the length of the quit attempt ($r = -.22, p < .001$). We also examined the measurement properties of the NDSA separately for middle and high school students and by gender and race or ethnicity. We found no meaningful differences in the measurement properties of the NDSA across these groups. The six-item self-report NDSA had good measurement properties in our sample.

Introduction

Nicotine is the major dependence-producing agent in tobacco products (U.S. Department of Health and Human Services [USDHHS], 1988). Nicotine dependence is characterized by repetitive and compulsive use, tolerance, cravings, and withdrawal symptoms during periods of nonuse (Shadel, Shiffman, Niaura, Nichter, & Abrams, 2000; USDHHS, 1988). Adolescent smoking is clearly linked to adult smoking, and the empirical evidence suggests that this is at least partly related to nicotine dependence, which underlines the importance of studying nicotine dependence in adolescence (Colby, Tiffany, Shiffman, & Niaura,

2000; Gilleskie & Strumpf, 2000; Gruber & Zinman, 2000; Pomerleau, Collins, Shiffman, & Pomerleau, 1993; Russell, 1990; Shadel et al., 2000).

Several methods are available for measuring nicotine dependence (Colby et al., 2000). One method involves a formal diagnostic assessment of symptoms of nicotine dependence, based either on diagnostic criteria from the 4th edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)*; American Psychiatric Association, 1994) or on criteria from the *International Classification of Diseases and Related Health Problems*, 10th revision [ICD-10] (World Health Organization, 1992). These diagnosis-based systems result in a dichotomized indicator of dependence or no dependence. A dichotomized measure is useful for diagnosis and for generating descriptive statistics of the extent of nicotine dependence in a population (assuming the cutoff point is valid) but is less useful for exploring relationships between nicotine dependence and smoking uptake (see Colby et al. for a detailed discussion of the potential limitations of a dichotomized scale).

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Another method for assessing nicotine dependence is to use self-report measures. These measures are more common than the diagnostic measures (Colby et al., 2000). In contrast to diagnostic measures, self-report scales result in continuous measures of nicotine dependence. Thus, an underlying continuum of dependence is assumed to run from no dependence to high levels of dependence.

The primary self-report measure of nicotine dependence is the Fagerström Tolerance Questionnaire and several modifications of it (Fagerström, 1978; Fagerström & Schneider, 1989). A limited number of studies have examined the measurement properties of Fagerström-type nicotine dependence scales in adolescent populations (Haddock, Lando, Klesges, Talcott, & Renaud, 1999; Prokhorov et al., 2000; Prokhorov, Pallonen, Fava, Ding, & Niaura, 1996; Rojas, Killen, Haydel, & Robinson, 1998). These studies have typically found alpha reliabilities in the .7 to .75 range (Prokhorov et al., 1996, 2000) and have found the scales significantly and positively correlated with smoking behaviors (Prokhorov et al., 1996, 2000), saliva cotinine levels (Prokhorov et al., 1996; Rojas et al., 1998), and retrospective accounts of withdrawal severity during a previous quit attempt (Rojas et al., 1998). One problem with these studies is that the samples are relatively small and not randomly selected.

A number of authors (Edwards, 1986; Edwards & Gross, 1976; Shadel et al., 2000) have suggested that nicotine dependence is multifactorial, with multiple threads woven together to comprise a syndrome. Based on the syndromal concept of nicotine dependence, Shiffman, Hickcox, Gyns, Paty, and Kassel (1995) developed the Nicotine Dependence Syndrome Scale (NDSS). The properties of this scale have not been examined in an adolescent population, although Nichter, Nichter, Thompson, Shiffman, and Moscicki (2002) discussed adapting NDSS items for use in an adolescent population.

Recently, DiFranza and colleagues (DiFranza et al., 2000, 2002a,b) and O'Loughlin and colleagues (O'Loughlin et al., 2002a,b,c) have developed and tested a scale for measuring nicotine dependence in adolescents – the Hooked On Nicotine Checklist (HONC). This scale is based on a theoretical model that hypothesizes that dependence is related to a loss of autonomy over the use of nicotine. The scale assesses three dimensions of dependence: Loss of autonomy, withdrawal symptoms, and feeling addicted (O'Loughlin et al., 2002b). The HONC scale appears to have excellent measurement properties, with an alpha reliability ranging from .90 in a sample of past 3-month smokers (O'Loughlin et al., 2002a,c) to .94 in a sample of ever-smokers (DiFranza et al., 2000). The HONC also is significantly associated with smoking behaviors and failed quit attempts (DiFranza et al., 2000; O'Loughlin et al., 2002a,c); several other scales for measuring dependence (Stanford

Dependence Inventory and ICD-10; O'Loughlin et al., 2002c); and scales formed of items that measure nicotine dependence symptoms, withdrawal symptoms, and self-medication (O'Loughlin et al., 2002a).

Several limitations of the reported studies of the HONC scale are worth noting. First, a model for the relationship between the dimensions of dependence that the scale represents and the loss of autonomy that the authors identify as the key construct determining dependence is not developed or presented. Second, the measurement properties are assessed only in relatively small samples. Third, the measurement properties of the scale are never assessed for a sample of current smokers (as would be expected, the measurement properties are strongest in the sample of ever-smokers). Finally, the measurement properties have not been reported for a consistent version of the scale.

Several items in the NDSA are essentially the same as items in the HONC, and the items cover similar domains. In the HONC, finding it hard to quit and failed quit attempts are cited as indicators of a loss of autonomy. In addition, the HONC includes an item measuring how hard it is not to smoke in places in which you are not supposed to smoke as an indicator of withdrawal symptoms as well as an item asking about cravings (O'Loughlin et al., 2002b). The NDSA has similar items. The HONC also asks about the experience of withdrawal symptoms, smoking urges, and a self-report of feeling addicted. Thus, the HONC potentially covers a broader domain of items that may better measure a multidimensional nicotine dependence construct, although this is an empirical question that has not been addressed.

The present study assessed the measurement properties of a nicotine dependence scale in an adolescent population. Two competing objectives influenced the development of the scale for this study: (a) The need for a short self-report scale and (b) the need to include items that would provide a reliable and valid measure of nicotine dependence in adolescents. To satisfy these objectives, we combined items from the Fagerström scale, adapted for use in an adolescent population (Nichter et al., 2002), and items from the NDSS related to craving (Shiffman et al., 1995).

This study makes several contributions to the literature on measuring nicotine dependence in adolescents. It adds to a limited literature studying the measurement of nicotine dependence in adolescent populations using a relatively large randomly selected sample of adolescent students, and it presents the measurement properties of a brief self-report scale that combines Fagerström-type items and items related to craving.

Method

Data

This analysis used baseline data from the American Legacy Longitudinal Tobacco Use Reduction Study, a 3-year longitudinal evaluation of tobacco counter-marketing campaigns conducted in seven communities in five states, encompassing approximately 10 school districts and 83 schools. The baseline survey was administered in class to students in grades 6 through 11 in spring and fall 2000. Assessment of the measurement properties of the NDSA was based on 4,904 students defined as current smokers. We classified students as current smokers based on two criteria: (a) Responses to the question "During the past 30 days, on how many days did you smoke cigarettes?," and (b) that students did not respond "I don't smoke now" to any of the individual items used to create the dependence scale. The questions used to assess nicotine dependence have "I don't smoke now" as a response category. Approximately 21% of students reported any smoking in the past 30 days based on the question asking about smoking in the past 30 days. Using our selection criteria, we classified 15.7% of students as current smokers. Thus, a substantial number of students, approximately 5.3%, who reported some smoking in the past 30 days reported that they were not smoking "now" on the questions measuring nicotine dependence and were dropped from this study. We further limited the sample to those students who had complete data on all of the items used to measure nicotine dependence.

In our sample, 36% of students were current experimental smokers (i.e., they reported smoking during the past 30 days but had not yet smoked 100 cigarettes in their lifetime – 92% of experimental smokers had smoked on 1–19 of the past 30 days, and 8% had smoked on 20–30 of the past 30 days), 18% were nondaily established smokers (i.e., they reported smoking on 1–19 days in the past 30 days and had smoked more than 100 cigarettes in their lifetime), and 45% were established smokers (i.e., they reported smoking on 20–30 of the past 30 days and had smoked 100 or more cigarettes in their lifetime). These classifications were based on descriptions of the smoking uptake process (Flay, 1993; Leventhal and Cleary, 1980; Mowery, Brick, & Farrelly, 2000; Pierce, Choi, Gilpin, & Farkas, 1996; Pierce, Farkas, Evans, & Gilpin, 1995).

The scale

Column 1 of Table 1 lists the survey questions used to measure nicotine dependence. For the purpose of this analysis, we changed the order of the response categories so that the lowest category represented the lowest level of nicotine dependence and the highest

category represented the highest level of nicotine dependence. The scale we analyzed is a simple linear sum of the included items. Columns 2 through 5 of Table 1 present descriptive statistics for the items that make up the NDSA as well as the scale itself.

To examine the measurement properties of the NDSA, we assessed the reliability and validity of the scale. We first conducted an exploratory factor analysis to establish that the items we used to measure nicotine dependence formed a single scale (Carmines & Zeller, 1979). To assess the reliability of our nicotine dependence scale, we estimated Cronbach's alpha for the scale, a measure of the internal consistency of the scale determined by the average interitem correlation and the number of items in the scale (Carmines & Zeller, 1979; Nunnally & Bernstein, 1994). To establish the validity of the scale, we examined associations between the construct of interest (nicotine dependence) and other measures (smoking behaviors, including cessation). The scale was considered valid if these associations were as expected based on models of nicotine dependence and smoking behavior (Carmines & Zeller).

Exposure to nicotine is hypothesized to be positively related to nicotine dependence (e.g., Pomerleau et al., 1993; USDHHS, 1988). Colby et al. (2000) argued that measures of dependence and measures of tobacco use are conceptually distinct and thus should not be scaled together. They suggested that measures of exposure be used to validate measures of dependence. We thus correlated our measure of nicotine dependence with the number of lifetime cigarettes smoked, days smoked in the past 30 days, and cigarettes smoked per day on the days smoked as a test of the validity of our measure. We expected the associations to be significant and positive.

We also correlated our scale with cessation-of-use measures. Theoretical models of dependence suggest that smokers express regret about the decision to smoke cigarettes and make numerous unsuccessful attempts to quit (Shadel et al., 2000). Empirical evidence suggests that adolescent smokers also follow this pattern (Lynch & Bonnie, 1994). Therefore, we expected our scale to be positively correlated with quit attempts but negatively correlated with success at quitting. We assessed success at quitting with a variable that measured the length of time the youth stayed off cigarettes during the last quit attempt.

Results

Table 1 presents results of the reliability analysis for the NDSA. Columns 6 and 7 of Table 1 present results of the factor analysis. Only one factor had an eigenvalue greater than 1 (2.3), which accounted for 46% of the total variance. Examination of a scree plot

Table 1. Descriptive statistics and reliability analysis of the scale items and the NDSA.

Item	Mean	SD	Minimum	Maximum	Factor loading	Uniqueness	Item-scale correlation	Average inter-item correlation	Alpha
Do you think you would be able to quit smoking if you wanted to?	1.92	0.90	1	4	0.64	0.59	0.74	0.48	0.78
How soon after you wake up do you usually smoke your first cigarette? (Average of response to question for weekdays and weekends)	3.23	1.98	0.5	6	0.69	0.52	0.77	0.46	0.77
If you are sick with a bad cold or sore throat, do you smoke cigarettes?	1.68	0.71	1	4	0.61	0.62	0.72	0.49	0.79
When I go without a smoke for a few hours, I experience craving.	2.44	1.18	1	4	0.79	0.38	0.83	0.42	0.74
I sometimes have strong cravings where it feels like I'm in the grip of a force that I can't control.	2.11	1.14	1	4	0.63	0.61	0.72	0.49	0.79
NDSA – rescaled ($min=0$)	6.88	4.55	0	16.5 ^a	–	–	–	0.47	0.81 (0.807) ^b

NDSA, Nicotine Dependence Scale for Adolescents. Two items had factor loadings below 0.55 (“Do you find it hard to avoid smoking in places where it’s not allowed?” and “After not smoking for a while, I need to smoke to relieve feelings of restlessness and irritability.”) These two items also had the lowest item-scale correlation. These items were dropped from the scale for subsequent analyses. Dropping these items did not affect the reliability or validity of the results. Factor analyses including these items also suggested a single scale.

^aEach scale item had a response category of “I don’t smoke.” Because we included only smokers in our analysis, this response category was essentially dropped. We averaged the items that ask “How soon after you wake up do you usually smoke your first cigarette on weekdays?” and “How soon after you wake up do you usually smoke your first cigarette on weekends?” We also created a version of the scale that included these two items separately – the performance of this scale was indistinguishable from the scale that included the average of these two items.

^bOne-sided 95% confidence interval.

Table 2. Validity assessment.

	NDSA	Lifetime cigarettes smoked	Days smoked in past 30	Cigarettes smoked per day on days smoked	Quit attempts ^a	Length of quit attempt
NDSA	1					
Lifetime cigarettes smoked	0.44	1				
Days smoked in past 30	0.66	0.65	1			
Cigarettes smoked per day on days smoked	0.61	0.52	0.65	1		
Quit attempts	0.10	0.07	0.07	0.02	1	
Length of quit attempt	–0.22	–0.04	–0.16	–0.18	0.43	1

NDSA, Nicotine Dependence Scale for Adolescents. All correlations are statistically significant at $p < .01$. Spearman correlations were very similar.

^aQuit attempts correlation excludes one school.

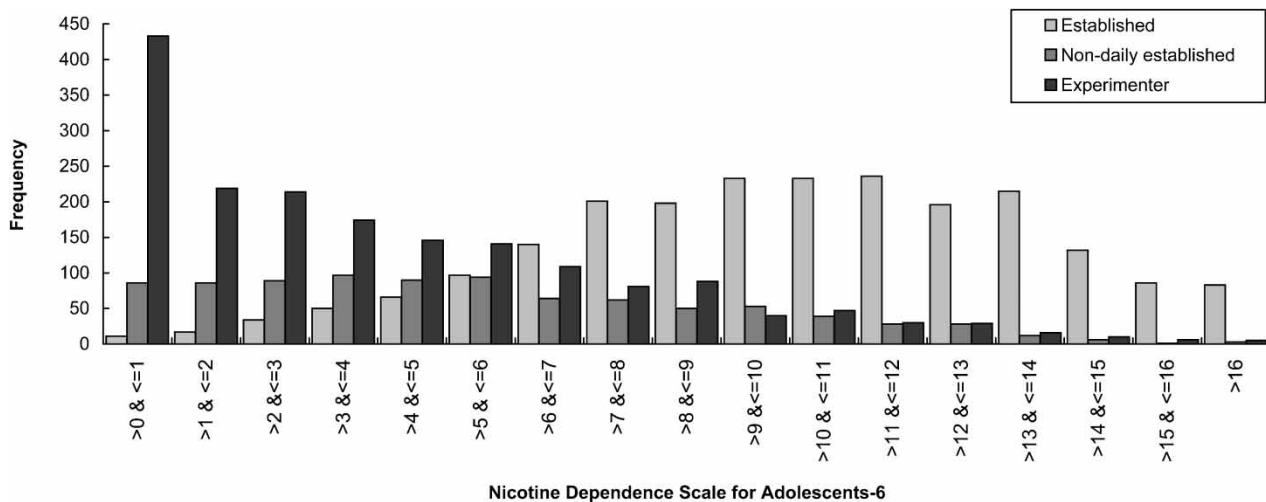


Figure 1. Distribution of NDSA by smoking status.

also suggested a single factor. The next highest eigenvalue was .1. The factor analysis was estimated using the principal factor method in Stata statistical software. Exploratory factor results indicated that the items factored into a single scale. We also estimated a confirmatory factor model using EQS and allowing for categorical items (Lee, Poon, & Bentler, 1995). Hu and Bentler (1999) suggested the following fit criteria for confirmatory factor models: Comparative fit index (CFI) $\geq .96$ and the standardized root mean square residual (SRMR) $\leq .06$. Results of this model also suggested a single-factor solution (CFI = .997, SRMR = .04).

Column 8 of Table 1 reports the correlation of the individual scale item for a given row with the scale formed by all other items. For each row, column 9 reports the average interitem correlation of the scale formed by excluding the item indicated by that row of the table. Similarly, for a given row, column 10 reports the alpha of the scale formed by excluding that row item from the scale. The last row of the table reports the average interitem correlation and the alpha reliability for the overall scale as well as a one-sided confidence interval for the Cronbach's alpha (Bleda & Tobías, 2000). No precise level of alpha reliability defines acceptable reliability for all situations. Some researchers have suggested that an alpha reliability of .8 or higher should be used to indicate a good scale (Carmines & Zeller, 1979). These results suggest the NDSA had good properties of internal consistency as measured by Cronbach's alpha.

Table 2 presents results that speak to the validity of the NDSA as a measure of nicotine dependence in adolescents. As hypothesized, the NDSA was positively correlated with lifetime number of cigarettes smoked, days smoked in the past 30 days, cigarettes smoked per day on days smoked, and number of quit attempts and was negatively correlated with the length of the quit attempt. These results suggest that the NDSA has validity as a measure of nicotine dependence.

Figure 1 demonstrates that the NDSA captures a shift in the level of dependence as adolescents progress through the smoking uptake process. Experimental smokers predominate at lower values of the scale, nondaily established smokers are more evenly distributed across low and medium values of the scale, and established smokers are distributed across higher values of the scale. Analysis of the contribution of each item to the total scale score indicated that for experimental smokers the experience of cravings was a more important determinant of the scale score, whereas for established smokers the item measuring the time after waking until the first cigarette of the day was the main contributor.

Figure 2 presents the mean score on the nicotine dependence scale for experimental, nondaily established, and established smokers. A clear positive relationship exists between stage in the smoking

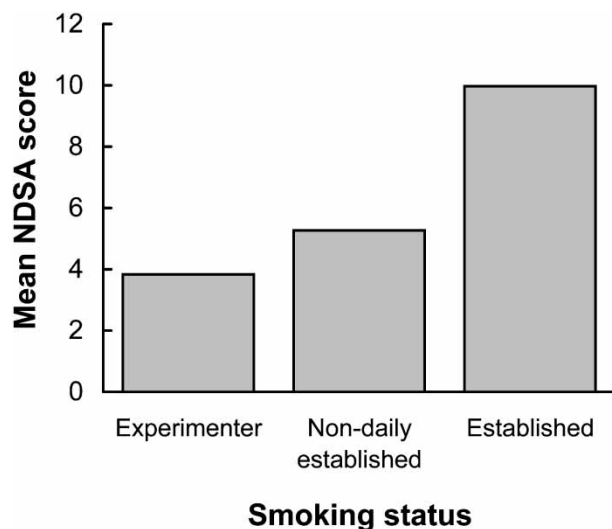


Figure 2. Nicotine dependence by smoking status. Nicotine dependence was measured by mean Nicotine Dependence Scale for Adolescents (NDSA) score.

uptake process and level of nicotine dependence. A one-way analysis of variance indicated that the mean level of nicotine dependence varied significantly across these groups. In addition, a Scheffé multiple comparison test indicated that the mean level of nicotine dependence was significantly different between each smoking level ($p < .001$ for each pairwise comparison).

Discussion

The items that make up the NDSA come from two previously established nicotine dependence scales, the Fagerström scale and the NDSS, neither of which was developed to measure nicotine dependence in adolescents. The NDSA includes items associated with behaviors to avoid withdrawal and with the experience of cravings.

The NDSA exhibited acceptable psychometric properties in our sample. It was reliable (alpha reliability of .81), and results of the validity analyses suggest it is a valid measure of nicotine dependence. Clearly, higher scores on the NDSA are associated with higher levels of cigarette use, a greater number of quit attempts, and shorter durations of quit attempts.

We also examined the measurement properties of the NDSA for middle and high school smokers separately as well as by gender and race or ethnicity. We found no significant or meaningful differences in the measurement properties of the NDSA between these groups of smokers. Therefore, we presented results only for the sample with all groups combined.

A few limitations of our study are worth noting. First, our validation efforts relied on self-report items of smoking and quitting behavior. Our results would be strengthened by validation with a measure that does not rely on self-report, such as saliva or blood cotinine levels. In addition, the validity of the NDSA would be strengthened by further demonstrating its importance as a predictor of other outcome measures, such as successful quit attempts, or its association with diagnosed symptoms in smokers related to withdrawal and craving.

Second, our results indicated that the nicotine dependence construct measured by the items in the NDSA is unidimensional. However, this result is conditional on the limited set of items used to form the NDSA. Our set of items might not be diverse enough to cover all the relevant dimensions of nicotine dependence. Thus, the nicotine dependence construct, in general, may be multidimensional. Our study did not attempt to address this issue. It is interesting that combining craving items to the items measuring behaviors to avoid withdrawal resulted in a unidimensional scale. Additional work is needed to better understand the dimensionality of nicotine dependence.

The NDSA was developed to provide a brief self-report measure of nicotine dependence that could be included on surveys that assess adolescent tobacco use. The NDSA was not designed to be, nor do we suggest its use as, a diagnostic tool for clinical purposes. We make this suggestion primarily because we have no good method for establishing a cutoff or threshold separating dependence from nondependence (see Colby et al., 2000, for a discussion of the difficulties with attempting to establish such cut-points). Rather, the NDSA is intended as a research tool for measuring individual differences in adolescent dependence that can be included in models of smoking behavior (e.g., to understand smoking uptake, escalation to regular smoking, and smoking cessation). This study provides evidence suggesting that the NDSA, a short self-report scale combining items related to behaviors to avoid withdrawal and craving, shows promise as a measure of nicotine dependence in adolescents. Additional work, such as prospective prediction of cessation, is needed to build a stronger case for the validity of the NDSA.

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References

- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
- Bleda, M., & Tobias, A. (2000). Cronbach's alpha one-sided confidence interval *Stata Technical Bulletin*, 56, 26–27.
- Carmines, E. G., & Zeller, R. A. (1979). *Reliability and validity assessment*. Newbury Park, CA: Sage.
- Colby, S. M., Tiffany, S. T., Shiffman, S., & Niaura, R. S. (2000). Measuring nicotine dependence among youth: A review of available approaches and instruments *Drug and Alcohol Dependence*, 59(Suppl. 1), S23–S39.
- DiFranza, J. R., Rigotti, N. A., McNeill, A. D., Ockene, J. K., Savageau, J. A., St. Cyr, D., & Coleman, M. (2000). Initial symptoms of nicotine dependence in adolescents *Tobacco Control*, 9, 313–319.
- DiFranza, J. R., Savageau, J. A., Fletcher, K., Ockene, J. K., Rigotti, N. A., McNeill, A. D., Coleman, M., & Wood, C. (2002a). Measuring the loss of autonomy over nicotine use in adolescents: The DANDY (Development and Assessment of Nicotine Dependence in Youths) study *Archives of Pediatric and Adolescent Medicine*, 156, 397–403.
- DiFranza, J. R., Savageau, J. A., Rigotti, N. A., Fletcher, K., Ockene, J. K., McNeill, A. D., Coleman, M., & Wood, C. (2002b). Development of symptoms of tobacco dependence in youths: 30 month follow up data from the DANDY study *Tobacco Control*, 11, 228–235.
- Edwards, G. (1986). The alcohol dependence syndrome: A concept as stimulus to enquiry *British Journal of Addiction*, 81, 171–183.
- Edwards, G., & Gross, M. M. (1976). Alcohol dependence: Provisional description of a clinical syndrome *British Medical Journal*, 1, 1058–1061.
- Fagerström, K.-O. (1978). Measuring the degree of physical dependence to tobacco smoking with reference to individualization of treatment *Addictive Behaviors*, 3, 235–241.
- Fagerström, K.-O., & Schneider, N. (1989). Measuring nicotine

- dependence: A review of the Fagerström Tolerance Questionnaire *Journal of Behavioral Medicine*, 12, 159–182.
- Flay, B. R. (1993). Youth tobacco use: Risks, patterns, and control In J. Slade & C. T. Orleans (Eds.), *Nicotine addiction: Principles and management* (pp. 365–385). New York: Oxford University Press.
- Gilleskie, D. B., & Strumpf, K. S. (2000, August). *Behavioral dynamics of youth smoking* (NBER Working Paper No. 7838). Cambridge, MA: National Bureau of Economic Research.
- Gruber, J., & Zinman, J. (2000, July). *Youth smoking in the U.S.: Evidence and implications* (NBER Working Paper No. 7780). Cambridge, MA: National Bureau of Economic Research.
- Haddock, C. K., Lando, H., Klesges, R. C., Talcott, G. W., & Renaud, E. A. (1999). A study of the psychometric and predictive properties of the Fagerström test for nicotine dependence in a population of young smokers *Nicotine & Tobacco Research*, 1, 59–66.
- Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives *Structural Equation Modeling*, 6, 1–55.
- Lee, S. Y., Poon, W. Y., & Bentler, P. M. (1995). A two stage estimation of structural equations with continuous and polytomous variables *British Journal of Mathematical and Statistical Psychology*, 48, 339–358.
- Leventhal, H., & Cleary, P. D. (1980). The smoking problem: A review of the research and theory in behavioral risk modification *Psychological Bulletin*, 88, 370–405.
- Lynch, B. S., & Bonnie, R. J. (Eds.). (1994). *Growing up tobacco free: Preventing nicotine addiction in children and youths*. Washington, DC: Committee on Preventing Nicotine Addiction in Children and Youths, Division of Biobehavioral Sciences and Mental Disorders, Institute of Medicine, National Academies Press.
- Mowery, P. D., Brick, P. D., & Farrelly, M. C. (2000). *Pathways to established smoking: Results from the 1999 National Youth Tobacco Survey* (Legacy First Look Report No. 3). Washington, DC: American Legacy Foundation.
- Nichter, M., Nichter, M., Thompson, P. J., Shiffman, S., & Moscicki, A. B. (2002). Using qualitative research to inform survey development on nicotine dependence among adolescents *Drug and Alcohol Dependence*, 68(Suppl. 1), S41–S56.
- Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory*. New York: McGraw-Hill.
- O'Loughlin, J., DiFranza, J., Tarasuk, J., Meshefedjian, G., McMillan-Davey, E., Paradis, G., Tyndale, R. F., Clarke, P., & Hanley, J. (2002a). Assessment of nicotine dependence symptoms in adolescents: A comparison of five indicators *Tobacco Control*, 11, 354–360.
- O'Loughlin, J., Kishchuk, N., DiFranza, J., Tremblay, M., & Paradis, G. (2002b). The hardest thing is the habit: A qualitative investigation of adolescent smokers' experience of nicotine dependence *Nicotine & Tobacco Research*, 4, 201–209.
- O'Loughlin, J., Tarasuk, J., DiFranza, J., & Paradis, G. (2002c). Reliability of selected measures of nicotine dependence among adolescents *Annals of Epidemiology*, 12, 353–362.
- Pierce, J. P., Choi, W. S., Gilpin, E. A., & Farkas, A. J. (1996). Validation of susceptibility as a predictor of which adolescents take up smoking in the United States *Health Psychology*, 15, 355–361.
- Pierce, J. P., Farkas, A. J., Evans, N., & Gilpin, E. A. (1995). An improved surveillance measure for adolescent smoking? *Tobacco Control*, 4, S47–S56.
- Pomerleau, O. F., Collins, A. C., Shiffman, S., & Pomerleau, C. S. (1993). Why some people smoke and others do not: New perspectives *Journal of Clinical and Consulting Psychology*, 61, 723–731.
- Prokhorov, A. V., DeMoor, C., Pallonen, U. E., Hudmon, K. S., Koehly, L., & Hu, S. (2000). Validation of the modified Fagerström Tolerance Questionnaire with salivary cotinine among adolescents *Addictive Behaviors*, 25, 429–433.
- Prokhorov, A. V., Pallonen, U. E., Fava, J. L., Ding, L., & Niaura, R. S. (1996). Measuring nicotine dependence among high-risk adolescent smokers *Addictive Behaviors*, 21, 117–127.
- Rojas, N. L., Killen, J. D., Haydel, K. F., & Robinson, T. N. (1998). Nicotine dependence among adolescent smokers *Archives of Pediatric and Adolescent Medicine*, 152, 151–156.
- Russell, M. A. H. (1990). The nicotine addiction trap: A 40-year sentence for four cigarettes *British Journal of Addiction*, 85, 293–300.
- Shadel, W. G., Shiffman, S., Niaura, R., Nichter, M., & Abrams, D. B. (2000). Current models of nicotine dependence: What is known and what is needed to advance understanding of tobacco etiology among youth *Drug and Alcohol Dependence*, 59(Suppl. 1), S9–S21.
- Shiffman, S., Hickcox, M., Gyns, M., Paty, J. A., & Kassel, J. D. (1995, February). *The Nicotine Dependence Syndrome Scale: Development of a new measure*. Poster presented at the annual meeting of the Society for Research on Nicotine and Tobacco, San Diego, CA.
- U.S. Department of Health and Human Services. (1988). *The health consequences of smoking: Nicotine addiction*. A report of the surgeon general. Washington, DC: U.S. Government Printing Office.
- World Health Organization. (1992). *International statistical classification of diseases and related health problems* (10th rev.). Geneva, Switzerland: Author.