

Using a latent variable approach to inform gender and racial/ethnic differences in cocaine dependence: A National Drug Abuse Treatment Clinical Trials Network study

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Abstract

This study applies a latent variable approach to examine gender and racial/ethnic differences in cocaine dependence, to determine the presence of differential item functioning (DIF) or item-response bias to diagnostic questions of cocaine dependence, and to explore the effects of DIF on the predictor analysis of cocaine dependence. The analysis sample included 682 cocaine users enrolled in two national multisite studies of the National Drug Abuse Treatment Clinical Trials Network (CTN). Participants were recruited from 14 community-based substance abuse treatment programs associated with the CTN, including 6 methadone and 8 outpatient nonmethadone programs. Factor and multiple indicators–multiple causes (MIMIC) procedures evaluated the latent continuum of cocaine dependence and its correlates. MIMIC analysis showed that men exhibited lower odds of cocaine dependence than women (regression coefficient, $\beta = -0.34$), controlling for the effects of DIF, years of cocaine use, addiction treatment history, comorbid drug dependence diagnoses, and treatment setting. There were no racial/ethnic differences in cocaine dependence; however, DIF by race/ethnicity was noted. Within the context of multiple community-based addiction treatment settings, women were more likely than men to exhibit cocaine dependence. Addiction treatment research needs to further evaluate gender-related differences in drug dependence in treatment entry and to investigate how these differences may affect study participation, retention, and treatment response to better serve this population. © 2010 Elsevier Inc. All rights reserved.

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1. Introduction

After marijuana, cocaine is the second most commonly used illicit drug in the United States (Substance Abuse and Mental Health Services Administration [SAMHSA], 2008). In 2007, an estimated 5.7 million Americans used cocaine in

the past year, and approximately 1.6 million Americans had a current (past-year) cocaine use disorder as defined by *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; SAMHSA, 2008)*. Cocaine also is one of the substances most frequently cited by Americans seeking substance abuse treatment, with at least 0.8 million

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Americans seeking treatment for cocaine use in 2007 (SAMHSA, 2008). When taking into account the number of users of specific drugs, those using cocaine or heroin are most likely to enter substance abuse treatment (SAMHSA, 2008).

Gender and race/ethnicity are among the most critical variables to study among those seeking treatment due to their paramount importance in demonstrating health disparities in drug addiction and implications for etiological research, diagnosis, intervention, and health policy (American Psychiatric Association [APA], 2000; US Department of Health and Human Services, 2000). Evidence on gender and racial/ethnic differences in cocaine dependence, however, has been mixed. Using data from the 1990–1992 National Comorbidity Survey, Wagner and Anthony (2007) found that there were no gender differences in the risk for developing cocaine dependence within the first year of cocaine use, but that this risk declined more rapidly among women in the next 3 years after first use. On the other hand, by analyzing a subsample of recent-onset cocaine users (first use of cocaine within 24 months) aged 12 years or more from the 2000–2001 National Surveys on Drug Use and Health, O'Brien and Anthony (2005) reported that women (compared with men) and Blacks (compared with Whites) had an increased likelihood for experiencing cocaine dependence. However, others did not find gender or racial/ethnic differences in cocaine dependence among recent-onset users in the 1995–1998 National Household Surveys on Drug Use (Reboussin & Anthony, 2006).

To date, little is known about gender and racial/ethnic differences in cocaine dependence among treatment-seeking cocaine users. Results from prior studies are limited. Studies of demographic or drug use characteristics typically rely on a small sample of cocaine-using patients (e.g., $n < 200$) who often were recruited from a single treatment program (Denier, Thevos, Latham, & Randall, 1991; Hernandez-Avila, Rounsaville, & Kranzler, 2004; Jones, Johnson, Bigelow, & Strain, 2004; Kosten, Gawin, Kosten, & Rounsaville, 1993; Lejuez, Bornovalova, Reynolds, Daughters, & Curtin, 2007; Weiss, Martinez-Raga, Griffin, Greenfield, & Hufford, 1997; Wong, Badger, Sigmon, & Higgins, 2002). Similarly, findings on demographic variations in drug use characteristics are often constrained by the descriptive nature of the analyses and a relatively low degree of generalizability. Although none of these studies directly tested or reported demographic disparities in the probability of cocaine dependence among cocaine users, they suggested that women who seek substance abuse treatment exhibit a more severe pattern of drug use-related social, medical, or psychiatric problems than their male counterparts (Denier et al., 1991; Hernandez-Avila et al., 2004; Weiss et al., 1997).

Recently, Najavits and Lester (2008) examined gender differences in demographic and drug use characteristics among 2,376 treatment-seeking cocaine-dependent patients who participated in the National Institute on Drug Abuse Collaborative Cocaine Treatment Study. Compared with men, women were less educated and report more drug use-

related problems (medical, family/social, employment, and psychiatric). These findings, however, were based on descriptive analyses, and gender or racial/ethnic differences in the probability of cocaine dependence were not available (Najavits & Lester, 2008).

In light of the lack of information on gender and racial/ethnic differences in cocaine dependence and their implications for treatment planning and interventions, this study examines gender and race/ethnicity differences in a sample of treatment-seeking cocaine users from two multisite trials conducted within the National Drug Abuse Treatment Clinical Trials Network (CTN). The CTN studies have three strengths. First, cocaine users were recruited from 14 community-based substance abuse treatment programs (greater diversity and generalizability) and were all assessed by an identical set of measures (Peirce et al., 2006; Petry et al., 2005). Second, gender and racial/ethnic differences in current (past-year) *DSM-IV* cocaine dependence were tested by examining the conditional probability of cocaine dependence among past-year cocaine users. Third, we applied a latent variable regression approach (multiple indicators–multiple causes [MIMIC]) to elucidate gender and racial/ethnic differences for the likelihood of cocaine dependence and the effects of differential item functioning (DIF) or item-response bias on the diagnostic assessment for cocaine dependence (e.g., see Blanco, Harford, Nunes, Grant, & Hasin, 2007; Chen & Anthony, 2003; Wu, Ringwalt et al., 2009, Wu, Pan et al., 2009).

DIF occurs when cocaine users with an equivalent level of dependence respond differentially to certain diagnostic items as a function of group membership such as gender (e.g., Wu, Ringwalt et al., 2009, Wu, Pan et al., 2009). In the MIMIC model, diagnostic items shown to have DIF by gender suggest that these items have a different severity (threshold) for women than for men (e.g., possibly due to different meanings or interpretations of diagnostic questions). The presence of DIF could lead to inaccurate comparisons across groups with similar diagnoses, as well as on prevalence rates, risk factors, and treatment outcome of the measured diagnoses (e.g., Chen & Anthony, 2003; McHorney & Fleishman, 2006; Wu, Pan et al., 2009). Analysis of DIF has timely and important implications for the emerging *DSM-V* because little is presently known about the effects of DIF by gender and race/ethnicity on predictor analysis for cocaine dependence, and failure to consider possible gender-related (possibly due to gender-specific biology or socialization) or racial/ethnic differences (possibly due to language and cultural differences in health beliefs or attitudes) in manifestations and expressions of symptoms may distort estimates of diagnoses and related risk factor analyses (e.g., Grant & Weissman, 2007; Room, 2006). Thus, evaluating and understanding DIF by gender and race/ethnicity for diagnostic criteria is fundamental to developing less biased estimates of a diagnosis for women and minority groups.

This study explores these issues by examining (a) whether gender or racial/ethnic differences in cocaine dependence

exist controlling for potential effects of DIF, and (b) the effects of DIF in relation to gender, race/ethnicity, and comorbid substance dependence (alcohol, marijuana, amphetamines, and opioids) on the analysis of potential risk factors for cocaine dependence. The large and heterogeneous sample of trial participants also permits an exploration of whether the presence of drug dependence may distort cocaine users' endorsement of dependence criteria, which has important implications for analyses of diagnostic data from treatment-seeking patients who frequently have comorbid drug dependence and for informing diagnostic assessments of women and minority groups (e.g., Grant & Weissman, 2007; Room, 2006; Wu, Pan, Blazer, Tai, Brooner, et al., 2009).

2. Methods

2.1. Data source

Analyses were performed on public-use data sets from two multisite CTN studies that evaluated stimulant use outcomes in an abstinence-based contingency management intervention as an addition to usual care in nonmethadone (non-MMT; Petry et al., 2005) and methadone maintenance treatment (MMT; Peirce et al., 2006). All programs were outpatient providers associated with CTN nodes in their geographic regions. Non-MMT participants were recruited from eight programs that did not administer methadone or other opioid agonists (Petry et al., 2005). Six of these programs were located in eastern, southeastern, or southwestern urban regions of the United States; one was in the suburban southeast and one in the rural southwest. Eligible patients were those who (a) reported stimulant use within 2 weeks of study entry, (b) used stimulants within 2 weeks of entering a controlled environment (a detoxification unit, hospital, or correctional facility) and exited it within 2 weeks of study entry, (c) submitted a stimulant-positive urine at treatment entry, (d) denied having or being in recovery from a gambling problem, and (e) demonstrated understanding of study procedures by correctly answering 80% or more of the questions on a quiz covering the requirements, risks, and benefits of participation in the parent study.

MMT participants were recruited from six programs located in urban areas in the northeastern, eastern, or southwestern United States (Peirce et al., 2006). Eligible participants included opioid-dependent patients who had (a) been enrolled in MMT for a minimum of 30 days but not longer than 3 years, (b) submitted a stimulant-positive (cocaine or amphetamines) urine within 2 weeks of study enrollment (verified from clinic records), (c) denied having or being in recovery from a gambling problem, and (d) demonstrated understanding of study procedures by correctly answering 80% or more of the questions on a quiz covering the requirements, risks, and benefits of participation in the parent study.

2.2. Assessments

Social and demographic variables collected at study intake included age, gender, race/ethnicity, and years of education; substance use disorders were assessed using the *DSM-IV* Checklist (Wu, Pan et al., 2009). All participants were asked about past-year use of five classes of substances: amphetamines, cocaine, opioids, alcohol, and marijuana. If participants reported use of any of these substances in the past year, they were asked about each of the seven *DSM-IV* dependence criteria associated with that substance (APA, 2000) and the *DSM-IV* Checklist assessed for dependence. Substance-specific *dependence* criteria were assessed, and endorsing three or more of the seven *DSM-IV* dependence criteria resulted in a dependence diagnosis: (a) tolerance; (b) withdrawal; (c) substance often taken in large amounts or for longer periods; (d) persistent desire or unsuccessful attempt to cut down or control use; (e) a great deal of time spent in activities necessary to get the substance; (f) important activities given up; and (g) continued substance use despite knowledge of having persistent or recurrent physical or psychological problems.

2.3. Data analyses

Analyses were based on data from 682 participants aged 18 years or more who reported cocaine use in the past year using the *DSM-IV* Checklist. We first examined the distributions of study variables and prevalence of cocaine dependence by gender and race/ethnicity. Next, factor analysis of binary data with the weighted least squares mean and variance adjusted estimator was done using Mplus (Muthén & Muthén, 2007) to examine the unidimensionality (a one-factor model) of the cocaine dependence criteria, which is established by demonstrating that a one-factor model provides the most parsimonious fit to the data. We assessed the number of factors to be retained with the scree test (Cattell, 1996), the ratio of the first eigenvalue to the second eigenvalue, and variance explained by the first eigenvector (Wu, Pan et al., 2009). Finally, MIMIC procedures in Mplus were applied to the seven dependence criteria and covariates of cocaine dependence (age, gender, race/ethnicity, years of education, years of cocaine use, drug abuse treatment episodes, comorbid drug dependence, and treatment setting). Cocaine dependence was specified as a one-factor model in the MIMIC modeling as shown from factor analysis.

The MIMIC model incorporates the measurement part of the seven dependence criteria (the latent dependence factor; cocaine dependence criteria) and a regression component of study covariates (the potential predictors of the latent dependence factor; Wu, Ringwalt et al., 2009, Wu, Pan et al., 2009, Wu, Pan, Yang, Reeve, & Blazer, 2010). This model was extended into a structural equation model that allowed us to examine DIF (significant direct effects or potential item-response bias) of each cocaine dependence

criterion item by each categorical covariate while simultaneously holding constant the level of cocaine dependence criteria. This model thus has advantages over the traditional regression model because MIMIC procedures take into account potential measurement errors (i.e., DIF) of the dependence measure and model it comprehensively as a continuous factor (increasing the statistical power). A traditional linear or logistic regression model cannot accommodate this feature.

To enhance the understanding of the effects of DIF on regression coefficients of predictors for cocaine dependence, we report regression coefficients of covariates from the crude model (one covariate plus the measurement part of cocaine dependence criteria), adjusted regression model (multiple covariates plus the measurement part), and structural equation regression model (multiple covariates, the measurement part, and DIF). Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA) were all used to assess the fit of the MIMIC model. Values of TLI and CFI ≥ 0.95 (1 = perfect fit) and values of RMSEA ≤ 0.06 (the lower the value, the better the fit) indicate an excellent fit to the data (Browne & Cudeck, 1993; Hu & Bentler, 1999).

3. Results

3.1. Characteristics of cocaine users

3.1.1. Demographic

Compared with MMT patients, non-MMT patients were younger (mean age = 37 vs. 42 years) and more likely

women (58% vs. 45%). There were no differences in race/ethnicity and years of education ($M = 11.8$ years). Most (74%) were members of non-White groups: Black, 53%; Hispanic, 15%; others, 6% (Table 1).

3.1.2. Drug use and DSM-IV dependence

There were no differences in years of cocaine use ($M = 9.1$ years) or prevalence of DSM-IV cocaine and amphetamine dependence by treatment setting. Notably, MMT patients had more episodes of prior drug abuse treatment ($M = 4.9$ vs. 2.8 episodes) and a higher prevalence of opioid dependence (79% vs. 12%) than non-MMT patients, although non-MMT patients had a higher prevalence of alcohol dependence (42% vs. 12%) and marijuana dependence (20% vs. 8%). Note that opioid dependence was determined from the DSM-IV checklist and that it reflected the status at study intake, not the status at admission to the MMT program. Because of methadone treatment, some of the patients had no signs or symptoms of dependence and thus did not endorse three or more of the dependence criteria items.

3.1.3. Cocaine dependence by gender and race/ethnicity

Because gender and race/ethnicity were the primary covariates of interest, we determined their association with cocaine dependence. Overall, women had a higher prevalence of cocaine dependence than men (85% vs. 76%; χ^2 test, $p < .01$); this finding was noted in both MMT (85% vs. 73%; χ^2 test, $p < .01$) and non-MMT patients (84% vs. 78%; χ^2 test, $p = .064$). There were no racial/ethnic differences in the prevalence of cocaine dependence overall or in either treatment setting.

Table 1
Selected characteristics of outpatient cocaine users ($N = 682$)

Characteristics	Overall	Non-MMT program	MMT program	χ^2 or t test p
Sample size	682 (100)	316 (46.3)	366 (53.7)	
Age in years				
M (SE)	39.8 (0.34)	37.3 (0.47)	42.0 (0.45)	<.01
Gender (%)				
Men	48.7	41.8	54.6	
Women	51.3	58.2	45.4	<.01
Race/Ethnicity (%)				
Black	52.8	54.1	51.6	
White	26.2	28.2	24.6	
Hispanic	15.1	12.0	17.8	
Other	5.9	5.7	6.0	<i>ns</i>
Years of education completed				
M (SE)	11.8 (0.08)	11.8 (0.11)	11.8 (0.10)	<i>ns</i>
Years of cocaine use				
M (SE)	9.1 (0.29)	8.7 (0.40)	9.4 (0.41)	<i>ns</i>
No. of drug abuse treatment episodes				
M (SE)	3.9 (0.19)	2.8 (0.24)	4.9 (0.27)	<.01
Past-year DSM-IV dependence (%)				
Cocaine	80.2	79.9	80.6	<i>ns</i>
Alcohol	25.8	42.1	11.7	<.01
Marijuana	13.2	19.6	7.7	<.01
Amphetamines	5.0	6.3	3.8	<i>ns</i>
Opioids	48.2	12.3	79.2	<.01

Note. $ns = p > .05$ for χ^2 test for proportion or t test for mean.

Table 2
Prevalence and factor loadings of past-year DSM-IV cocaine dependence criteria (N = 682)

Symptoms of cocaine dependence	Prevalence (%)	Factor loadings
D1: Tolerance	68.9	0.82
D2: Withdrawal	50.0	0.75
D3: Taking larger amounts or longer	65.1	0.86
D4: Inability to cut down	79.2	0.90
D5: Time spent using or recovering	66.6	0.92
D6: Giving up activities	61.9	0.86
D7: Continued use despite resulting problems	65.7	0.82
First eigenvalue		5.24
Ratio of first eigenvalue/second eigenvalue		5.24/0.60
Variance explained by the first eigenvalue		75%
Cronbach's alpha		0.86

3.2. Unidimensionality of the dependence construct

The prevalence of specific dependence criterion (ranging from 50% for withdrawal to 79% for inability to cut down) and their factor loading (ranging from 0.75 for withdrawal to 0.92 for time spent using cocaine) are summarized in Table 2. The scree test showed that a one-factor model fitted the seven

criteria for cocaine dependence. Specifically, the first eigenvalue (5.24) and the ratio of the first-to-second eigenvalues were high (5.24/0.60 = 8.7); the first eigenvector explained 75% of the variance. All criterion items showed a good level of factor loadings (≥0.75) and the seven dependence criteria exhibited a high level of internal consistency (Cronbach's alpha coefficient = .86). Together,

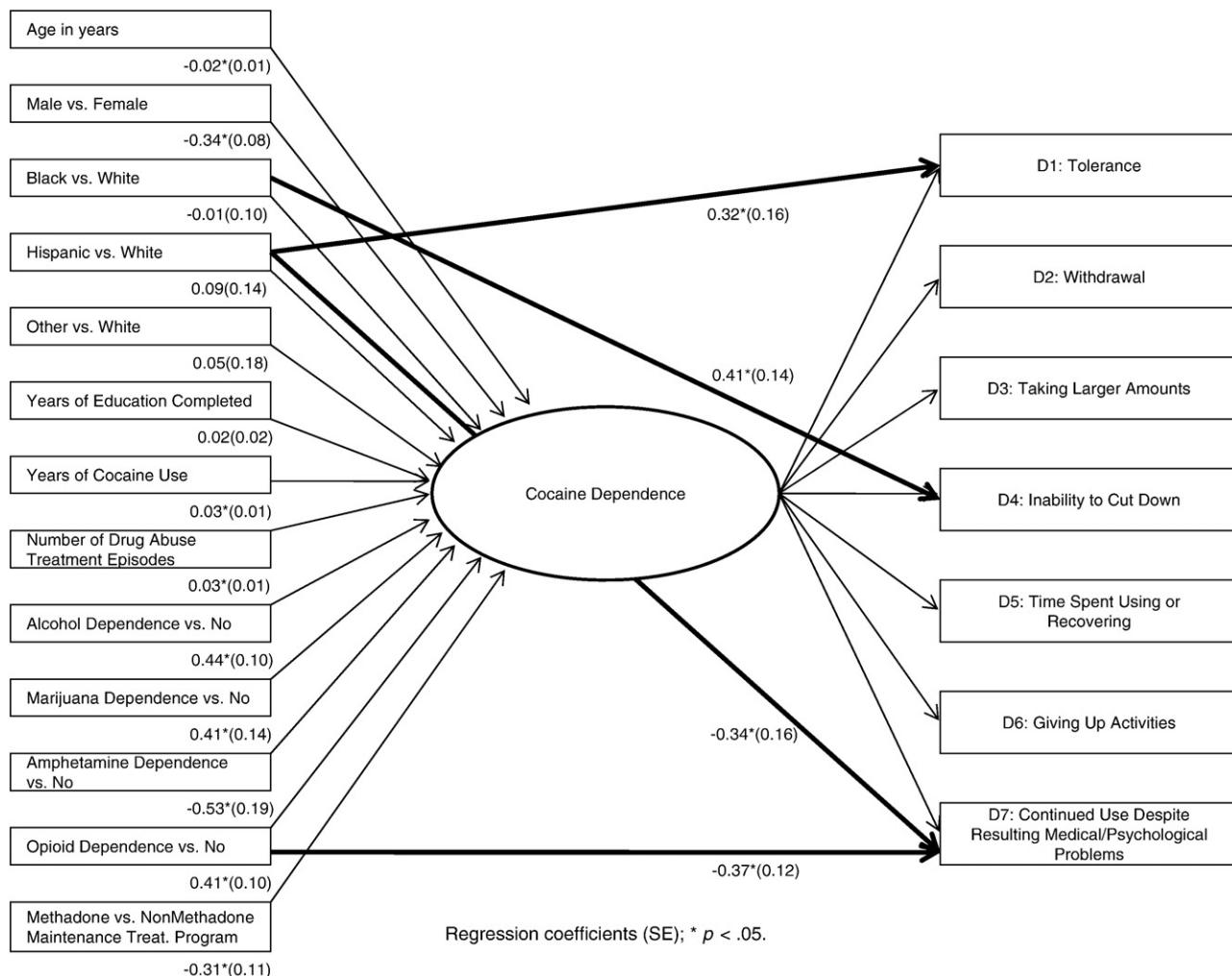


Fig. 1. The MIMIC model of DSM-IV cocaine dependence (N = 682).

Table 3
Significant DIF in the endorsements of cocaine dependence symptoms: results of MIMIC modeling ($N = 682$)

Participants' characteristics	Regression coefficient estimates of DIF (SE)	<i>P</i>	Cocaine dependence symptoms
Hispanic vs. White	0.32 (0.16)	.05	D1: Tolerance
Black vs. White	0.41 (0.14)	<.01	D4: Inability to cut down
Hispanic vs. White	−0.34 (0.16)	.04	D7: Continued use despite medical or psychological problems
Opioid dependence vs. no	−0.37 (0.12)	<.01	D7: Continued use despite medical or psychological problems

these findings provided support for the subsequent analysis of cocaine dependence criteria as a one-factor construct in the MIMIC model (Table 2).

3.3. The MIMIC model of cocaine dependence syndrome

Within the MIMIC model, cocaine dependence (a continuous index of severity) was regressed on covariates, and dependence criterion items showing DIF by covariates were regressed on the covariates in question. The MIMIC model (Fig. 1) showed an excellent fit to the data (CFI = 0.982, TLI = 0.985, RMSEA = 0.034).

3.3.1. Differential item functioning

This analysis suggested the presence of DIF by cocaine users' racial/ethnic background and opioid dependence status. Holding constant the level of cocaine dependence, Hispanics were more likely than Whites to endorse "tolerance" (regression coefficient, $\beta = 0.32$) but less likely

to endorse "continued use despite resulting problems" ($\beta = -0.34$); Blacks were more likely than Whites to report "inability to cut down" ($\beta = 0.41$). Holding constant the level of cocaine dependence, cocaine users with opioid dependence were less likely than those without it to report continued cocaine use despite resulting problems ($\beta = -0.37$). These DIF findings indicate different severity (threshold) levels of certain criterion items by race/ethnicity or opioid dependence status (Table 3).

3.3.2. Predictors of cocaine dependence

Holding constant DIF, older ages ($\beta = -0.02$), male gender ($\beta = -0.34$), amphetamine dependence ($\beta = -0.53$), and MMT setting ($\beta = -0.31$) were associated with decreased odds of cocaine dependence. On the other hand, years of cocaine use ($\beta = 0.03$), prior drug abuse treatment ($\beta = 0.03$), alcohol dependence ($\beta = 0.44$), marijuana dependence ($\beta = 0.41$), and opioid dependence ($\beta = 0.41$) were associated with increased odds of cocaine dependence (Table 4).

Table 4
Regression coefficient estimates for predictors of cocaine dependence: results of MIMIC models ($N = 682$)

Independence variables	Crude model ^a		Adjusted model without significant DIF included ^b		Adjusted model with significant DIF ^c	
	Estimate (SE)	<i>p</i>	Estimate (SE)	<i>p</i>	Estimate (SE)	<i>p</i>
Regression coefficient						
Age in years	−0.01 (0.004)	<.01	−0.02 (0.01)	<.01	−0.02 (0.01)	<.01
Gender						
Male vs. female	−0.38 (0.07)	<.01	−0.34 (0.08)	<.01	−0.34 (0.08)	<.01
Race/Ethnicity						
Black vs. White	−0.01 (0.09)	.60	0.02 (0.09)	.84	−0.01 (0.10)	.96
Hispanic vs. White	−0.07 (0.15)	.63	0.04 (0.12)	.73	0.09 (0.14)	.52
Other vs. White	−0.06 (0.12)	.64	0.04 (0.16)	.80	0.05 (0.18)	.78
Years of education completed	0.002 (0.02)	.91	0.02 (0.02)	.33	0.02 (0.02)	.32
Years of cocaine use	0.03 (0.01)	<.01	0.03 (0.01)	<.01	0.03 (0.01)	<.01
No. of drug abuse treatment episodes	0.03 (0.01)	<.01	0.03 (0.01)	<.01	0.03 (0.01)	<.01
DSM-IV dependence						
Alcohol (yes vs. no)	0.55 (0.09)	<.01	0.44 (0.10)	<.01	0.44 (0.10)	<.01
Marijuana (yes vs. no)	0.49 (0.12)	<.01	0.41 (0.14)	<.01	0.41 (0.14)	<.01
Amphetamines (yes vs. no)	−0.31 (0.17)	.06	−0.53 (0.19)	<.01	−0.53 (0.19)	<.01
Opioids (yes vs. no)	0.07 (0.07)	.31	0.36 (0.10)	<.01	0.41 (0.10)	<.01
Treatment setting						
Methadone maintenance program vs. non-methadone maintenance program	−0.22 (0.07)	<.01	−0.31 (0.11)	<.01	−0.31 (0.11)	<.01

^a Results are from each separate MIMIC model that included the measurement part plus one independent variable corresponding to the reported variable in the first column.

^b The MIMIC model included the measurement part plus all independent variables in the first column (TLI = 0.972, CFI = 0.979, RMSEA = 0.041).

^c The MIMIC model included the measurement part, all independent variables in the first column, and significant DIF in Table 3 (TLI = 0.982, CFI = 0.985, RMSEA = 0.034).

3.3.3. The impact of DIF on regression coefficients of cocaine dependence

The impact of DIF on regression coefficients for cocaine dependence was explored by comparing the above-mentioned MIMIC model with one that excluded DIF (Table 4). A small change (14%) was observed on the estimated association (β) between opioid dependence status and cocaine dependence (β was changed from 0.36 to 0.41) after adjusting for DIF.

4. Discussion

Cocaine is the second most prevalent illicit drug used in the United States (SAMHSA, 2008). This study demonstrates a novel application of secondary data analysis of CTN public-use data (National Institute on Drug Abuse, 2009; <http://www.ctndatashare.org/>). It contributes new and important information on the assessment and the predictor analysis of dependence of patients seeking treatment for cocaine-related problems by examining a large and geographically diverse sample of cocaine users recruited from 14 addiction treatment programs, investigating measurement bias (DIF) in assessing for cocaine dependence, applying a latent variable regression model to take into account measurement errors in the predictor analysis of cocaine dependence, and exploring the effects of DIF on diagnostic criteria. The latter has been an understudied and overlooked area of research for drug dependence but has implications for improving the validity of analyzing self-reported diagnostic data.

MIMIC modeling revealed that (a) female cocaine users exhibited a higher likelihood of cocaine dependence than male cocaine users even after controlling for the potential confounding influences of age groups, race/ethnicity, years of cocaine use, addiction treatment history, comorbid drug dependence diagnoses, and treatment setting; (b) there was no evidence of gender-related item-response bias in the assessment of cocaine dependence; and (c) there was race/ethnicity-related DIF on the endorsement of cocaine dependence criteria. These findings have important implications not only for improving the analysis of self-reported data but also for the assessment of drug dependence, including the emerging *DSM-V*.

Traditionally, drug dependence is examined as a binary outcome. Such a categorical approach tends to have less statistical power and fails to consider potential measurement errors resulting from self-reported data of multiple diagnostic items. In fact, *the dependence syndrome* was originally conceptualized as a continuous, dimensional construct (Edwards & Gross, 1976). Consistent with prior studies of less geographically diverse or smaller samples (Bryant, Rounsaville, & Babor, 1991; Feingold & Rounsaville, 1995; Morgenstern, Langenbucher, & Labouvie, 1994), the results of factor analysis support our analysis of cocaine dependence as a single dimensional construct in the MIMIC model.

In addition, MIMIC modeling of the criteria for cocaine dependence extends earlier research by utilizing response patterns from all dependence items and providing a flexible regression framework to statistically control for potential measurement errors from self-reports. Thus, results from the MIMIC model are less biased because the construct of the outcome of interest can be more properly modeled, and potential item-response biases from self-reports can be incorporated into the analysis.

Recently, results from the 2001–2002 National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) suggest that women, Hispanics, and Blacks are more likely than men and Whites to report substance dependence but without abuse symptoms (Hasin, Hatzenbuehler, Smith, & Grant, 2005; Hasin & Grant, 2004). The result is somewhat inconsistent with the *DSM-IV*'s specification because dependence is generally considered a more severe pattern of substance use than abuse (APA, 2000), and little is known about the reasons that may explain this finding. We utilized MIMIC procedures to evaluate whether there were potential item-response biases by gender and race/ethnicity in the assessment of drug dependence. Consistent with our recent research on alcohol and marijuana dependences (Wu, Pan et al., 2009), we did not find gender-related DIF.

However, our analyses suggested the presence of DIF by cocaine users' racial/ethnic backgrounds. A recent analysis of alcohol dependence data from NESARC also found evidence of DIF by race/ethnicity (Carle, 2009). Holding constant the cocaine dependence level, Hispanics were more likely than Whites to endorse tolerance but less likely to endorse continued use despite resulting problems; Blacks were more likely than Whites to report inability to cut down. Thus, Hispanics have a lower threshold than Whites to report tolerance but a higher threshold to report continued use despite resulting problems; Blacks have a lower threshold than Whites to report inability to cut down. This finding suggests the need to control for race/ethnicity statistically in the analysis of cocaine dependence and to investigate reasons accounting for measurement invariance (e.g., racial/ethnic variations in the meaning or interpretation of diagnostic items) so as to reduce its potential confounding effects on assessing for cocaine dependence. Further, accurate estimates of cocaine dependence rely on the use of a sound measure. Study findings are, therefore, consistent with recommendations that cross-cultural research is needed for *DSM-V* to ensure that diagnostic criteria are equivalent or valid for different racial/ethnic groups (Escobar & Vega, 2006; Room, 2006).

Further, in addition to women, we found that young adults had increased odds of exhibiting a high level of cocaine dependence. Years of cocaine use, episodes of prior drug abuse treatment, as well as dependence on alcohol, marijuana, and opioids were all positively associated with cocaine dependence. These results are in line with prior findings suggesting that abusing one drug increases the

likelihood of abusing others, which could be influenced through a shared vulnerability (Tsuang et al., 1998), greater opportunities for substance use (Wilcox, Wagner, & Anthony, 2002), or direct effects from substance use (APA, 2000). For example, cocaine and opioids are often used together to enhance their subjective reinforcing effects (Leri, Bruneau, & Stewart, 2003), and alcohol is reportedly used by cocaine users to moderate the discomfort following cocaine use (Magura & Rosenblum, 2000).

Given that dependence on other substances was positively associated with the level of cocaine dependence in this study, women's greater odds for exhibiting cocaine dependence is a cause of concern. Recently, we utilized latent class analysis to examine cocaine users in treatment and found that women were more likely than men to be classified in the most severe subgroup that was characterized by reporting five or more dependence symptoms (Wu, Blazer et al., 2009). Another study on marijuana dependence among clinical patients also found greater odds of having it among women as compared with men (Wu, Pan et al., 2009). Taken together, this and other studies suggest that treatment-seeking cocaine-using women may be disproportionately more severe in their substance use patterns and related problems than treatment-seeking men (Denier et al., 1991; Hernandez-Avila et al., 2004; Weiss et al., 1997; Wu, Blazer et al., 2009).

Lastly, amphetamine dependence in this study was associated with decreased odds of cocaine dependence, suggesting that dependence on both cocaine and amphetamines is infrequent. Our recent study of cocaine dependence among treatment-seeking stimulant users also found a low rate (7%) of co-use of cocaine and amphetamines within a 12-month period among stimulant users (Wu, Blazer et al., 2009). It has been suggested that infrequent co-use of cocaine and amphetamines among regular stimulant users may be related to unique differences in demographic characteristics of users and pharmacological effects (see Wu, Blazer et al., 2009). For example, cocaine users were older and primarily Black, and amphetamine users were younger and predominantly White (Wu, Blazer et al., 2009). Differences between cocaine and amphetamines in their duration of effects, accessibility, and distribution networks may explain unique racial variations in the use of cocaine and amphetamines (Sexton et al., 2005).

4.1. Study limitations and strengths

These findings should be interpreted within the context of the following limitations. First, these findings are based on treatment-seeking drug users who participated in CTN trials. The study sample is not necessarily representative of all outpatient cocaine-using patients. Another limitation is reliance on participants' self-reported information, which is subject to recall errors, exaggeration, or underreporting. Third, cocaine abuse was not examined due to the fact that dependence was assessed first, and abuse was not assessed among those who met the criteria for dependence.

According to the *DSM-IV* (APA, 2000), abuse is not recognized among those with a dependence diagnosis. In this sample, 80% of cocaine users were classified as having cocaine dependence.

This study also has several strengths. It extends prior studies of correlates of cocaine dependence by investigating a large, geographically diverse sample of users and employs MIMIC methods to understand item-level measurement errors in the risk factor analysis for cocaine dependence. Generalizability to clinical patients is improved because study participants were recruited from 14 major outpatient programs across the nation. These findings also demonstrate a novel use of CTN data to shed light on the quality of a drug dependence measure, the latent construct of cocaine dependence criteria, and predictors of cocaine dependence while simultaneously incorporating measurement errors into the analysis. Thus, this approach not only enhances our understanding of the drug-using population but also provides important empirical information for future research on the quality and validity of diagnostic assessments for major diagnostic systems. Considering that substance use diagnoses are determined almost exclusively by self-reports and that the quality of self-report measures affects the validity of research and clinical findings, the need for the use of latent variable approaches to take into account measurement errors from self-reports is clear (Wu, Pan et al., 2009).

4.2. Conclusions

Within the context of multiple community-based addiction treatment settings, this study demonstrates that women and young adults are more likely than men and older adults to exhibit cocaine dependence according to *DSM-IV* criteria and that race/ethnicity is not associated with cocaine dependence. These findings suggest that addiction treatment research needs to evaluate further gender- and age-related differences at treatment entry and investigate how these differences may affect study participation, retention, and treatment response to better serve these populations.

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Statement of Conflict of Interest

The authors report the following possible conflicts of interest with the sponsor of this supplement article or products discussed in this article: Grant Research Support: NIH HHSN271200522071C, R01 DA019623, R01DA019901, R21 DA 027503 (Wu); National Institute on Drug Abuse, National Institute of Mental Health (Blazer); National Institute on Drug Abuse (Woody). Honorarium: American Assoc Ger Psychiatry (honorarium for serving as associate editor; Blazer), Belvier Publications (honorarium for serving as editor for Duke Medicine Health News; Blazer). Employee: Duke University Medical Center (Wu, Blazer); Veterans Health Administration (Pan). Employee: National Institute on Drug Abuse/National Institutes of Health/Department of Health and Human Services (Tai).

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