Published in final edited form as:

Psychol Med. 2013 October ; 43(10): 2179–2190. doi:10.1017/S0033291712002954.

Validity of proposed DSM-5 diagnostic criteria for nicotine use disorder: results from 734 Israeli lifetime smokers

D. Shmulewitz^{1,2}, M.M. Wall^{1,2,3}, E. Aharonovich^{1,2}, B. Spivak⁴, A. Weizman^{4,5,6}, A. Frisch^{4,5}, B. F. Grant⁷, and D. Hasin^{1,2,8,*}

¹New York State Psychiatric Institute, New York, NY, USA

²Department of Psychiatry, College of Physicians and Surgeons, Columbia University, New York, NY, USA

³Department of Biostatistics, Mailman School of Public Health, Columbia University, New York, NY, USA

⁴Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel

⁵Felsenstein Medical Research Center, Petach Tikva, Israel

⁶Research Unit, Geha Mental Health Center, Petach Tikva, Israel

⁷Laboratory of Epidemiology and Biometry, National Institute on Alcohol Abuse and Alcoholism, Bethesda, MD, USA

⁸Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY, USA

Abstract

Background—The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) proposes aligning nicotine use disorder (NUD) criteria with those for other substances, by including the current DSM fourth edition (DSM-IV) nicotine dependence (ND) criteria, three abuse criteria (neglect roles, hazardous use, interpersonal problems) and craving. Although NUD criteria indicate one latent trait, evidence is lacking on: (1) validity of each criterion; (2) validity of the criteria as a set; (3) comparative validity between DSM-5 NUD and DSM-IV ND criterion sets; and (4) NUD prevalence.

Method—Nicotine criteria (DSM-IV ND, abuse and craving) and external validators (e.g. smoking soon after awakening, number of cigarettes per day) were assessed with a structured interview in 734 lifetime smokers from an Israeli household sample. Regression analysis evaluated the association between validators and each criterion. Receiver operating characteristic analysis assessed the association of the validators with the DSM-5 NUD set (number of criteria endorsed) and tested whether DSM-5 or DSM-IV provided the most discriminating criterion set. Changes in prevalence were examined.

© Cambridge University Press 2013

*Address for correspondence: D. S. Hasin, Ph.D., Columbia University College of Physicians and Surgeons, Department of Psychiatry, 1051 Riverside Drive #123, New York, NY 10032, USA. dsh2@columbia.edu.

Supplementary material

For supplementary material accompanying this paper visit <http://dx.doi.org/10.1017/S0033291712002954>.

Declaration of Interest

None.

Results—Each DSM-5 NUD criterion was significantly associated with the validators, with strength of associations similar across the criteria. As a set, DSM-5 criteria were significantly associated with the validators, were significantly more discriminating than DSM-IV ND criteria, and led to increased prevalence of binary NUD (two or more criteria) over ND.

Conclusions—All findings address previous concerns about the DSM-IV nicotine diagnosis and its criteria and support the proposed changes for DSM-5 NUD, which should result in improved diagnosis of nicotine disorders.

Keywords

Cigarettes; DSM-5; Israel; nicotine dependence; nicotine use disorders; receiver operating characteristic curve analysis; smoking; validity

Introduction

Recommendations of the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) Substance Use Disorders (SUD) Workgroup for changes in DSM-5 diagnostics for SUD include consolidating the two main DSM fourth edition (DSM-IV) SUD, dependence and abuse, into one disorder that is defined by all DSM-IV dependence criteria, three of the four DSM-IV abuse criteria (dropping legal problems), and craving (APA, 2010a). Extensive evidence showing that the 11 criteria indicate one latent trait (e.g. Lynskey & Agrawal, 2007; Borges *et al.* 2010; Shmulewitz *et al.* 2010; Kerridge *et al.* 2011; Hasin *et al.* 2012; Saha *et al.* 2012; reviewed in D. Hasin *et al.* unpublished observations) supports this consolidation.

DSM-IV handled nicotine differently from other substances by including nicotine dependence (ND) but not abuse. Omitting abuse was based on expert opinion about two issues. First, abuse criteria were assumed to be redundant (i.e. rarely endorsed) in the absence of ND (Hughes, 1994). This assumption, also made for DSM-IV alcohol and drug abuse but subsequently shown to be incorrect (Hasin & Grant, 2004; Hasin *et al.* 2005), might also be incorrect for nicotine. Second, the abuse criteria were assumed irrelevant for nicotine disorders (Hughes, 1994). Increasingly wide-spread anti-smoking norms and policies (potentially causing more problems with others about smoking) and greater recognition of smoking-related injury (Benowitz, 2010; Shmulewitz *et al.* 2011) suggest increasing relevance of abuse criteria as indicators of a nicotine disorder.

Therefore, the DSM-5 SUD Workgroup investigated whether to align DSM-5 criteria for nicotine use disorders (NUD) with those for other substances, a greater change for nicotine because it involves adding three new abuse criteria and craving (APA, 2010b). Initial evidence indicated that these criteria formed one latent trait (Shmulewitz *et al.* 2011; Chung *et al.* 2012). However, further validity evidence was needed, given critiques of the general DSM approach to nicotine disorders.

These general critiques focus on (a) the individual criteria and (b) the criteria as a set. Concerns about the individual criteria include face and concurrent validity (Hughes, 2006; DiFranza *et al.* 2010; Baker *et al.* 2012). Some believe that several dependence and abuse criteria lack face validity, seeing them as less relevant to nicotine than other substances, e.g. tolerance and activities given up to smoke (Hughes, 2006; Hughes *et al.* 2011; Baker *et al.* 2012). The sparse evidence for concurrent validity is inconsistent: most ND criteria are associated with smoking quantity in the general population (Nelson & Wittchen, 1998; John *et al.* 2004) but not in clinical samples (Hendricks *et al.* 2008), where variance may be limited because participants were heavy smokers. No concurrent validity evidence for nicotine abuse criteria has been reported.

Concerns about the DSM-IV ND criteria as a set include: lack of craving (considered a key indicator) (DiFranza *et al.* 2010; Hughes *et al.* 2011; Baker *et al.* 2012), inconsistent evidence on concurrent validity (DiFranza *et al.* 2010; Baker *et al.* 2012), dichotomized diagnosis (Shiffman *et al.* 2004; Hughes *et al.* 2011; Baker *et al.* 2012) and under-diagnosis leading to low prevalence (Baker *et al.* 2012). Additional concerns about the proposed DSM-5 NUD set include: lack of direct evidence on concurrent validity (i.e. based on number of criteria endorsed) and that adding criteria could decrease the predictive validity (or discriminatory ability) of the set if the new items were of poor quality (Hughes, 2006; Chung *et al.* 2012).

Validation involves analysing relationships of the criteria (individually or as a set) with external validators, i.e. variables theoretically linked to the underlying disorder (e.g. NUD) but external to the criterion set (Cronbach & Meehl, 1955; Feighner *et al.* 1972; Colby *et al.* 2000a; Piper *et al.* 2006). Those relevant to nicotine disorders include key indicators already shown to predict smoking course, such as smoking quantity/frequency (Breslau & Johnson, 2000; Colby *et al.* 2000a; Hughes, 2006), smoking shortly after morning awakening (Colby *et al.* 2000b; Baker *et al.* 2007) and waking at night to smoke (Scharf *et al.* 2008). Validating the individual criteria could determine if the abuse criteria are weaker NUD indicators than the others, and could support adding abuse and craving. Validating the set, using total number of criteria endorsed, would also provide evidence for criterion count as a continuous measure of NUD severity. Comparing validity of the two sets, DSM-5 NUD and DSM-IV ND, by comparing the associations between the sets and external validators, would indicate if adding abuse and craving criteria improves validity by strengthening the associations. Lastly, investigating relative prevalence of binary DSM-IV ND and DSM-5 NUD could address validity concerns (i.e. under-diagnosis) as well as redundancy, since adding redundant criteria should not affect prevalence.

The proposed DSM-5 changes could alleviate the concerns noted above if the changes show validity. The present study therefore aimed to: (1) validate the individual DSM-5 NUD criteria by evaluating their relationships to each external validator and examining strength of associations; (2) validate the DSM-5 NUD criteria as a set by evaluating the relationship between each validator and number of NUD criteria endorsed; (3) test differences in the validity of the DSM-IV ND and DSM-5 NUD criterion sets; and (4) assess NUD prevalence. We used data from an Israeli household sample (Hasin *et al.* 2002; Shmulewitz *et al.* 2010, 2011) that has contributed findings concerning the proposed DSM-5 changes to alcohol (Shmulewitz *et al.* 2010) and nicotine (Shmulewitz *et al.* 2011) use disorders.

Method

Study procedures and sample

Data were collected in 2007–2009 from 1349 household residents; details are available elsewhere (Hasin *et al.* 2002; Shmulewitz *et al.* 2010, 2011). We oversampled males because alcohol use (a key aspect of the general study) is limited in Israeli women (Hasin *et al.* 1998; Spivak *et al.* 2007). Interviewers received structured training and administered face-to-face computer-assisted interviews, after obtaining written informed consent approved by relevant American and Israeli Institutional Review Boards (Shmulewitz *et al.* 2010, 2011). The overall response rate was 68.9%. Quality control included field observations, reviews of recorded interviews, and telephone verification of responses. This analysis included the final sample of lifetime smokers, respondents who ever smoked 100 cigarettes ($n=734$). Of these, 81.6% were male; 19.4% were aged 21–29 years, 33.4% were aged 30–44 years, and 47.3% were aged 45 years or older; 28.2% were immigrants from the former Soviet Union (FSU).

Measures

Nicotine criteria and disorders—Lifetime ND criteria (Table 1) were assessed with the Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS; Grant *et al.* 1995, 2003, 2004*b*), also used in other large epidemiological studies (Pull *et al.* 1997; Grant & Dawson, 2001; Grant *et al.* 2004*a*). The AUDADIS has excellent test–retest reliability for number of lifetime ND symptoms (intraclass correlation coefficient=0.76; Grant *et al.* 2003). The ND criteria, except tolerance, were operationalized using the generic DSM-IV dependence criteria (APA, 2000, p. 197). For tolerance, we included two additional symptoms with better face validity (first cigarette of the day had a much stronger effect; no longer dizzy or nauseous from smoking) (Hughes, 1993; APA, 2000, p. 264). The nicotine abuse criteria were assessed with questions parallel to those for DSM-IV substance abuse (Table 1). These questions underwent pre-testing in Israel and *post hoc* review by the DSM-5 SUD Workgroup (Shmulewitz *et al.* 2011), confirming that they represent the proposed nicotine abuse criteria. The craving criterion was similar to alcohol and drug craving questions from other studies (Hasin *et al.* 1996; Foroud *et al.* 2007; Keyes *et al.* 2010). Use of lifetime criteria count (total number of criteria endorsed) was justified by the unidimensionality of DSM-IV ND criteria and DSM-5 NUD criteria (Shmulewitz *et al.* 2011). We refer to the seven ND criteria as ‘DSM-IV criteria’ and to the eleven proposed NUD criteria as ‘DSM-5 criteria’. Lifetime ND was diagnosed by endorsing three or more (≥ 3) criteria, and lifetime NUD was diagnosed with ≥ 2 criteria (the proposed DSM-5 threshold; APA, 2010*a*) and explored with four additional cut-offs (≥ 3, ≥ 4, ≥ 5 or ≥ 6 criteria).

External validators—We use six lifetime validators, each considered a key indicator of nicotine addiction and/or predictor of smoking course (Table 2): (1) smoke-morning: smoking shortly after morning awakening (Colby *et al.* 2000*b*; Foulds *et al.* 2006; Baker *et al.* 2007; Hughes *et al.* 2011); (2) smoke-night: wake at night to smoke (Foulds *et al.* 2006; Scharf *et al.* 2008); (3) smoke-couldn’t: smoking just after being in a situation where smoking was prohibited, similar to ‘Do you find it difficult to refrain from smoking in places where it is forbidden?’ from the Fagerström Test for Nicotine Dependence (FTND; Heatherton *et al.* 1991); (4) smoke-ill: smoking when sick in bed (Heatherton *et al.* 1991); (5) daily smoker: ever smoked daily (Sargent *et al.* 1998); and (6) cigarette amount: number of cigarettes usually smoked per day during heaviest period (Breslau & Johnson, 2000; Colby *et al.* 2000*a*; Hughes, 2006; Baker *et al.* 2007), dichotomized at ≥ 20/day (John *et al.* 2004).

Statistical analysis

Association between validators and nicotine criteria—Logistic regression (SAS 9.2; SAS Institute Inc.) evaluated the relationship between each external validator (predictor) and each DSM-5 criterion (outcome), reported as odds ratios (ORs) indicating the increase in odds of endorsing the criterion given the presence of the validator, adjusted for gender, age and FSU status (Baron-Epel *et al.* 2004). Both generic tolerance and tolerance expanded (including the additional nicotine specific symptoms) were analysed. Associations were significant for both forms, but slightly stronger for tolerance expanded; those results were reported.

Comparative validity of the DSM-IV and DSM-5 sets—Receiver operating characteristic (ROC) curve analysis evaluates the predictive ability (validity) of a continuous diagnostic test (e.g. criterion count) against a binary standard (e.g. validator) (Shin, 2009). The area under the ROC curve (AUC) measures discrimination, i.e. the total ability of the continuous diagnostic test to predict the presence or absence of the binary standard (Hanley & McNeil, 1982). The AUC of a test without predictive value is 0.50 (50%), reflecting

chance, while the AUC of a perfect test is 1.0; $AUC > 0.7$ indicates good validity (Terwee *et al.* 2007). ROC analysis can also test differences in discrimination (or validity) between two continuous tests by testing differences between the two AUCs for the same validator.

ROC curve analysis was conducted with PROC LOGISTIC (SAS 9.2), correcting for gender, age and FSU status (Shin, 2009). For each validator, we plotted two ROC curves, corresponding to the DSM-IV and DSM-5 sets, and calculated the AUC for each. A criterion set had significant predictive value for the validator if the difference between the AUC and the AUC for chance (0.50) was significantly greater than zero (DeLong *et al.* 1988). Since both criterion sets were measured in the same sample, paired-sample tests were used to compare the AUCs (DeLong *et al.* 1988; Shin, 2009). We subtracted the DSM-IV AUC from the DSM-5 AUC; a difference significantly greater than zero indicated that the DSM-5 set offered significantly more validity than the DSM-IV set. To further understand the differences between the sets, additional comparisons were explored: (1) DSM-IV set and craving (DSM-IV+ C) *v.* DSM-IV; (2) DSM-IV set and abuse criteria (DSM-IV+AB) *v.* DSM-IV; (3) DSM-IV+C *v.* DSM-IV+ AB; (4) DSM-IV+C *v.* DSM-5; and (5) DSM-IV+ AB *v.* DSM-5.

Binary NUD—We evaluated prevalence of DSM-IV ND and DSM-5 NUD (using five thresholds) and measured chance-corrected agreement between ND and each NUD diagnosis with the κ statistic (SAS 9.2).

Results

Prevalence of the nicotine criteria and validators is shown in Tables 1 and 2. The average number of criteria endorsed was 3.56 (S.D.=1.77) for DSM-IV and 4.93 (S.D.=2.56) for DSM-5.

Each of the 11 DSM-5 criteria was strongly and significantly associated with each validator (Fig. 1; Tables S1 and S2), with one exception [‘neglect roles to smoke’ was not associated with smoking when ill in bed (smoke-ill)]. For example, ORs for the associations were as follows: ‘tolerance’, 2.23 (smoke-ill) to 6.01 [smoke just after being where smoking was prohibited (smoke-couldn’t)]; ‘activities given up to smoke’, 2.52 (smoke-ill) to 4.64 (daily smoker); ‘smoking in hazardous situations’, 4.18 (smoking shortly after morning awakening) to 6.91 (smoke-couldn’t); and ‘craving’, 5.53 (waking at night to smoke) to 10.93 (smoke-couldn’t) (Fig. 1, Tables S1 and S2). For each criterion, mean OR across all validators was calculated, and error bars representing the 95% confidence interval (CI) of the OR distribution around the mean were generated. Visually, associations with craving were higher than with other criteria, but the 95% CIs overlapped across all criteria with one exception (‘craving’ and ‘smoking more than intended’; Fig. 1), indicating that generally the dependence, abuse and craving criteria showed validity evidence of similar strength.

For all validators, the DSM-5 criteria as a set significantly discriminated between individuals with or without the validator, indicated by AUCs (Fig. 2) significantly greater than chance (50%), $p < 0.0001$ (Table 3). For example, based on criteria count, the DSM-5 set had 86.2% (AUC=0.862) probability of correctly distinguishing a person endorsing smoke-couldn’t from a person not endorsing smoke-couldn’t. Stated otherwise, 86.2% of the time, a person endorsing smoke-couldn’t would have more DSM-5 criteria than a person not endorsing that validator.

The DSM-5 set resulted in AUCs significantly larger than those from the DSM-IV set (i.e. the differences were significantly greater than 0; Table 3) for all validators. For example, the

DSM-5 set had 4.5% more discriminatory ability for smoke-couldn't than DSM-IV; across all validators, the DSM-5 set showed increases ranging from 3.8% to 5.2%.

Further exploration (Table S3) showed that adding craving only (DSM-IV+C) significantly increased discrimination over DSM-IV for all validators (increases from 1.6% to 3.4%), and adding three abuse criteria (DSM-IV+AB) significantly increased discrimination over DSM-IV for all validators (increases from 2.3% to 3.3%). Although DSM-IV+C and DSM-IV+AB showed similar discrimination, adding abuse criteria to DSM-IV+C (completing the DSM-5 set) significantly increased discrimination over DSM-IV+C for all validators except smoke-at-night (increases from 1.5% to 2.3%), and adding craving to DSM-IV+AB (DSM-5 set) significantly increased discrimination over DSM-IV+AB for all validators except daily smoker (increases from 0.9% to 2.5%).

Prevalence of binary DSM-IV ND was 72.3%, with a higher prevalence of binary DSM-5 NUD using the two or more (2) or 3 criteria threshold (88.6% and 80.9%, respectively), similar prevalence using the 4 threshold (71.1%), and a lower prevalence using the 5 (57.2%) or 6 threshold (42.9%). Diagnostic agreement between ND was largest with NUD based on 4 criteria ($\kappa = 0.80$), and lower for the other thresholds (2, $\kappa = 0.51$; 3, $\kappa = 0.76$; 5, $\kappa = 0.64$; and 6, $\kappa = 0.45$).

Discussion

This study examined validity of the proposed DSM-5 NUD criterion set using six clinically important validators, supporting the proposed changes to NUD diagnosis (APA, 2010b) with four main findings. Each DSM-5 NUD criterion was associated with the validators with similar strength across the criteria, since the effect sizes (ORs) were generally within the same range. The DSM-5 criterion set was associated with all validators, as seen by the ability to discriminate between the presence or absence of each validator, with greater validity (increased discrimination) than the DSM-IV set for all validators. Last, the prevalence of binary DSM-5 NUD was higher than that of DSM-IV ND.

Dependence criteria

Although the face validity of the DSM-IV dependence criteria has been discussed (e.g. Hughes, 1993, 2006; Hughes *et al.* 2011), only a few studies tested concurrent validity (Nelson & Wittchen, 1998; John *et al.* 2004; West, 2005; Hendricks *et al.* 2008). Our results suggest that the DSM-IV criteria are valid indicators of a nicotine disorder. These results were similar to those from general populations (Nelson & Wittchen, 1998; John *et al.* 2004), but different from those in clinical samples (West, 2005; Hendricks *et al.* 2008), suggesting the need for additional studies in clinical samples with higher disorder severity.

Two criteria merit additional mention. In the mid-to-late 20th century, 'giving up activities to smoke' was seldom necessary because smoking was generally accepted and unrestricted. However, with increasing restrictions and decreasing social acceptance of smoking, this criterion now appears to have face validity (Leshov *et al.* 2004), and showed concurrent validity in this study, similar to the other criteria. This does not mean that changing external circumstances should be confused with the biological processes underlying inability to stop smoking, but rather, that a smoking disorder is now indicated by smoking despite external pressures not to. 'Tolerance', operationalized using the generic definition (smoking more to get desired effect; increasing use over time), may not apply once smokers reach a baseline level of heavy, consistent use (Hughes, 2006). Therefore, DSM-IV (APA, 2000, p. 264) provides additional tolerance indicators (first cigarette of the day has a stronger effect than others; cessation of dizziness or nausea with continued use), which appear to have face validity (Hughes, 1993). In our study, generically defined tolerance gave similar but slightly

weaker results (data not shown) than the tolerance criterion we included, suggesting that while both forms of tolerance show validity, expanding the assessment of tolerance may increase validity.

Abuse criteria

The abuse criteria have been criticized as irrelevant to NUD (Hughes *et al.* 2011). If this were true, they would rarely be endorsed and show little relationship to validators. Our results suggest otherwise: the abuse criteria had prevalence patterns similar to the patterns found for other substances, and were significantly and strongly related to the external validators. Furthermore, these criteria now appear to have face validity. ‘Neglect of roles to smoke’ appears applicable given changes in the legal and social landscape regarding smoking. For this criterion, low prevalence does not show lack of validity, but rather suggests a role in identifying severe cases of NUD, similar to this criterion for other substances (Hasin *et al.* 2012). To support this, additional research is needed in clinical settings with more severe cases. The ‘hazardous use’ criterion is supported by epidemiological studies showing that individuals smoke in situations despite increased risk of harm. For example, smokers have a higher risk of traffic accidents than other drivers (Brisson, 1990; Sacks & Nelson, 1994) and smoking is a leading cause of fire-related injury and mortality (Sacks & Nelson, 1994; Leistikow *et al.* 2000; Goldstein *et al.* 2010). ‘Continued smoking despite interpersonal problems’ because of smoking may have validity due to increased public awareness of the hazards of direct and second-hand cigarette smoke.

Craving criterion

Craving, considered a core feature of ND by many, may be the most proximal cause of smoking, and predicts smoking cessation and abstinence (Hughes, 1994; Tiffany *et al.* 2009; Benowitz, 2010; DiFranza *et al.* 2010; Baker *et al.* 2012; Tiffany & Wray, 2012). Although craving was recognized as being relevant for nicotine and was included in DSM-III as a withdrawal symptom, DSM-IV excluded craving during withdrawal partially because craving can occur during smoking (Hughes, 1994). The proposal to include craving as a separate criterion in DSM-5 was supported by nicotine clinicians and researchers (Hughes *et al.* 2011; Baker *et al.* 2012); this study provides empirical evidence for its inclusion, by showing strong association between the craving criterion and all validators.

DSM-5 NUD criterion set

The DSM-5 set showed validity, as indicated by significant ability to discriminate between individuals with or without the validators. This validity evidence also supports criterion count as a measure of NUD severity. The DSM-5 set had significantly more discriminatory ability (predictive validity) than the DSMIV set, as evidenced by larger AUC, suggesting that the DSM-5 provides a more valid criterion set. Further exploratory analyses suggested that the validity increased due to both craving and abuse criteria, since adding either the abuse criteria or craving to the DSMIV criteria resulted in increased validity. Although both sets [DSM-IV plus craving (DSM-IV+C) and DSM-IV plus abuse (DSM-IV+AB)] showed similar validity, completing the DSM-5 set by adding abuse to the DSM-IV+C set or by adding craving to the DSM-IV+ AB set further significantly increased validity. This differs from the increase in total information for the DSM-5 set compared with the DSM-IV set shown previously (Shmulewitz *et al.* 2011); the earlier analysis did not take into account validators, while here, increased validity indicates a stronger relationship to validators.

Adding relevant criteria to an existing set does not necessarily increase discrimination (AUC). For example, adding criteria at the extreme ends of the disorder would not increase the AUC, since the validator is either present or absent for all participants at those points. Also, adding criteria that discriminate the validator in any region of the AUC that is already

well discriminated by other criteria would not increase the AUC. Since adding criteria increases the AUC, the new criteria are not redundant with existing criteria and can improve diagnostic efficiency. Although gains in discrimination were modest (between 4% and 5%), possibly due to the use of related validators instead of the ‘gold standard’ (underlying ‘nicotine disorder’), any gain in diagnostic accuracy is important for a disorder with a large impact on world health.

NUD prevalence

DSM-5 will utilize a diagnostic cut-off of 2 SUD criteria based on empirical evidence that this cut-off produced best agreement in prevalence with diagnoses of DSM-IV SUD (dependence or abuse; APA, 2010a; D. Hasin *et al.* unpublished observations). For nicotine, this evidence-based strategy is not directly relevant, since DSM-IV has only one nicotine disorder, i.e. dependence, and did not include abuse. Therefore, the SUD Workgroup was not trying to identify the cut-off for DSM-5 NUD that best matched disorder prevalence to DSM-IV (i.e. 4 criteria, which showed the best agreement here). Rather, the 2 criteria threshold was preferred for two main reasons. The first was to increase NUD prevalence, addressing concerns that individuals whose smoking patterns suggest dependence have not been diagnosed as dependent using the DSM-IV (Baker *et al.* 2012). Since nicotine disorders place a profound health and economic burden on individuals and society, correcting under-diagnosis should be a major public health priority. The second was to provide consistency with the other DSM-5 SUDs, unless evidence suggested that this was inadvisable.

Examining the evidence, a NUD diagnosis based on 2 criteria was strongly associated with all six validators (p values <0.0001 ; data not shown), providing empirical validity for this cut-off. Diagnoses based on other cut-offs (3 or 4) also showed strong association with the validators (p values <0.0001 ; data not shown), an unsurprising result given that the DSM-5 NUD criteria form one continuous latent trait (Shmulewitz *et al.* 2011), suggesting that no particular cut-off would show stronger empirical support. However, DSM-5 will have a dimensional severity index (2–3 criteria, mild; 4–5 criteria, moderate; and 6 criteria, severe; APA, 2010b), which can be used for graded diagnoses.

The FTND (Heatherton *et al.* 1991) is a widely used diagnostic tool for ND (Baker *et al.* 2012). Four validators we used were either taken directly from the FTND (smoke-ill) or were related to FTND questions (smoke-morning, smoke-couldn’t, and 20+ cigarettes). Further studies directly evaluating whether adding any of the DSM-5 NUD criteria to the FTND improves its validity are beyond the scope of this study but could be informative. A similar strategy to what we did in this study could be applied, i.e. investigating the comparative validity of the FTND and FTND+DSM-5 to other external validators. Evidence of increased validity with the combined set would suggest value in adding new criteria to the FTND.

We note study limitations. Data were collected by self-report, similar to other epidemiological studies. However, we used a well-validated measure (AUDADIS) that has been used in large studies worldwide. While lifetime criteria may be affected by memory and recall bias, the validators were assessed for the same lifetime time-frame. Future studies should be conducted using current criteria with current validators. Prospective validators such as smoking cessation, abstinence or treatment response (Hughes, 2006) were not available, but most validators used here have previously been shown to predict those outcomes (Heatherton *et al.* 1991; Sargent *et al.* 1998; Breslau & Johnson, 2000; Foulds *et al.* 2006; Baker *et al.* 2007; Scharf *et al.* 2008). All validators were related to quantity and pervasiveness of smoking behavior; investigation of additional variables relating to more distal outcomes, such as overall physical health and psychiatric disorders (e.g. other substance use or disorders, depression), is warranted. Furthermore, this study focused solely

on convergent validity; studies of discriminant validity should be carried out. Although ND and NUD were assessed without requiring temporal clustering, such a requirement would be expected to reduce both ND and NUD prevalence, maintaining higher prevalence for NUD. This should be addressed in future studies. Lastly, although we tested six validators for each criterion or criterion set, these are not necessarily ‘independent’ tests, as the validators are related. Even so, if we apply the highly conservative Bonferroni correction, i.e. reduce the p value for significance to $0.05/6=0.0083$, all results remain significant except the association of ‘neglect roles to smoke’ and daily smoker (nominal p value= 0.036).

Additional study strengths are noted. Data collection involved stringent quality-assurance procedures and resulted in a sizable sample with a good response rate. This is the first study to analyse many validators in a large general population sample of adult smokers to test validity of each ND criterion, and the first study of any kind to assess validity of the abuse criteria and of the entire DSM-5 criterion set, and to assess comparative validity with the DSM-IV set. Thus, this sample contributes unique results to the existing literature.

In conclusion, these validity results support the addition of nicotine abuse and craving criteria to NUD in DSM-5, leading to a more discriminatory measure of NUD and aligning the diagnostic criteria across all substances. The proposed changes to DSM-5 NUD alleviate several concerns about the DSM-IV approach to nicotine disorders, such as lack of validity, exclusion of craving, dichotomous diagnosis, and under diagnosis of nicotine disorders (Shiffman *et al.* 2004; DiFranza *et al.* 2010; Hughes *et al.* 2011; Baker *et al.* 2012). Each dependence and abuse criterion showed concurrent validity in this general population sample. Adding craving was supported by the validity results. The DSM-5 set, using criterion count, showed concomitant validity, and provided a continuous measure of disorder severity. Increased discrimination compared with the DSM-IV set addresses the concern that adding criteria could reduce diagnostic efficiency (Hughes, 2006; Chung *et al.* 2012). Finally, dichotomous DSM-5 NUD (two or more criteria) showed increased prevalence. Therefore, adoption of these proposed changes in DSM-5 should improve NUD diagnosis.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This research was funded by National Institutes of Health grants no. R01AA013654, R01DA018652 and K05AA014223 (to D.H.) and no. K23DA016743 (to E.A.), and by the New York State Psychiatric Institute (to D.H.). None of the authors or researchers has any connection with the tobacco, alcohol, pharmaceutical or gaming industries or any body substantially funded by one of these organizations. We acknowledge the helpful consultations of Rachel Bar-Hamburger, Ph.D., Rina Meyer and Zalman Shoval in collecting the data in Israel.

References

- APA. Diagnostic and Statistical Manual of Mental Disorders. 4. American Psychiatric Association; Washington, DC: 2000. text revision (DSM-IV-TR)
- APA. [Accessed 19 September 2011.] DSM-5 Development, proposed revision: substance use disorder (. 2010a. <http://www.dsm5.org/ProposedRevisions/Pages/proposedrevision.aspx?rid=431>
- APA. [Accessed 8 September 2011.] DSM-5 Development, proposed revision: tobacco use disorder. 2010b. (<http://www.dsm5.org/ProposedRevisions/Pages/proposedrevision.aspx?rid=459>)
- Baker TB, Breslau N, Covey L, Shiffman S. DSM criteria for tobacco use disorder and tobacco withdrawal: a critique and proposed revisions for DSM-5. *Addiction*. 2012; 107:263–275. [PubMed: 21919989]

- Baker TB, Piper ME, McCarthy DE, Bolt DM, Smith SS, Kim SY, Colby S, Conti D, Giovino GA, Hatsukami D, Hyland A, Krishnan-Sarin S, Niaura R, Perkins KA, Toll BA. Time to first cigarette in the morning as an index of ability to quit smoking: implications for nicotine dependence. *Nicotine and Tobacco Research*. 2007; 9 (Suppl. 4):S555–S570. [PubMed: 18067032]
- Baron-Epel O, Haviv-Messika A, Tamir D, Nitzan-Kaluski D, Green M. Multiethnic differences in smoking in Israel: pooled analysis from three national surveys. *European Journal of Public Health*. 2004; 14:384–389. [PubMed: 15542874]
- Benowitz NL. Nicotine addiction. *New England Journal of Medicine*. 2010; 362:2295–2303. [PubMed: 20554984]
- Borges G, Ye Y, Bond J, Cherpitel CJ, Cremonese M, Moskalewicz J, Swiatkiewicz G, Rubio-Stipec M. The dimensionality of alcohol use disorders and alcohol consumption in a cross-national perspective. *Addiction*. 2010; 105:240–254. [PubMed: 20078482]
- Breslau N, Johnson EO. Predicting smoking cessation and major depression in nicotine-dependent smokers. *American Journal of Public Health*. 2000; 90:1122–1127. [PubMed: 10897192]
- Brisson RJ. Risk of automobile accidents in cigarette smokers. *Canadian Journal of Public Health*. 1990; 81:102–106. [PubMed: 2331646]
- Chung T, Martin CS, Maisto SA, Cornelius JR, Clark DB. Greater prevalence of proposed DSM-5 nicotine use disorder compared to DSM-IV nicotine dependence in treated adolescents and young adults. *Addiction*. 2012; 107:810–818. [PubMed: 22092543]
- Colby SM, Tiffany ST, Shiffman S, Niaura RS. Are adolescent smokers dependent on nicotine ? A review of the evidence. *Drug and Alcohol Dependence*. 2000a; 59 (Suppl. 1):S83–S95. [PubMed: 10773439]
- Colby SM, Tiffany ST, Shiffman S, Niaura RS. Measuring nicotine dependence among youth: a review of available approaches and instruments. *Drug and Alcohol Dependence*. 2000b; 59 (Suppl. 1):S23–S39. [PubMed: 10773436]
- Cronbach LJ, Meehl PE. Construct validity in psychological tests. *Psychological Bulletin*. 1955; 52:281–302. [PubMed: 13245896]
- DeLong ER, DeLong DM, Clarke-Pearson DL. Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach. *Biometrics*. 1988; 44:837–845. [PubMed: 3203132]
- DiFranza J, Ursprung WW, Lauzon B, Bancej C, Wellman RJ, Ziedonis D, Kim SS, Gervais A, Meltzer B, McKay CE, O'Loughlin J, Okoli CT, Fortuna LR, Tremblay M. A systematic review of the Diagnostic and Statistical Manual diagnostic criteria for nicotine dependence. *Addictive Behaviors*. 2010; 35:373–382. [PubMed: 20056335]
- Feighner JP, Robins E, Guze SB, Woodruff RA Jr, Winokur G, Munoz R. Diagnostic criteria for use in psychiatric research. *Archives of General Psychiatry*. 1972; 26:57–63. [PubMed: 5009428]
- Foroud T, Wetherill LF, Liang T, Dick DM, Hesselbrock V, Kramer J, Nurnberger J, Schuckit M, Carr L, Porjesz B, Xuei X, Edenberg HJ. Association of alcohol craving with *a*-synuclein (SNCA). *Alcoholism: Clinical and Experimental Research*. 2007; 31:537–545.
- Foulds J, Gandhi KK, Steinberg MB, Richardson DL, Williams JM, Burke MV, Rhoads GG. Factors associated with quitting smoking at a tobacco dependence treatment clinic. *American Journal of Health Behavior*. 2006; 30:400–412. [PubMed: 16787130]
- Goldstein AO, Grant E, McCullough A, Cairns B, Kurian A. Achieving fire-safe cigarette legislation through coalition-based legislative advocacy. *Tobacco Control*. 2010; 19:75–79. [PubMed: 19748887]
- Grant, BF.; Dawson, DA. [Accessed 4 October 2011.] Introduction to the National Epidemiologic Survey on Alcohol and Related Conditions (. 2001. <http://pubs.niaaa.nih.gov/publications/arh29-2/74-78.htm>)
- Grant BF, Dawson DA, Stinson FS, Chou PS, Kay W, Pickering R. The Alcohol Use Disorder and Associated Disabilities Interview Schedule-IV (AUDADIS-IV): reliability of alcohol consumption, tobacco use, family history of depression and psychiatric diagnostic modules in a general population sample. *Drug and Alcohol Dependence*. 2003; 71:7–16. [PubMed: 12821201]
- Grant BF, Harford TC, Dawson DA, Chou PS, Pickering RP. The Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS): reliability of alcohol and drug modules

in a general population sample. *Drug and Alcohol Dependence*. 1995; 39:37–44. [PubMed: 7587973]

Grant BF, Hasin DS, Chou SP, Stinson FS, Dawson DA. Nicotine dependence and psychiatric disorders in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Archives of General Psychiatry*. 2004a; 61:1107–1115. [PubMed: 15520358]

Grant BF, Stinson FS, Dawson DA, Chou SP, Ruan WJ, Pickering RP. Co-occurrence of 12-month alcohol and drug use disorders and personality disorders in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Archives of General Psychiatry*. 2004b; 61:361–368. [PubMed: 15066894]

Hanley JA, McNeil BJ. The meaning and use of the area under a receiver operating characteristic (ROC) curve. *Radiology*. 1982; 143:29–36. [PubMed: 7063747]

Hasin D, Aharonovich E, Liu X, Mamman Z, Matseoane K, Carr L, Li TK. Alcohol and ADH2 in Israel: Ashkenazis, Sephardics, and recent Russian immigrants. *American Journal of Psychiatry*. 2002; 159:1432–1434. [PubMed: 12153842]

Hasin D, McCloud S, Li Q, Endicott J. Cross-system agreement among demographic subgroups: DSM-III, DSM-III-R, DSM-IV and ICD-10 diagnoses of alcohol use disorders. *Drug and Alcohol Dependence*. 1996; 41:127–135. [PubMed: 8809501]

Hasin D, Rahav G, Meydan J, Neumark Y. The drinking of earlier and more recent Russian immigrants to Israel: comparison to other Israelis. *Journal of Substance Abuse*. 1998; 10:341–353. [PubMed: 10897288]

Hasin DS, Fenton MC, Beseler C, Park JY, Wall MM. Analyses related to the development of DSM-5 criteria for substance use related disorders: 2. Proposed DSM-5 criteria for alcohol, cannabis, cocaine and heroin disorders in 663 substance abuse patients. *Drug and Alcohol Dependence*. 2012; 122:28–37. [PubMed: 21963333]

Hasin DS, Grant BF. The co-occurrence of DSM-IV alcohol abuse in DSM-IV alcohol dependence: results of the National Epidemiologic Survey on Alcohol and Related Conditions on heterogeneity that differ by population subgroup. *Archives of General Psychiatry*. 2004; 61:891–896. [PubMed: 15351767]

Hasin DS, Hatzenbuehler M, Smith S, Grant BF. Co-occurring DSM-IV drug abuse in DSM-IV drug dependence: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Drug and Alcohol Dependence*. 2005; 80:117–123. [PubMed: 16157234]

Heatherton TF, Kozlowski LT, Frecker RC, Fagerström KO. The Fagerström Test for Nicotine Dependence: a revision of the Fagerström Tolerance Questionnaire. *British Journal of Addiction*. 1991; 86:1119–1127. [PubMed: 1932883]

Hendricks PS, Prochaska JJ, Humfleet GL, Hall SM. Evaluating the validities of different DSM-IV-based conceptual constructs of tobacco dependence. *Addiction*. 2008; 103:1215–1223. [PubMed: 18554351]

Hughes JR. Smoking is a drug dependence: a reply to Robinson and Pritchard. *Psychopharmacology (Berlin)*. 1993; 113:282–283. [PubMed: 7855194]

Hughes JR. Nicotine withdrawal, dependence, and abuse. In: Widiger, TA.; Frances, AJ.; Pincus, HA.; First, MB.; Ross, R.; Davis, W., editors. *DSM-IV Sourcebook*. American Psychiatric Association; Washington, DC: 1994. p. 109–116. p. 1

Hughes JR. Should criteria for drug dependence differ across drugs? *Addiction*. 2006; 101 (Suppl. 1): 134–141. [PubMed: 16930170]

Hughes JR, Baker T, Breslau N, Covey L, Shiffman S. Applicability of DSM criteria to nicotine dependence. *Addiction*. 2011; 106:894–895. [PubMed: 21477244]

John U, Meyer C, Hapke U, Rumpf HJ. Nicotine dependence and lifetime amount of smoking in a population sample. *European Journal of Public Health*. 2004; 14:182–185. [PubMed: 15230506]

Kerridge BT, Saha TD, Smith S, Chou PS, Pickering RP, Huang B, Ruan JW, Pulay AJ. Dimensionality of hallucinogen and inhalant/solvent abuse and dependence criteria: implications for the Diagnostic and Statistical Manual of Mental Disorders-Fifth Edition. *Addictive Behaviors*. 2011; 36:912–918. [PubMed: 21621334]

Keyes KM, Krueger RF, Grant BF, Hasin DS. Alcohol craving and the dimensionality of alcohol disorders. *Psychological Medicine*. 2010; 41:629–640. [PubMed: 20459881]

- Leistikow BN, Martin DC, Milano CE. Fire injuries, disasters, and costs from cigarettes and cigarette lights: a global overview. *Preventive Medicine*. 2000; 31:91–99. [PubMed: 10938207]
- Lesso CN, Martin NG, Statham DJ, Todorov AA, Slutske WS, Bucholz KK, Heath AC, Madden PA. Defining nicotine dependence for genetic research: evidence from Australian twins. *Psychological Medicine*. 2004; 34:865–879. [PubMed: 15500307]
- Lynskey MT, Agrawal A. Psychometric properties of DSM assessments of illicit drug abuse and dependence: results from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). *Psychological Medicine*. 2007; 37:1345–1355. [PubMed: 17407621]
- Nelson CB, Wittchen HU. Smoking and nicotine dependence. Results from a sample of 14- to 24-year-olds in Germany. *European Addiction Research*. 1998; 4:42–49. [PubMed: 9740816]
- Piper ME, McCarthy DE, Baker TB. Assessing tobacco dependence: a guide to measure evaluation and selection. *Nicotine and Tobacco Research*. 2006; 8:339–351. [PubMed: 16801292]
- Pull CB, Saunders JB, Mavreas V, Cottler LB, Grant BF, Hasin DS, Blaine J, Mager D, Ustun BT. Concordance between ICD-10 alcohol and drug use disorder criteria and diagnoses as measured by the AUDADIS-ADR, CIDI and SCAN: results of a cross-national study. *Drug and Alcohol Dependence*. 1997; 47:207–216. [PubMed: 9306046]
- Sacks JJ, Nelson DE. Smoking and injuries: an overview. *Preventive Medicine*. 1994; 23:515–520. [PubMed: 7971880]
- Saha TD, Compton WM, Chou SP, Smith S, Ruan WJ, Huang B, Pickering RP, Grant BF. Analyses related to the development of DSM-5 criteria for substance use related disorders: 1. Toward amphetamine, cocaine and prescription drug use disorder continua using Item Response Theory. *Drug and Alcohol Dependence*. 2012; 122:38–46. [PubMed: 21963414]
- Sargent JD, Mott LA, Stevens M. Predictors of smoking cessation in adolescents. *Archives of Pediatrics and Adolescent Medicine*. 1998; 152:388–393. [PubMed: 9559717]
- Scharf DM, Dunbar MS, Shiffman S. Smoking during the night: prevalence and smoker characteristics. *Nicotine and Tobacco Research*. 2008; 10:167–178. [PubMed: 18188757]
- Shiffman S, Waters AJ, Hickcox M. The nicotine dependence syndrome scale: a multidimensional measure of nicotine dependence. *Nicotine and Tobacco Research*. 2004; 6:327–348. [PubMed: 15203807]
- Shin, S. [Accessed 28 August 2012.] ROC analysis for the evaluation of continuous biomarkers: existing tools and new features in SAS® 9.2. 2009. (<http://pharmasug.org/download/papers/SP09.pdf>)
- Shmulewitz D, Keyes K, Beseler C, Aharonovich E, Aivadyan C, Spivak B, Hasin D. The dimensionality of alcohol use disorders: results from Israel. *Drug and Alcohol Dependence*. 2010; 111:146–154. [PubMed: 20537809]
- Shmulewitz D, Keyes KM, Wall MM, Aharonovich E, Aivadyan C, Greenstein E, Spivak B, Weizman A, Frisch A, Grant BF, Hasin D. Nicotine dependence, abuse, and craving: dimensionality in an Israeli sample. *Addiction*. 2011; 106:1675–1686. [PubMed: 21545668]
- Spivak B, Frisch A, Maman Z, Aharonovich E, Alderson D, Carr LG, Weizman A, Hasin D. Effect of *ADH1B* genotype on alcohol consumption in young Israeli Jews. *Alcoholism: Clinical and Experimental Research*. 2007; 31:1297–1301.
- Terwee CB, Bot SD, De Boer MR, Van Der Windt DA, Knol DL, Dekker J, Bouter LM, De Vet HC. Quality criteria were proposed for measurement properties of health status questionnaires. *Journal of Clinical Epidemiology*. 2007; 60:34–42. [PubMed: 17161752]
- Tiffany ST, Warthen MW, Goedecker KC. The functional significance of craving in nicotine dependence. *Nebraska Symposium on Motivation*. 2009; 55:171–197. [PubMed: 19013944]
- Tiffany ST, Wray JM. The clinical significance of drug craving. *Annals of the New York Academy of Sciences*. 2012; 1248:1–17. [PubMed: 22172057]
- West, R. Defining and assessing nicotine dependence in humans. In: Goode, J., editor. *Understanding Smoking and Nicotine Addiction*. Wiley: London; 2005. p. 36-52.

Fig. 1. Association of Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5) nicotine use disorder criteria and validators. Symbols indicate odds ratios corrected for age, gender and former Soviet Union status. Confidence intervals for odds ratios are shown in Tables S1 and S2. For each criterion, gray diamonds indicate mean odds ratios across all validators, with error bars representing 95% of the distribution around the mean.

Fig. 2.

Receiver operating characteristic curves for validators and Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV and DSM-5 criterion sets. See Table 3 for a summary of the areas under the receiver operating characteristic curves (AUCs) for each figure. (a) Smoke upon waking in the morning; (b) wake at night to smoke; (c) smoke after being in a situation where smoking was prohibited; (d) smoke even when ill in bed; (e) ever smoke daily; (f) usually smoked 20+ cigarettes a day during period of heaviest smoking.

Table 1

Prevalence of and questions used to assess lifetime nicotine criteria in lifetime smokers (n=734) (adapted from Shmulewitz et al. 2011)

Lifetime criterion	%	<i>n</i>	Assessment
Dependence ^a			
Tolerance	80.7	592	Use more nicotine to get desired effect OR increase smoking by at least 50% OR first cigarette of the day had a much stronger effect OR no longer got dizzy/nauseous from smoking ^b
Withdrawal	24.7	181	Withdrawal syndrome ^c , as assessed by experiencing 4+ symptoms (depression, sleep problems, concentration problems, eat more/gain weight, irritable, slower heart beat, anxious/nervous, restlessness) after stopping/cutting down on smoking, that cause distress/dysfunction OR smoke to avoid having symptoms
More	55.2	405	Often smoked more than intended to
Stop/cut down	61.4	451	More than once want to OR unable to stop/cut down on smoking
Time spent	38.6	283	Chain smoking
Activities given up	15.9	117	Give up/restrict important or pleasurable activities because smoking was prohibited
Health problems	79.2	581	Continue to smoke even though caused or exacerbated a physical/psychological health problem OR made you jittery/anxious/depressed
Abuse ^d			
Neglect roles	07.8	57	Smoking interfered with job, school, or home responsibilities
Hazardous use	36.4	267	Smoke in a situation that increased chances of getting hurt, like in bed or around flammable chemicals
Interpersonal problems	41.1	302	Continue to smoke despite making people angry or unhappy
Craving	52.6	386	When run out of cigarettes, often find it almost unbearable until can get more OR often get a strong desire to smoke when have not smoked for a while

^aAPA (2000), p. 197.

^bAPA (2000), p. 264.

^cAPA (2000), p. 266.

^dAPA (2000), p. 199.

Table 2

Assessment and prevalence of lifetime validators in lifetime smokers (n=734)

Binary validator	%	Assessment
Smoke-morning	43.5	Often smoke just or shortly after getting in the morning
Smoke-night	18.1	Wake up in the middle of the night to smoke
Smoke-couldn't	69.8	Smoking just after being in a situation where smoking was not permitted – like on a plane, at a meeting or the mall
Smoke-ill	27.8	Smoke even when ill in bed most of the day
Daily smoker	88.1	Ever smoked daily
Cigarette amount (20+/day)	64.7	How many cigarettes usually smoked in a single day, during period of heaviest smoking

Table 3

Receiver operating characteristic curve analysis in lifetime smokers (n=734), showing the relationship of the validators and the number of DSM-IV or DSM-5 criteria endorsed

Validator	DSM-IV AUC ^a (95% CI)	DSM-5 AUC ^a (95% CI)	Difference (95% CI) between DSM-5 and DSM-IV AUCs
Smoke-morning ^b	0.755 (0.720–0.789)	0.801 (0.770–0.832)	0.046 (0.029–0.063), $p<0.0001$
Smoke-night ^c	0.757 (0.714–0.800)	0.795 (0.757–0.833)	0.038 (0.017–0.059), $p=0.0003$
Smoke-couldn't ^d	0.817 (0.783–0.850)	0.862 (0.833–0.891)	0.045 (0.030–0.061), $p<0.0001$
Smoke-ill ^e	0.713 (0.673–0.754)	0.765 (0.729–0.801)	0.052 (0.034–0.070), $p<0.0001$
Daily smoker ^f	0.776 (0.725–0.828)	0.814 (0.767–0.862)	0.038 (0.018–0.059), $p=0.0002$
20+ cigarettes ^g	0.791 (0.756–0.826)	0.841 (0.810–0.872)	0.051 (0.035–0.066), $p<0.0001$

DSM, Diagnostic and Statistical Manual of Mental Disorders; AUC, area under the receiver operating characteristic curve, CI, confidence interval.

^a All AUCs significantly greater than chance (0.50), $p<0.0001$.

^b Smoke upon waking in the morning.

^c Wake at night to smoke.

^d Smoke after being in a situation where smoking was prohibited.

^e Smoke even when ill in bed.

^f Ever smoke daily.

^g Usually smoked 20+ cigarettes a day during period of heaviest smoking.