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Dimensionality of DSM-IV nicotine dependence in a national sample: An item response theory application☆

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Abstract

Background—Research focusing on the development of a dimensional representation of DSM-IV nicotine dependence is scarce and prior research has not assessed the role of nicotine use criteria in that a dimensional representation, nor the invariance of the DSM-IV nicotine dependence criteria across important population subgroups.

Methods—Using a large, representative sample of the U.S. population, this study utilized item response theory (IRT) analyses to explore the dimensionality of DSM-IV nicotine dependence criteria and several candidate criteria for cigarette use among past-year cigarette smokers (n = 10,163).

Results—Factor analyses demonstrated the unidimensionality of nicotine dependence criteria and IRT analyses demonstrated good fit of the observed responses and the underlying, unobserved latent trait of dependence severity. The model containing all seven DSM-IV dependence criteria, along with the consumption criterion of smoking at least a quarter of a pack of cigarettes in a day in the past year, was identified as the best-fitting model. No differential criterion functioning was shown across sex, race-ethnicity, and age subgroups.

Discussion—Major implications of this study are discussed in terms of the addition of a dimensional representation of nicotine dependence to pre-existing categorical representations of the disorder in the DSM-V, and the need for a nicotine consumption criterion to improve representations of nicotine dependence severity.

☆The views and opinions expressed in this report are those of the authors and should not be construed to represent the views of any of the sponsoring organizations, agencies, or the U.S. government.

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Contributors

Drs. Grant, Saha and Smith prepared the first draft of the manuscript and together with Drs. Stinson, Pulay conceived and planned the study. Drs. Saha, Smith and Ruan conducted the analyses and Drs. Grant, Saha, and Stinson collected the data. All authors contributed to several revisions of the manuscript.

Conflict of interest

None declared.

Disclaimer

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Keywords

Nicotine dependence; Item response theory; Nicotine use criterion; Psychiatric assessment; DSM-V revision

1. Introduction

An important consideration for the Diagnostic and Statistical Manual of Mental Disorders-Fifth Edition (DSM-V) Substance Related Disorders Workgroup is the empirical evaluation of potential dimensional diagnoses of substance use disorders that can be related back to their corresponding categorical diagnoses. The Diagnostic and Statistical Manual-Third Edition, revised (DSM-III-R; American Psychiatric Association, 1987) and the Diagnostic and Statistical Manual-Fourth Edition (DSM-IV; American Psychiatric Association, 1994) both emphasized the need to dimensionalize substance use disorders and to describe the phenomena as distributed continuously and possibly without clear boundaries. The task now rests with the Fifth Edition Workgroup to identify dimensional representations of substance use disorders that will gain wider acceptance both as means of conveying clinical information and as research tools.

Numerous studies have applied item response theory (IRT) methodology to data on symptoms and criteria of DSM substance use disorders. This methodology has been applied to a broad array of diverse clinical and general population samples for alcohol use disorders (Kahler et al., 2003a,b; Kahler and Strong, 2006; Krueger et al., 2004; Langenbucher et al., 2004; Martin et al., 2006; Proudfoot et al., 2006; Saha et al., 2006, 2007), cannabis use disorders (Compton et al., 2009; Gillespie et al., 2007; Kirisci et al., 2002, 2006; Langenbucher et al., 2004; Lynskey and Agrawal, 2007; Martin et al., 2006; Teesson et al., 2002), cocaine and opioid use disorders (Gillespie et al., 2007; Langenbucher et al., 2004; Wu et al., 2009), and sedative and stimulant use disorders (Gillespie et al., 2007). All of these studies have consistently identified strong evidence for a unidimensional construct underlying the DSM abuse and dependence criteria for these substances.

Despite the accumulating evidence for the unidimensionality of the substance use disorder continua for alcohol, cannabis, opioids, cocaine, sedatives, and stimulants, there is a paucity of studies examining the dimensionality of DSM nicotine dependence criteria. Except for one study (Muthén and Asparouhov, 2006), all factor analyses examining the dimensionality of nicotine dependence criteria using IRT methodology has consistently shown unidimensionality (Strong et al., 2003b, 2007, 2009). However, these studies had limitations including nonrepresentative samples of nicotine users and individuals dependent on nicotine (Kahler et al., 2003a, 2007, 2009), use of lifetime criteria that may invite recall bias (Kahler et al., 2003b), absence of the key nicotine dependence criterion of tolerance (Kahler et al., 2003b, 2007), and reliance on the one-parameter Rasch analysis without testing model fit for the two-parameter IRT model (Kahler et al., 2003b, 2007). In the one study that used data from a large, representative sample of the U.S. population, only lifetime symptoms were assessed, tolerance was not examined, and there was exclusive reliance on the Rasch model with no tests of competing IRT models (Kahler et al., 2003b). This was the only study to assess differential item functioning across important sociodemographic subgroups of the population; however, the related statistical analysis was not optimal.

Consistent with most prior research on alcohol, cannabis, opioid, cocaine, sedative, and stimulant use disorders, all of the work examining the unidimensionality of nicotine dependence criteria using IRT methodology has failed to examine the role of nicotine use or exposure as a possible addition to the criteria set for DSM nicotine dependence. Considering

prior research on nicotine dependence that has shown DSM-IV dependence criteria to represent the moderate and more severe end of the nicotine dependence continuum (Kahler et al., 2009), together with similar evidence for alcohol (Saha et al., 2007) and cannabis (Compton et al., 2009) applications, a nicotine use criterion may have an important role to play in representing the milder end of the nicotine dependence continuum.

The present study was designed to address the limitations of prior research on the unidimensionality of DSM nicotine dependence criteria by using a large, representative sample of the U.S. population, utilizing current measures of nicotine use and DSM-IV nicotine dependence criteria to reduce substantially the risk of recall bias, and including a complete comparison of the one-parameter IRT Rasch model with the two-parameter IRT model. Further, to our knowledge, no previous study has examined the role of nicotine use as a candidate criterion for nicotine dependence. In this study, several nicotine use criteria were examined in terms of model fit.

Accordingly, the purposes of this study were: (1) to determine whether DSM-IV nicotine dependence criteria defined a unidimensional underlying construct; (2) to compare one- and two-parameter IRT models for the nicotine dependence criteria in models with and without candidate nicotine use criteria, to ascertain the best-fitting model; (3) to determine the differential severity of criteria for the best-fitting model; and (4) to ascertain the presence of differential item functioning across important sociodemographic subgroups of the general population.

2. Methods

2.1. Sample

The 2001–2002 NESARC is a study of a representative of the USA conducted by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) and described in detail elsewhere (Grant et al., 2003b). The NESARC target population was the civilian noninstitutionalized population residing in households and group quarters, 18 years and older. Face-to-face interviews were conducted with 43,093, with a response rate of 81%. Blacks, Hispanics, and young adults ages 18–24 years were oversampled, with data adjusted for oversampling and household- and person-level nonresponse. The weighted data were then adjusted to represent the U.S. civilian populations based on the 2000 census.

2.2. Nicotine use criteria

Among the total NESARC sample, 28.4% were current (past 12 months) users of tobacco products, while 24.9% were current smokers of cigarettes. Accordingly, analyses presented herein were restricted to the subgroup of cigarette smokers (n = 10,163). Among survey respondents who were lifetime cigarette smokers (defined as having smoked at least 100 cigarettes over the life course), current cigarette use was defined as any smoking during the year preceding the interview. Among current smokers, the total number of cigarettes smoked in the last year was determined by respondents' answers to the following question: "On the days that you smoked in the past year, about how many cigarettes did you usually smoke?" Three cigarette use variables were tested as candidate criteria in this study: consumed at least one quarter, one half, or one full pack of cigarettes per day in the past year. Test–retest reliability of the number of cigarettes smoked in the past year was excellent, with intraclass correlation coefficients of 0.83 (Grant et al., 1995, 2003a).

The NIAAA Alcohol Use Disorder and Associated Disabilities Interview Schedule – DSM-IV Version (Grant et al., 2001) was designed to generate DSM-IV diagnoses of nicotine dependence. Following DSM-IV, criteria for nicotine dependence included: (1) tolerance; (2) withdrawal; (3) using larger amounts for longer periods than intended; (4) persistent

desire or unsuccessful efforts to cut down or control use; (5) a great deal of time spent in activities to obtain nicotine or recover from its effects; (6) giving up or reducing important social, occupational, or recreational activities in favor of use; and (7) continued use despite knowledge of a physical or psychological problem caused or exacerbated by nicotine use. All dependence criteria were measured and coded dichotomously (yes/no). As reported in detail elsewhere, the reliability and validity were good to excellent for nicotine dependence diagnoses (Grant et al., 2003a, 2004).

2.3. Statistical analysis

2.3.1. Factor analysis and unidimensionality—Preliminary to the IRT analyses, factor analyses were conducted within a confirmatory factor-analytic framework using Mplus software (Muthén and Muthén, 2004) to test the IRT assumption of unidimensionality. Factor analyses conducted within this confirmatory framework produce goodness-of-fit statistics and chi-square statistics. However, because the chi-square statistic is highly sensitive to large sample sizes, as in the present case, and may overstate the lack of fit of structural models (Bollen, 1989), this test statistic was not used. Instead, a number of additional fit indices that have been developed to address the problem associated with the chi-square statistic, were used. Hu and Bentler (1999) provided a test of the “rules of thumb” cutoffs for the most commonly used fit indices. They advocated a two-index strategy to assess the adequacy of fit of structural models. Hu and Bentler (1999) suggested a cutoff of 0.95 or above on either the Tucker Lewis Index (TLI; Tucker and Lewis, 1973) or the Comparative Fit Index (CFI; Bentler, 1990). A root mean squared error of approximation (RMSEA) “close to 0.06” also indicates good fit of a factor model. These factor-analytic methods were applied to the dependence criteria without candidate cigarette use measures and to each of three models that included one of the candidate cigarette use criteria.

2.3.2. Comparison of IRT models—For each of the aforementioned models examined in this study, the one-parameter Rasch model (Rasch, 1960) and two-parameter IRT model (Birnbaum, 1968; Lord and Novick, 1968) were compared with respect to goodness-of-fit. The Rasch model contains only one parameter, *b*, the threshold parameter that measures the severity of a criterion; criteria with high thresholds are endorsed less frequently and are therefore considered more severe. The two-parameter IRT model contains an additional parameter, *a*, the discrimination parameter, that measures the ability of a criterion to discriminate people higher on the nicotine dependence continuum from those lower on the continuum. This parameter measures how strongly a criterion is related to the underlying trait or construct. The larger the *a* parameter (i.e., the slope at its steepest point), the greater the discrimination of the criterion. IRT models were generated using marginal maximum likelihood estimates (Bock and Aitkin, 1981; Harwell et al., 1988). The BILOG-MG statistical program (Scientific Software International, 2003) was used for this purpose.

2.3.3. Comparison of IRT models with and without the cigarette use measures —Once the best-fitting model (Rasch or two-parameter) was selected for all scenarios with the cigarette use measures using the Bayesian Information Criterion (BIC) as the fit index, the best-fitting of model among those with a candidate cigarette use criterion was compared to the model with no candidate cigarette use criterion. These two models were compared by plotting them graphically as criterion response curves (CRCs) that depict the relationship between observed responses to the criteria and the underlying, unobserved trait or construct (i.e., nicotine dependence severity). These plots contain only the *b* (severity) parameter if the one-parameter was the better fitting or, additionally, the *a* (discrimination) parameter if the two-parameter model yielded the best fit. The *b* parameter represents the criterion's location along the latent continuum (located on the horizontal axis). The *b* parameter is the point on the latent continuum where there is a 50% chance of the criterion being present. The *b*

parameter shifts the CRC from left to right as the criterion becomes more severe. The *a* or discrimination parameter indicates how steep the slope of the CRCs are at their steepest points.

The final two models were also compared with respect to information value. The aggregate criterion information function (ACIF) was estimated using BILOG-MG (Scientific Software International, 2003) for each model. The ACIF graphically depicts the information value of the criteria as a collective or in the aggregate. The ACIF measures the contribution of each criterion to the reduction of error of measurement.

2.3.4. Differential criterion functioning—The comparison between the models without the cigarette use criterion and the best-fitting model with a cigarette use criterion eventuated in the choice of the final, single best-fitting model. For the final model, differential criterion functioning (DCF) was assessed across sex, age (i.e., 18–29, 30–44, and 45+) and race-ethnic (i.e., White, Black, and Hispanic) subgroups of the population. Criteria that demonstrate DCF need not reflect bias or variance across subgroups if the DCF occurs in opposing directions, e.g., with some criteria resulting in greater discrimination or severity among men and other criteria showing these characteristics among women (Cooke et al., 2001; Bolt et al., 2004). Whether criteria demonstrating significant DCF do in fact reflect invariance across subgroups can be determined if the observed DCFs cancel out at the total test (scale) score level. To examine this, we plotted the expected raw scores by the severity of the nicotine dependence continuum by age, sex, and race-ethnicity, plots referred to as test response curves (TRCs). If the TRCs for subgroups (e.g., for men and women) did not substantially differ, we could conclude that any significant criterion-level DCFs that were observed cancelled out when considered at the total scale level and that, for any latent trait value, men and women had identical expected raw scores. If, however, the TRCs did differ substantially between subgroups defined by sex, race-ethnicity, or age, individual criteria demonstrating DCF were biased, lacking invariance across important subgroups of the population, and should be eliminated.

3. Results

3.1. Prevalence and factor analyses

The 12-month prevalence of DSM-IV nicotine dependence criteria ranged from 8.1% for activities given up in favor of smoking to 67.7% for withdrawal (Table 1). Prevalences of smoking at least one pack of cigarettes per day, half a pack per day, and a quarter of a pack per day were 40.9%, 66.2%, and 77.3%, respectively (Table 2).

Consistent with the recommendations of Hu and Bentler (1999) for good fit indices, the one-factor solutions for each model with or without a cigarette use criterion demonstrated excellent fit (CFIs, 0.948–0.983; TLIs, 0.963–0.975; RMSEAs, 0.051–0.075), indicating the unidimensionality of the underlying construct of nicotine dependence severity (Tables 1 and 2).

3.2. IRT analyses

As can be seen in Tables 1 and 2, the two-parameter IRT models yielded better fits than the one-parameter model, indicated by the smallest BIC, regardless of which of the four scenarios was examined. With regard to the comparison across models, the one containing consumption of a quarter-pack a day gave the best fit among models containing a candidate use measure, whereas the model without any candidate use criterion was the best-fitting among all models.

The CRCs for the model without any consumption measure and for the best-fitting model with a consumption measure, that is with the cigarette use criterion of a quarter-pack a day, are shown in Figs. 1 and 2. The CRCs associated with each model were quite similar in terms of relative severity of dependence criteria, with the cigarette use criterion falling along the less severe end of the nicotine dependence continuum. In both models, criterion severity was similar and spread fairly well along the entire range of the continuum, with most criteria falling within the moderate to severe end of the continuum. The activities given up in favor of smoking, tolerance, time spent, and larger/longer criteria fell along the more severe end, whereas quit/control, withdrawal, and physical/psychological problems criteria fell along the least severe end of the continuum.

Discrimination among criteria, that is the slope of the curves at their steepest point, was similar in ranking between the models but not identical. In the model with the consumption criterion, the withdrawal criterion was most discriminating (a = 2.14) and the quit/control criterion was least discriminating (a = 1.48), followed closely by candidate cigarette use criterion of a quarter-pack a day (a = 1.45). In model without the cigarette use criterion, the tolerance, withdrawal and larger/longer criteria were most discriminating (a = 1.93–1.99) with activities given up criterion the least discriminating (a = 1.51).

3.3. ACIF curves

The ACIF curves are shown in Fig. 3. Relative to the IRT model without the cigarette use criterion, the model with the use criterion demonstrated higher levels of information at the lower range of the severity continuum, while retaining informational values similar to those of the model without the use criterion at the severe end of the continuum.

3.4. DCF analysis

As can be seen in Fig. 4(a)–(c), the TRCs were essentially identical, overlapping for each sex, race-ethnic, and age subgroup of the population, in the model containing the cigarette use criterion of smoking at least a quarter-pack per day. These findings indicate a lack of evidence for DCF across sex, race-ethnicity, and age subgroups of the general population.

4. Discussion

Consistent with prior research on the dimensionality of DSM-IV substance use disorders (Compton et al., 2009; Gillespie et al., 2007; Kahler et al., 2003a,b; Kahler and Strong, 2006; Krueger et al., 2004; Langenbucher et al., 2004; Proudfoot et al., 2006; Saha et al., 2006, 2007; Teesson et al., 2002), DSM-IV criteria for nicotine dependence mapped nicely onto a unidimensional continuum of dependence severity, regardless of whether or not a cigarette use criterion was entered into the model.

However, the relative ordering of the severity of the DSM-IV dependence criteria in the present study of U.S. adults differed in several ways from that of previous research. This study found that the activities given up, tolerance, time spent, and larger/longer criteria fell along the most severe end of the dependence severity continuum, with withdrawal, quit/control, and physical/psychological problems criteria falling along the mild to moderate end of the continuum. By contrast, another study of U.S. adults (Strong et al., 2003b) found the tolerance criterion to be among the least severe and activities given up along with the physical or psychological problems to be the most severe. Consistent with the present study, both withdrawal and quit/control criteria fell along the mild severe position in the continuum.

Some of these discrepancies might have been due to the use of a proxy measure of nicotine dependence that failed to measure the tolerance or time spent criteria of the DSM-IV

definition of nicotine dependence. In the two studies conducted among adolescents (Strong et al., 2007, 2009), most of the assessed nicotine dependence criteria fell in the middle range of the severity continuum, with the activities given up criterion falling along the more severe end of the continuum, as in this study. Interestingly, in one of these studies (Strong et al., 2007) that compared IRT severity results between adolescents and adults, some criteria, like tolerance, were associated with lower severity levels among adults than among adolescents, strongly suggesting that the severity of criteria may change as a function of the course of the disorder.

Although the DSM-IV nicotine dependence criteria were spread more widely across the dependence severity continuum than in previous research on IRT applications to other substance use disorders (Compton et al., 2009; Saha et al., 2006, 2007) including nicotine dependence (Strong et al., 2003a,b, 2009), the present study found that DSM-IV criteria for nicotine dependence tended to identify pathology at the more moderate and severe range of the severity continuum. The need to improve measurement of the mildest end of the continuum was addressed in the present study by examining the performance of three cigarette use measures as candidate criteria for nicotine dependence. Although all of these use criteria did map well into the mildest end of the dependence severity continuum, adding the cigarette use criterion (i.e., smoking at least a quarter-pack of cigarettes a day in the past year) did not substantially improve the fit of the initial model that included only DSM-IV dependence criteria. However, when ACIF for the models with and without this cigarette use criterion were compared, it became quite clear that the model that included use of at least a quarter-pack of cigarettes per day demonstrated higher levels of information in the milder and moderate ranges of the continuum relative to the model without the cigarette use criterion, whereas both models demonstrated similar informational values at the severe end of the continuum. These results identify the model with the consumption measure as the optimal model in terms of information value despite the fact that it did not demonstrate a better fit than the model without the consumption criterion. Taken together, these findings support the clinical and etiologic utility of the addition of a cigarette use criterion to the DSM-V. Future research to conduct empirical testing of the other candidate consumption measures is warranted, especially in clinical and other less-researched samples.

To our knowledge, this study was the first to examine DCF among nicotine dependence criteria and a cigarette use criterion by sex, race-ethnicity, and age. The TRCs showed virtually no differential scale functioning across these population subgroups. The present results show clearly that these nicotine criteria have a strong relationship to a common latent variable, i.e., nicotine dependence severity, for each sex, race-ethnic, and age subgroup as indicators of a common construct. Future research is needed to replicate these DCF results and to examine their invariance across additional sociodemographic and other subgroups of the population.

The major implications of the dimensional nature of nicotine dependence presented herein for clinical and epidemiologic assessment and diagnosis are twofold. First, severity and/or discrimination values derived from replicated IRT analyses can be used as weights in the dimensional representation of nicotine dependence severity. For example, criteria that are more severe would deserve greater weight in the determination of nicotine dependence severity. This weighted dimensional representation could be compared to alternative representations of dependence severity (e.g., simple symptom counts) with regard to their relationships to external validators such as family history, treatment, and age at onset of dependence. Second, the dimensional representations proposed in the present study and other similar representations do map directly to the criteria of the categorical classification of the nicotine dependence diagnosis appearing in the DSM-IV and could form the basis for a second new dimensional axis in further revisions. The development of an empirically

derived and valid dimensional measure of nicotine dependence holds great promise for genetic and neuroscience research on nicotine dependence, heretofore hindered by the constraints of categorical representations of the disorder.

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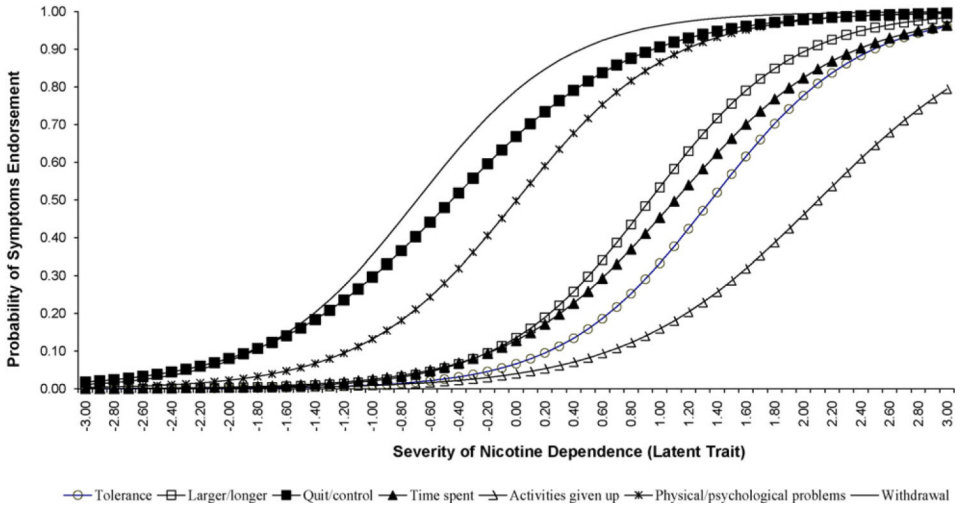

Fig. 1.
Criterion response curves for seven DSM-IV criteria for nicotine dependence.

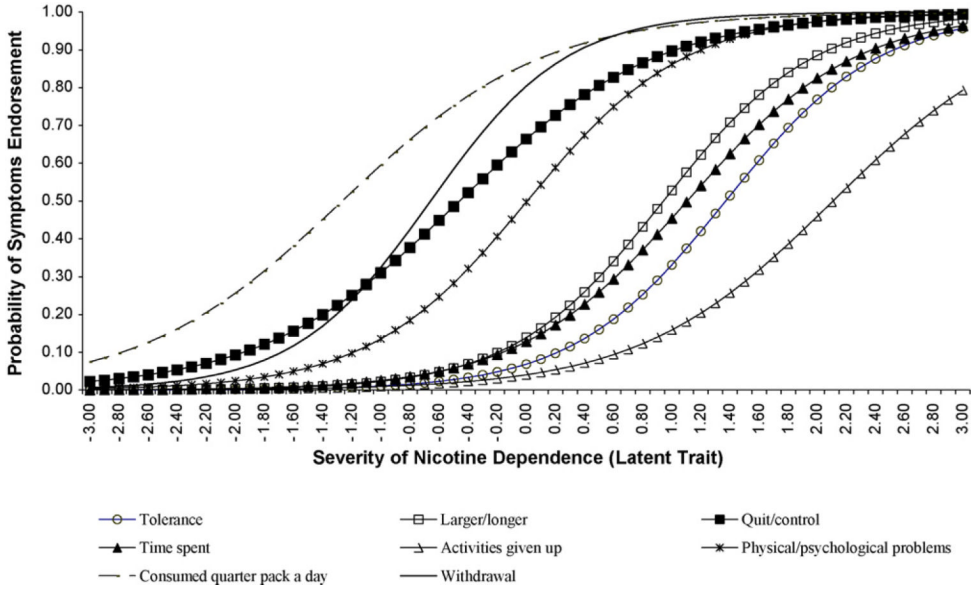

Fig. 2.

Criterion response curves for seven DSM-IV nicotine dependence criteria and cigarette use criterion of a quarter-pack a day.

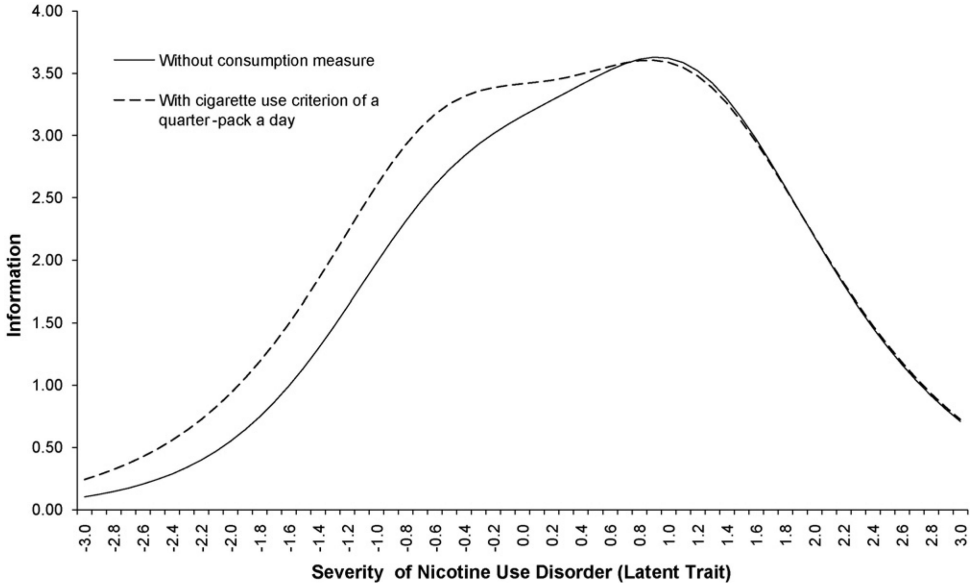

Fig. 3.

Aggregate criteria information function for DSM-IV nicotine dependence criteria with and without the cigarette use criterion of a quarter-pack a day.

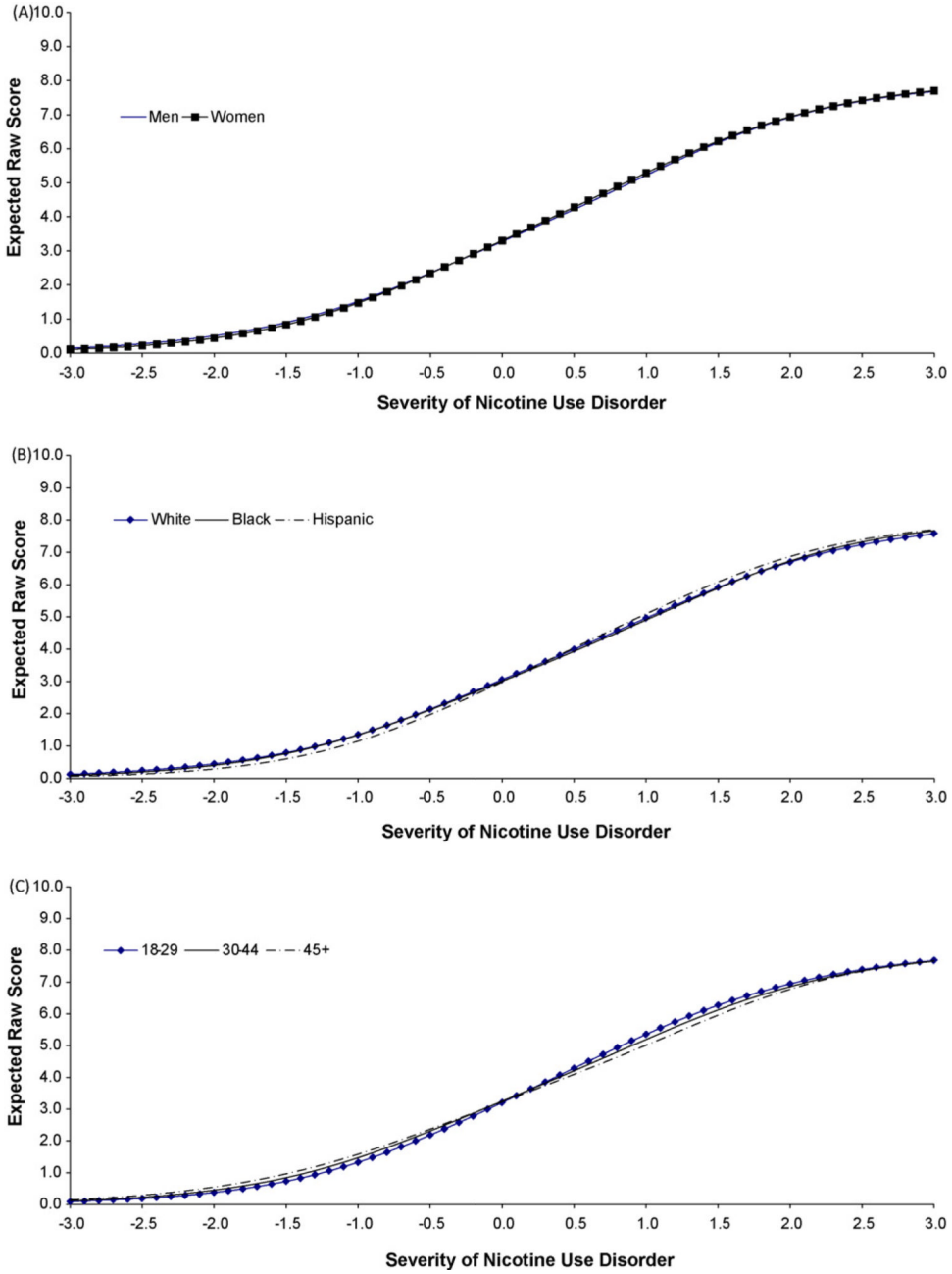

Fig. 4.

(A)–(C) Test response curves (TRCs) for sex (A), race-ethnicity (B) and age (C) for DSM-IV nicotine dependence criteria with the cigarette use criterion at least a quarter of a pack of cigarettes per day.

Table 1

Prevalence, factor loadings, and criterion response parameters DSM-IV nicotine dependence.

Past-year nicotine dependence	Prevalence (%)	Factor loadings	Criterion response parameters		
			Rasch model	Two-parameter model	
			Severity (*b*), Estimate *b* (S.E.)	Discrimination (*a*), estimate *a* (S.E.)	Severity (*b*), estimate *b* (S.E.)
Tolerance	14.32	0.789	1.39 (0.02)	1.95 (0.05)	1.36 (0.03)
Withdrawal	67.71	0.803	–0.70 (0.02)	1.93 (0.05)	–0.69 (0.02)
Larger/longer	23.18	0.802	0.97 (0.02)	1.99 (0.05)	0.93 (0.02)
Quit/control	60.87	0.654	–0.41 (0.02)	1.57 (0.03)	–0.45 (0.02)
Time spent	20.54	0.706	1.08 (0.02)	1.73(0.04)	1.11 (0.02)
Activities given up	8.11	0.515	1.90 (0.02)	1.51 (0.03)	2.11 (0.04)
Physical/psychological problems	48.08	0.758	0.01 (0.02)	1.87(0.04)	0.01 (0.02)
Bayesian Information Criterion (BIC)			67026.11	66837.93	
Comparative Fit Index (CFI)		0.983			
Tucker Lewis Index (TLI)		0.975			
Root mean squared error of approximation (RMSEA)		0.051			

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Table 2

Prevalence, factor loadings and criterion response parameters: DSM-IV nicotine dependence criteria and cigarette use criteria.

Past-year nicotine dependence (D)and cigarette use (C) criteria	Prevalence (%)	Factor loadings			Model with cigarette use criterion 'one pack a day'			Model with cigarette use criterion 'med half a pack a day'			Model with cigarette use criterion 'med quarter-pack a day'		
					Two-parameter model		Rasch model	Two-parameter model		Rasch model	Two-parameter model		Rasch Model
		With 'ack a day'	With 'half a pack a day'	With 'quarter a pack a day'	Discrimination (*a*), estimate *a* (S.E.)	Severity (*b*), estimate *b* (S.E.)	Severity (*b*), estimate *b* (S.E.)	Discrimination (*a*), estimate *a* (S.E.)	Severity (*b*), estimate *b* (S.E.)	Severity(*b*), estimate *b* (S.E.)	Discrimination (*a*), estimate *a* (S.E.)	Severity (*b*), estimate *b* (S.E.)	Severity (*b*), estimate *b* (S.E.)
Tolerance (D)	14.32	0.782	0.776	0.771	1.90 (0.05)	1.37 (0.03)	1.50 (0.02)	1.90 (0.05)	1.37 (0.03)	1.46 (0.02)	1.90 (0.05)	1.37 (0.03)	1.43 (0.02)
Withdrawal (D)	67.71	0.836	0.868	0.868	2.05 (0.05)	–0.67 (0.02)	–0.76 (0.02)	2.15(0.06)	–0.66 (0.02)	–0.74 (0.02)	2.14 (0.06)	–0.66 (0.02)	–0.72 (0.02)
Larger/longer (D)	23.18	0.786	0.781	0.782	1.90 (0.05)	0.95 (0.02)	1.04 (0.02)	1.92 (0.05)	0.95 (0.02)	1.01 (0.02)	1.93 (0.05)	0.94 (0.02)	0.99 (0.02)
Quit/control (D)	60.87	0.633	0.627	0.633	1.47 (0.03)	–0.46 (0.02)	–0.45 (0.02)	1.46 (0.03)	–0.47 (0.02)	–0.44 (0.02)	1.48 (0.03)	–0.46 (0.02)	–0.43 (0.02)
Time spent (D)	20.54	0.718	0.708	0.705	1.76 (0.04)	1.10 (0.02)	1.16 (0.02)	1.74 (0.04)	1.10 (0.02)	1.13 (0.02)	1.74 (0.04)	1.11 (0.02)	1.11 (0.02)
Activities given up (D)	8.11	0.522	0.517	0.515	1.50 (0.03)	2.11 (0.04)	2.06 (0.03)	1.50 (0.03)	2.11 (0.04)	2.00 (0.03)	1.50 (0.03)	2.11 (0.04)	1.96 (0.03)
Physical/Psychological problems (D)	48.08	0.753	0.744	0.745	1.84 (0.04)	0.01 (0.02)	0.01 (0.02)	1.83 (0.04)	0.01 (0.02)	.003 (0.02)	1.84 (0.04)	0.01 (0.02)	.004 (0.02)
Consumed one pack a day(C)	40.91	0.420	-	-	1.14 (0.02)	0.23 (0.02)	0.19 (0.02)	-	-	-	-	-	-
Consumed half a pack a day(C)	66.15	-	0.520	-	-	-	-	1.31 (0.03)	–0.85 (0.03)	–0.74 (0.02)	-	-	-
Consumed quarter-pack a day (C)	77.26	-	-	0.572	-	-	-	-	-	-	1.45 (0.03)	–1.27(0.03)	–1.16(0.02)
Bayesian Information Criterion (BIC) (smaller is better)					80180.34		81068.56	78180.11		78819.68	**75987.38**		76439.04
Comparative Fit Index (CFI)		0.955	0.948	0.952									
Tucker Lewis Index (TLI)		0.968	0.963	0.966									
Root mean squared error of approximation (RMSEA)		0.068	0.075	0.073									