Published in final edited form as:

Addict Behav. 2010 January ; 35(1): 23–29. doi:10.1016/j.addbeh.2009.08.003.

Examining Factorial Structure and Measurement Invariance of the Brief Symptom Inventory (BSI)-18 among Drug Users

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Abstract

The purpose of this study is to examine the factorial structure of the Brief Symptom Inventory 18 (BSI-18) and test its measurement invariance among different drug using populations. A total sample of 710 drug users was recruited using respondent-drive sampling (RDS) from three states: Ohio (n=248), Arkansas (n=237), and Kentucky (n=225). The results of confirmatory factor analysis (CFA) show: 1) the BSI-18 has a three-factor structure (somatization, depression, and anxiety) with an underlying second-order factor (global severity index of distress); and 2) its factorial structure and metric (factor loadings) are invariant across populations under study. However, the scalars (intercepts) of the BSI-18 items are not invariant, and the means of the latent factors also varied across populations. Our findings provide evidence of a valid factorial structure of the BSI-18 that can be readily applied to studying drug using populations.

Keywords

BSI-18; psychological distress; CFA model; measurement invariance; drug users

1. INTRODUCTION

The interconnections between substance abuse and mental illness have long been a concern for clinicians, behavioral research scientists, and addiction treatment specialists. The relationships between substance abuse and mental health has been demonstrated in numerous epidemiological studies (e.g. Kessler et al, 1996; Grant et al., 2004). As such, the

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reliable and valid measurement of mental health symptomatology remains a critical objective of clinical and behavioral research related to substance abuse. To further strengthen efforts to address the methodological challenges related to the measurement of mental health symptoms, the following paper addresses some of the psychometric properties of the BSI-18. More specifically, we report the details of an analysis of the factorial structure of this measure in order to assess the extent to which the BSI-18 provides a precise and robust means to measure mental health among drug users.

1.1 Substance Abuse and Mental Health

Clinicians and researchers have attended to the links between substance abuse and mental illness for several decades (e.g. Braught et al., 1973; Weissman & Myers, 1980). These connections may arise from several different mechanisms. Substance abuse may potentially trigger or relate to the development of psychiatric symptoms. Conversely, underlying psychopathology may contribute to the abuse of psychoactive substances. Finally, some underlying factor may increase individuals' vulnerability to both substance abuse and mental illness. Regardless of the mechanism driving these connections, these links have been well established.

Dual diagnoses remain a key concern related to substance abuse and mental health. Research studies have documented the extent to which mental illness and substance abuse disorders co-occur and exacerbate one another. In particular, substance abuse disorders have a high rate of occurrence with anxiety and affective disorders (Merikangas et al., 1998; Grant et al., 2004). Indeed, individuals with mental illnesses may be most at risk for developing substance abuse problems (Goodwin et al., 2002). The co-occurrence of mental illness and substance abuse is significant since those with such co-morbid disorders are less likely to be adherent to medication regimens (Drake & Wallach, 1989), have a greater likelihood of psychosis (Dixon, 1999), have higher treatment costs (McCrone et al., 2000), are more likely to have physical health problems (Dixon, 1999), and are more likely to have contact with the criminal justice system or to be homeless (Osher et al., 1994). Additionally, those with dual diagnoses are more likely to relapse after treatment than other substance abusers (Bradizza, Stasiewicz, & Paas, 2006). As such, integrated treatment for individuals with dual diagnoses is more complicated and more intense than treatment for individuals suffering from each of these problems alone (Drake et al., 1998).

Although the concern for dual diagnoses remains an important matter in the field of substance abuse, the connection between mental health and substance use is not limited to those with diagnosable mental illness. Beyond diagnosable conditions, the presence of symptoms of mental health problems is associated with substance abuse. For example, depressive symptoms and other psychopathologies have been recognized as a risk factor for adolescent substance abuse (White et al., 2001). On the other hand, mental health symptoms can be related to outcomes in the wake of substance use. For example, anxiety has been recognized as a symptom of withdrawal among drug users (Stewart & Brown, 1995). Thus, concerns for mental health issues extend beyond those with diagnosable conditions in a wide variety of ways. Given the significant associations between substance abuse and mental health, the proper measurement of mental health is a critical element of substance abuse studies.

1.2 The Brief Symptom Inventory

The Brief Symptom Inventory (BSI) (Derogatis & Spencer, 1983), an outgrowth of the Symptom Checklist 90 (Derogatis, 1983), was developed to assess psychological problems in clinical and non-clinical populations. The original BSI 53-item instrument has good psychometric properties including high internal consistency and test-retest reliability

(Derogatis & Spencer, 1983; Derogatis, 1993). Given these strengths, the BSI has become a common measure of mental health in studies of substance abuse and it has been utilized for studies of users of a wide range of substances from cocaine (Magura, Rosenblum, & Rodriguez, 1998) to methamphetamine (Booth et al., 2006) to ecstasy (Soar, Turner, & Parrott, 2006), as well as studies of residential therapeutic communities (Metrikina et al., 2003). The BSI has also been used in different types of research including clinical studies of pharmacotherapy for methamphetamine dependence (Meredith et al., 2007), therapy for couples in substance abuse treatment (Li et al., 2007), and studies of anti-retroviral adherence among drug users (Knowlton et al., 2006). Studies have shown that the BSI is useful for mental health screenings of substance abuse clients (Royse & Drude, 1984) and those with formal dual diagnoses generally score higher on the BSI (Primm et al., 2000). Thus, this measure has demonstrated considerable utility to those in the field of substance abuse and addiction.

Although its hypothesized nine subscales are theoretically well defined, the factorial structure of the original BSI has not been confirmed in factor analyses (Boulet & Boss, 1991; Ruiperez et al., 2001). Subsequently, Derogatis (2000) developed a shorter version of the instrument -- the Brief Symptom Inventory 18 (BSI-18) -- to be used as a screening tool for the most common psychiatric disorders: somatization (SOM), depression (DEP), and anxiety (ANX). The BSI-18 items were taken verbatim from the BSI 53-item instrument to represent three subscales/factors (SOM, DEP, and ANX). In his studies, Derogatis (2000, 2001) showed that the first two factors (SOM and DEP) remain as defined, but the third factor (ANX) may be split into two factors: Factor 3 underlying agitation (AGI) symptoms (3, Nervousness; 6, Tense; 15, Restlessness); and Factor 4 underlying panic (PAN) symptoms (9, Scared; 12, Panic episodes; 18, Fearful), yielding a four-factor solution (SOM, DEP, AGI, and PAN). Nonetheless, because the last two factors collectively measure anxiety (ANX), a 3-factor structure can be considered valid in BSI-18 (Derogatis, 2000, 2001).

While the original three dimensions of the BSI-18 proposed by Derogatis (2000) was confirmed using principal components analysis (PCA) (Derogatis, 2000), most studies on the factorial structure of the BSI-18 have applied exploratory factor analysis (EFA) and their findings are inconsistent. Many suggest that the BSI-18, like its parent assessments (i.e., the BSI and the SCL-90-R), may ultimately be measuring one underlying factor -- a global severity index (GSI) of general psychological distress (Prelow et al., 2005; Asner-self, Schreiber, & Marotta, 2006; Boulet & Boss, 1991; Coelho, Strauss, & Jenkins, 1998).

By using confirmatory factor analysis (CFA), a more rigorous approach for assessment of factorial structure based on a theory of the underlying latent variable structure, recent investigations of the BSI-18 have validated the three-dimensional structure (i.e., DEP, SOM, and ANA) as originally designed by Derogatis (2000), although an alternative 4-factor model (i.e., DEP, SOM, Agitation, and Panic) also fit the data (Recklitis et al., 2006; Durá et al., 2006). While both the 3-factor and 4-factor models fit the data well, the 3-factor model is more parsimonious and easier for interpretation than the 4-factor model. In addition, as a screening measure, the BSI-18 is not intended to make a distinction between anxiety subtypes (Derogatis, 2000). Therefore, the 3-factor model is preferred (Recklitis et al., 2006; Durá et al., 2006).

1.3 Present Study

To the best of our knowledge, the factorial structure of the BSI-18 has not been assessed among illicit drug-users, which is an important population given the high rates of psychological distress both as a consequence of drug use and as a factor inducing drug use (e.g. self-medication) (Grant, Stinson, Dawson et al., 2004). In this study, we test various

hypothesized factorial structures (e.g., one factor, three factors, four factors, and hierarchical factors) of the BSI-18 among drug users recruited from three different sites in Ohio, Kentucky, and Arkansas. The study not only provides us with an opportunity to assess the factorial structure of the BSI-18 among drug users in different locations, but also allows us to test measurement invariance across different drug using populations.

2. METHODS

2.1 Sample

Data used for the study were from a multi-site natural history study of rural illicit drug users. A total sample of 710 drug users was recruited from three counties in each of three states: Ohio (n=248), Kentucky (n=225), and Arkansas (n=237), beginning in October 2003. Study eligibility included the following: being age 18 or older; self-reported use of crack cocaine, powdered cocaine, or methamphetamine/amphetamine in the past 30 days; no recent formal substance abuse treatment (past 30 days); residence in one of the targeted counties; and providing informed consent to participate in the study.

Respondent-driven sampling (RDS), which has been widely applied to recruit hidden drug using populations, was used for sample recruitment (Abdul-Quader et al., 2006; Heckathorn, 1997, 2002; Wang et al., 2005, 2007). To start the RDS process, ethnographic methods were used to recruit “seeds” who met the eligibility criteria for the study (Draus et al., 2005). Having finished the baseline interview, each seed was asked to distribute up to three referral coupons to others they felt might be eligible and would wish to participate in the study. In turn, each new eligible participant was given three referral coupons to recruit other potential participants. A participant received \$50 financial compensation for his/her time spent completing the baseline interview, which lasted about 2–2.5 hours; and \$10 for referring each drug using peer to the study. Peer recruitment with referral coupons and the dual incentives were employed to help reduce volunteerism and masking effects during the recruitment process (Heckathorn, 1997, 2002). More detail on recruitment approaches can be found in previous publications (Draus et al. 2005; Siegal et al., 2006; Booth, et al., 2006; Wang et al., 2007).

2.2 Measures

The BSI-18 items were designed to measure three dimensions of psychiatric disorders: somatization (SOM), depression (DEP), and anxiety (ANX). Each of the three subscales was measured by six items, respectively (see Table 2). All BSI-18 items used a 5-point, Likert-type response option format (0- not at all; 1- a little bit; 2- moderately; 3- quite a bit; 4- extremely). All subscales of the BSI-18 have excellent reliabilities with Cronbach’s alphas greater than 0.80 in the populations under study (see Table 2).

2.3 Analytical Methods

Confirmatory factor analysis (CFA) models were used to test several factorial structures of the BSI-18 with a single factor, three factors, and four factors separately for each of the samples under study. The first-order factors (e.g., SOM, DEP, and ANX) are highly correlated with each other (the correlation between the factors ranges from 0.58 to 0.87 in our samples), and general psychological distress can be theoretically hypothesized to account for the covariance among the first-order factors. As such, second-order CFA models based on the three- and four-factor models were also evaluated to account for a hierarchical factorial structure in the BSI-18 items. A broader measure of the global severity index (GSI) of distress was specified as a second-order factor underlying the three first-order factors (i.e., SOM and DEP, and ANX) in each sample.

Having compared all alternative models, a baseline model was determined for each sample, and then incorporated in multi-group CFA models to test measurement invariance of the BSI-18 across populations focusing on first examining the configural invariance (Horn & McArdle, 1992; Reise, Widaman, & Pugh, 1993; Byrne, 2006). This approach is particularly useful to compare different samples that are recruited from different populations (Jöreskog, & Sörbom, 1989). In the configural invariance model, the same factorial structure (i.e., the same pattern of fixed and free factor loadings) was specified for each sample, and no equality constraints were imposed on model parameters across samples. Our second focus was on examining the metric invariance or factor loading invariance -- testing whether the same relations between the observed variables (i.e., the measures of the BSI-18 items) and their underlying constructs (i.e., SOM, DEP, and ANX) hold among different populations. Third, we examined scalar invariance -- testing whether the intercepts of regressing each of the BSI-18 items on the latent constructs are invariant across populations. Finally, we tested whether the factor means or levels of the latent constructs were invariant across populations. For testing factor mean invariances in multi-group second-order CFA, three model specification approaches (Approaches A, B, and C) are usually proposed to address model identification problems (see Byrne, 2006). Approach A imposes constraints on the second-order factor intercepts/means; Approach B imposes constraints on the intercepts/means of the observed variables; and Approach C imposes constraints on the first-order factor intercepts/means to zero (Byrne, 2006). In our study, approaches A and C were used for comparing the means of the first-order and second-order factors between populations, respectively.

All the CFA models were estimated using the computer program Mplus 5 (Muthén & Muthén, 1998–2008). As the measures of the BSI-18 items are not normally distributed (Recklitis et al., 2006)¹, using the ML estimator for model estimation can produce an inflated chi-square estimate that increases the likelihood of erroneously rejecting the model (Type I error) (Chou, Bentler, & Satorra, 1991; Curran, West, & Finch, 1996; Muthén & Kaplan, 1985). The maximum likelihood mean adjusted (MLM) estimator was applied for CFA model estimation in the study. Under MLM, mean and covariance structures (MACS), instead of the covariance structures (COVS), were analyzed. The MLM provides maximum likelihood parameter estimates with robust standard errors and a mean-adjusted chi-square (Muthén & Muthén, 1998–2007), which is also referred to as the Satorra-Bentler type of chi-square (Satorra & Bentler, 1994). The method adjusts the ML chi-square by a correction factor to account for non-normality of observed measures (Curran, West, & Finch, 1996; Chou, Bentler, & Satorra, 1991; Hu, Bentler, & Kano, 1992; Yu, 2002). The likelihood ratio (LR) χ^2 statistics used for model comparisons were computed based on the log likelihood values and scaling correction factors obtained with the MLM estimator. The formulas for such calculations are described on the Mplus website (<http://www.statmodel.com/chidiff.shtml>).

The model fit indexes used to assess model fit were the comparative fit index (CFI) (Bentler, 1990), the Tucker-Lewis index (TLI) (Tucker & Lewis, 1973) or Bentler & Bonett's Nonnormed Fit Index (NNFI) (Bentler & Bonett, 1980), root mean square error of approximation (RMSEA) (Steiger, 1990; Browne & Cudeck, 1992), and the standardized root mean square residual (SRMR). All the model fit indices reported in this study are based on robust versions of these model fit indexes; that is, all were computed on the basis of the MLM chi-square, adjusting for the effect of non-normality. The cutoff value for CFI and TLI is usually 0.90, but higher values (e.g., 0.95) have been considered as the cutoff value

¹The estimated scaling correction factor is substantially greater than 1.0 in each of the samples in this study (see Table 5), indicating multivariate normality assumption does not hold in the BSI-18 items (Muthén & Muthén, 1998–2007).

in recent years. Also RMSEA values less than .06 and SRMR values less than .08 would indicate a good fit of the model to the data (Hu & Bentler, 1999).

3. RESULTS

Table 1 shows that the socio-demographic characteristics, such as age, ethnicity, and education are, while gender composition was not, statistically significant among drug users between research sites in Ohio, Kentucky, and Arkansas. The experiences of lifetime mental health treatment, as well as treatment during the past three years, among drug users were also significantly different between the sites. In regard to drug use in the past 30 days, the frequencies of self-reported use of all the drugs were significantly different, except that marijuana use was only marginally significant ($P=0.0502$), across sites.

Table 2 shows the descriptive statistics of the observed measures of the BSI-18 items and their composite measures for somatization (SOM), depression (DEP), anxiety (ANX), and global severity index (GSI), as well as their internal consistency measured by Cronbach's coefficient alpha for each sample. Similar to the findings in other studies (Derogatis, 2000; Recklitis et al. 2006), the Cronbach alpha values are high, ranging from 0.79 to 0.88 for the composite measure of SOM, DEP, and ANX, and over 0.90 for the global severity index (GSI) of distress in all the samples under study.²

Table 3 shows the model fit statistics/indexes for the single-factor, three-factor (i.e., SOM, DEP, and ANX) and four-factor (i.e., SOM, DEP, ANX, and PAN) CFA models as well as second-order three- and four-factor CFA models by site. Out of the models, the single-factor CFA model fits data the worst; it has the largest χ^2 value, and CFI and TLI values much lower than 0.90, although its RMSEA and SRMR are not much off the cutoff values (i.e., 0.06 and 0.08, respectively). For each sample, both the three-factor and four-factor models adequately fit the data (i.e., CFI and TLI are close to or above 0.95, RMSEA 0.06, and SRMR 0.06).

The model fit statistics/indexes of the second-order three-factor CFA models are identical to the first-order three-factor models as the second-order component of the model is just identified with three first-order factors. The addition of a second-order factor (i.e., GSI) in the four-factor CFA models only slightly improves model fit (see Table 3). In both the first- and second-order CFA models, model fit statistics/indexes slightly favor the four-factor model. Following Derogatis (2000) and Recklitis et al. (2006), the more parsimonious three-factor structure of the BSI-18 was selected for further evaluation using second-order CFA.

The baseline second-order three-factor CFA model fits data very well for each sample (CFI>0.95, TLI>0.95, RMSEA=0.04, SRMR 0.06) (see Table 4). Parameter estimates reported in Table 4 are from a completely standardized solution in which both observed and latent variables are all standardized. It appears that the intercepts of all the BSI-18 items in Arkansas sample are smaller than those in Ohio and Kentucky samples, while factor loadings seems similar among the samples. The invariance of these important measurement components across samples was tested via multi-group CFA models, and the model results are shown in Table 5.

Model 1 in Table 5 is the configural model, which simply incorporates the baseline models for all the samples and allows for simultaneous analyses. In the configural model, no equality constraints were imposed on model parameters across samples; however, all first-order factor intercepts and the mean of the second-order factor were constrained to zero for

²The widely-accepted social science cut-off is that alpha should be .70 or higher (Nunnally, 1994).

the purpose of model identification.³ The model fits the data very well (CFI=0.96; TLI=0.95; RMSEA =0.04; SRMR= 0.05), indicating invariance of factorial structure among the populations (Byrne, 2006).

In Model 2 equality constraints were imposed on factor loadings across populations. Then, equality constraints were further imposed on intercepts of observed measures, yielding Model 3 (see Table 5).

It is important to note that the χ^2 statistics estimated from a robust estimator, such as MLM, MLR and WLSM cannot be directly used for the likelihood ratio (LR) test (Muthén & Muthén, 1998–2008). To compare Models 2 and 3 with Model 1 (i.e., configural model), χ^2 differences were computed based on log likelihood values and scaling correction factors.⁴ The LR χ^2 test results show no significant difference in model fit between Models 2 and 1 ($\chi^2=37.97$, d.f.=33, $P=0.2531$), indicating factor loading invariance or metric invariance of the BSI-18 items among the populations under study. However, the difference between Models 3 and 1 is statistically significant ($\chi^2=108.37$, d.f.=69, $P=0.0017$), indicating that the intercepts or scalars of the BSI-18 items are not invariant across populations.

To compare factor means across populations, the Ohio sample was treated as the reference sample against which Kentucky and Arkansas samples were compared. Technically speaking, the factor means for Ohio sample were set to zero for the purpose of model identification, and the estimated factor “means” in the Mplus output for the other two samples were actually the mean differences between each of the two samples and the reference sample. The means of the first-order factors (SOM, DEP, and ANX) and the second-order factor (GSI) were estimated using Approaches A and C, respectively as discussed by Byrne (2006). The model results are shown in Table 6.

The means of subscales Somatization (SOM) and Anxiety (ANX) were significantly lower among drug users in Kentucky than in Ohio, while the means of subscale Depression (DEP) and the global severity index (GSI) of distress were not significantly different between the two sites. Compared with Ohio, all the three subscales and the global severity index of distress had significantly lower mean values in Arkansas.

4. DISCUSSION

To the best of our knowledge, this study is the first to examine the factorial structure of the BSI-18 among illicit drug users in the U.S. Our results support the findings of Derogatis (2000) and Recklitis et al. (2006), showing that the BSI-18 has a three-factor structure (i.e., SOM and DEP, and ANX) with an underlying second-order factor (i.e., the global severity index (GSI) of distress) in each population.

This study is also the first to conduct measurement invariance assessment of the BSI-18 across different populations using multi-group CFA models. Our results provide evidence that the BSI-18 has invariant factorial structure and metric among different drug using populations. However, the scalars of the BSI-18 items are not invariant across the populations. This indicates that participants in at least one of the populations under study tended to respond systematically higher or lower to the BSI-18 items, even if the relations between the BSI-18 items with the underlying factors (i.e., factor loading invariance) remained the same across populations. Consequently, the means of the first-order and

³To estimate intercepts of all the observed variables, factor intercepts/means must be constrained to zero in order to avoid under-identification related to the means structure part of the model. In analysis of MACS, the number of intercepts/means to be estimated in the model must always be less than the number of observed variables (Bentler, 2005).

⁴The method is described in the Mplus website (<http://www.statmodel.com/chidiff.shtml>).

second-order factors were different among the populations. It is reasonable to observe different levels of psychiatric measures of somatization, depression, and anxiety, as well as the global severity of distress among different populations because the drug using populations under study had significant differences in terms of socio-demographic characteristics, history of mental health treatment, and drug use practices (see Table 1). The explanations for those differences and the association between those factors and the levels of psychiatric measures need further study.

The findings of this study serve to broaden our knowledge with respect to the factorial structure of the BSI-18. The valid factorial structure of the BSI-18 enables one to model the relationships between the psychiatric disorders (e.g., somatization, depression, and anxiety, as well as the global severity index) and other variables via structural equation modeling, eliminating the influence of measurement errors in the observed items.

Although the findings of this study support the use of the BSI-18 with drug using populations, some limitations remain. First, the RDS samples are not random samples although they are more representative of the target populations compared to the samples recruited using convenience sampling methods, such as targeted sampling and chain-referral sampling. Second, the drug users in this study were all recruited from rural areas, and similar studies are needed to assess the validity of the BSI-18 factorial structure among urban drug using populations. And finally, the external validity of the latent factors (i.e., SOM, DEP, and ANX) underlying the BSI-18 items needs to be further assessed. Despite these limitations, these findings indicate that the BSI-18 provides a robust means to measure mental health among drug users.

Acknowledgments

This research was supported by National Institute on Drug Abuse grant numbers R01 DA15363 & R01 DA14340. The views expressed in this paper do not necessarily reflect those of the National Institute on Drug Abuse or any other governing agency.

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Table 1
Descriptive sample statistics on demographic, mental health treatment, and drug use by site

	Ohio (n =248)		Kentucky (n = 225)		Arkansas (n = 237)	
Variable	n	(%)	n	(%)	n	(%)
Socio-demographics						
Gender						
Male	166	(66.9)	129	(57.3)	141	(59.5)
Female (P= 0.0765)	82	(33.1)	96	(42.7)	96	(40.5)
Ethnicity						
Black/Other	32	(12.9)	41	(18.2)	155	(65.4)
White (P<0.0001)	216	(87.1)	184	(81.8)	82	(34.6)
Age group						
< 25	90	(36.3)	65	(28.9)	50	(21.1)
25 – 35	83	(33.5)	68	(30.2)	59	(24.9)
35+ (P<0.0001)	75	(30.2)	92	(40.9)	128	(54.0)
Education						
< High school	102	(41.1)	80	(35.6)	112	(47.3)
High school	122	(49.2)	115	(51.1)	87	(36.7)
College (P=0.0075)	24	(9.7)	30	(13.3)	38	(16.0)
Mental health treatment history ¹						
Life time						
No	156	(62.9)	166	(73.8)	179	(75.5)
Yes (P=0.0042)	92	(37.1)	59	(26.2)	58	(24.5)
Last 3 years						
No	204	(82.3)	174	(77.3)	211	(89.0)
Yes (P=0.0035)	44	(17.7)	51	(22.7)	26	(11.0)
Drug use in the past 30 days						
Crack cocaine						
No use	78	(31.5)	131	(58.2)	81	(34.2)

Variable	Ohio (n =248)		Kentucky (n = 225)		Arkansas (n = 237)	
	n	(%)	n	(%)	n	(%)
Non-daily use	125	(50.4)	82	(36.5)	89	(37.6)
Daily use (P<0.0001)	45	(18.1)	12	(5.3)	67	(28.2)
Powdered Cocaine						
No use	68	(27.4)	156	(69.3)	141	(59.5)
Non-daily use	151	(60.9)	67	(29.8)	72	(30.4)
Daily use (P<0.0001)	29	(11.7)	2	(0.9)	24	(10.1)
Methamphetamine						
No use	174	(70.2)	86	(38.2)	142	(59.9)
Non-daily use	63	(25.4)	116	(51.6)	73	(30.8)
Daily use (P<0.0001)	11	(4.4)	23	(10.2)	22	(9.3)
Drunkenness						
None	71	(28.6)	127	(56.5)	137	(57.8)
Non-daily	144	(58.1)	86	(38.2)	87	(36.7)
Daily (P<0.0001)	33	(13.3)	12	(5.3)	13	(5.5)
Marijuana						
No use	36	(14.5)	48	(21.3)	51	(21.5)
Non-daily use	96	(38.7)	97	(43.1)	100	(42.2)
Daily use (P=0.0502)	116	(46.8)	80	(35.6)	86	(36.3)
Amphetamine						
No Use	188	(75.8)	203	(90.2)	210	(88.6)
Use (P<0.0001)	60	(24.2)	22	(9.8)	27	(11.4)
Tranquilizers						
No Use	157	(63.3)	157	(69.8)	207	(87.3)
Use (P<0.0001)	91	(36.7)	68	(30.2)	30	(12.7)
Heroin						
No Use	205	(82.7)	223	(99.1)	234	(98.7)
Use (P<0.0001)	43	(17.3)	2	(0.9)	3	(1.3)

Note.

¹ Ever been treated for emotional or psychological problems other than those for alcohol and other drug abuse.

Table 2

Descriptive statistics of the BSI-18 items and the composite measures of the three underlying subscales by state

		Ohio (N=248) ^I	Kentucky (N=225) ^I	Arkansas (N=237) ^I
Item	Item #	M (SD)	M (SD)	M (SD)
Somatization (SOM)		6.71 (6.07) ($\alpha = 0.84$)	5.27 (5.47) ($\alpha = 0.83$)	3.15 (5.27) ($\alpha = 0.84$)
Faintness	1	0.63 (0.97)	0.44 (0.82)	0.26 (0.68)
Chest pains	4	0.80 (1.11)	0.62 (1.03)	0.32 (0.75)
Nausea	7	1.14 (1.26)	0.90 (1.18)	0.53 (0.97)
Short of breath	10	0.69 (1.07)	0.51 (0.90)	0.36 (0.84)
Numb or tingling	13	1.13 (1.23)	0.87 (1.12)	0.55 (0.96)
Body weakness	16	1.22 (1.28)	1.11 (1.23)	0.59 (0.97)
Depression (DEP)		6.13 (5.33) ($\alpha = 0.85$)	5.84 (5.53) ($\alpha = 0.86$)	3.51 (4.61) ($\alpha = 0.87$)
Lonely	5	1.35 (1.31)	1.30 (1.34)	0.79 (1.17)
No interest	2	1.30 (1.29)	1.23 (1.22)	0.84 (1.09)
Blue	8	1.23 (1.24)	1.30 (1.30)	0.71 (1.07)
Worthlessness	11	0.98 (1.22)	0.81 (1.20)	0.47 (0.99)
Hopelessness	14	1.13 (1.24)	1.03 (1.32)	0.61 (1.03)
Suicidal thoughts	17	0.17 (0.59)	0.16 (0.63)	0.10 (0.46)
Anxiety (ANX)		6.44 (5.40) ($\alpha = 0.84$)	5.36 (5.49) ($\alpha = 0.88$)	3.78 (4.67) ($\alpha = 0.79$)
Nervousness	3	1.42 (1.23)	1.27 (1.30)	0.87 (1.16)
Tense	6	1.51 (1.27)	1.30 (1.30)	0.91 (1.19)
Scared	9	0.66 (1.11)	0.58 (1.09)	0.37 (0.88)
Panic episodes	12	0.65 (1.13)	0.50 (1.00)	0.31 (0.89)
Restlessness	15	1.51 (1.33)	1.14 (1.26)	0.87 (1.24)
Fearful	18	0.69 (1.14)	0.56 (1.02)	0.45 (0.92)
Global Severity Index (GSI) of Distress	1–18	19.28 (14.86) ($\alpha = 0.92$)	16.46 (14.85) ($\alpha = 0.93$)	10.44 (11.56) ($\alpha = 0.91$)

Note.

^I Samples size slightly varies by item due to missing values.

Table 3

Goodness-of-fit indices for CFA models by state[/]

Model	χ^2	d.f.	P	CFI	TLI	RMSEA	SRMR
Ohio (N=243)							
First-order CFA							
1 Factor	400.29	135	<0.001	0.83	0.81	0.09	0.06
3 Factors	236.80	132	<0.001	0.93	0.92	0.06	0.05
4 Factors	211.86	129	<0.001	0.95	0.94	0.05	0.05
Second-order CFA							
3 Factors	236.80	132	<0.001	0.93	0.92	0.06	0.05
4 Factors	211.72	131	<0.001	0.95	0.94	0.05	0.05
Kentucky (N=224)							
First-order CFA							
1 Factor	306.56	135	<0.001	0.88	0.86	0.08	0.06
3 Factors	215.52	132	<0.001	0.94	0.93	0.05	0.05
4 Factors	191.35	129	<0.001	0.96	0.95	0.05	0.05
Second-order CFA							
3 Factors	215.52	132	<0.001	0.94	0.93	0.05	0.05
4 Factors	191.16	131	<0.001	0.96	0.95	0.05	0.05
Arkansas (N=230)							
First-order CFA							
1 Factor	310.96	135	<0.001	0.81	0.78	0.08	0.08
3 Factors	188.79	132	<0.001	0.94	0.93	0.04	0.06
4 Factors	173.29	129	<0.001	0.95	0.94	0.04	0.06
Second-order CFA							
3 Factors	188.79	132	<0.001	0.94	0.93	0.04	0.06
4 Factors	173.10	131	<0.001	0.95	0.95	0.04	0.06

Note.

[/] All models were estimated using MLM estimator in Mplus. The minor change in sample size is due to listwise deletion, which is required by MLM. No cross-loadings and measurement error covariances were specified in the models.

Table 4

Results of baseline second-order 3-factor CFA model by state¹

Item	Item #	Ohio (N=243)			Kentucky (N=224)			Arkansas (N=230)		
		SOM	DEP	ANX	SOM	DEP	ANX	SOM	DEP	ANX
Faintness	1	<i>v</i> 0.63			0.44			0.23		
	λ	0.71			0.64			0.71		
Chest pains	4	<i>v</i> 0.82			0.61			0.30		
	λ	0.61			0.65			0.59		
Nausea	7	<i>v</i> 1.13			0.90			0.53		
	λ	0.75			0.68			0.65		
Short of breath	10	<i>v</i> 0.68			0.51			0.34		
	λ	0.71			0.61			0.57		
Numb or tingling	13	<i>v</i> 1.12			0.88			0.54		
	λ	0.57			0.67			0.53		
Body weakness	16	<i>v</i> 1.20			1.11			0.57		
	λ	0.76			0.79			0.80		
Lonely	5	<i>v</i>	1.34			1.31			0.77	
	λ		0.73			0.68			0.83	
No interest	2	<i>v</i>	1.20			1.23			0.82	
	λ		0.78			0.82			0.72	
Blue	8	<i>v</i>	1.22			1.31			0.69	
	λ		0.80			0.76			0.85	
Worthlessness	11	<i>v</i>	0.97			0.82			0.43	
	λ		0.79			0.81			0.75	
Hopelessness	14	<i>v</i>	1.14			1.03			0.60	
	λ		0.63			0.68			0.71	
Suicidal thoughts	17	<i>v</i>	0.18			0.16			0.10	
	λ		0.41			0.38			0.45	
Nervousness	3	<i>v</i>		1.43			1.27			0.85
	λ			0.71			0.74			0.51
Tense	6	<i>v</i>		1.51			1.30			0.90

Item	Item #	Ohio (N=243)			Kentucky (N=224)			Arkansas (N=230)		
		SOM	DEP	ANX	SOM	DEP	ANX	SOM	DEP	ANX
	λ			0.73			0.76			0.72
Scared	ν			<i>0.64</i>			<i>0.59</i>			<i>0.34</i>
	λ			0.64			0.71			0.66
Panic episodes	ν			<i>0.63</i>			<i>0.51</i>			<i>0.31</i>
	λ			0.66			0.78			0.68
Restlessness	ν			<i>1.50</i>			<i>1.14</i>			<i>0.84</i>
	λ			0.69			0.77			0.76
Fearful	ν			<i>0.69</i>			<i>0.57</i>			<i>0.45</i>
	λ			0.65			0.68			0.64
			GSI			GSI			GSI	
SOM			0.85			0.86			0.78	
DEP			0.86			0.91			0.80	
ANX			0.97			0.98			0.97	
Model Fit		CFI=0.98, TLI=0.97, RMSEA=0.04, SRMR=0.04			CFI=0.97, TLI=0.97, RMSEA=0.04, SRMR=0.04			CFI=0.96, TLI=0.96, RMSEA=0.04, SRMR=0.06		

Note.

I In the baseline models, the measurement error covariances Cov(Y₅, Y₈) and Cov(Y₉, Y₁₂) were set to be correlated for Ohio, Cov(Y₅, Y₈) and Cov(Y₁₁, Y₁₄) for Kentucky sample, and Cov(Y₁, Y₁₆) for Arkansas sample, based on the modification indices provided by Mplus 5. All factor intercepts/means were constrained to zero for the purpose of model identification. Models were estimated based on analysis of mean and covariance structures (MACS), using MLM estimator. Results of completely standardized solution are reported.

ν Intercept of the observed variables (the numbers in italic).

λ Factor loadings.

CFI: Comparative Fit Index.

TLI: Tucker-Lewis index, also called the Bentler-Bonett's Non-Normed Fit Index (NNFI).

RMSEA: Root Mean Square Error Of Approximation.

SRMR: Standardized Root Mean Square Residual.

Table 5

Testing for configural invariance, factor loading and intercept invariance of the BSI-18 items across samples

Model	Log-likelihood	Number of Parameters	Scaling Correction Factor for MLM	LR χ^2
1) Configural Model ¹	-15593.44	174	1.519	-
2) Equality constraints on factor loadings ²	-15621.54	141	1.527	37.97 (d.f.=33) (P=0.2531)
3) Equality constraints on factor loadings and intercepts ³	-15678.51	105	1.486	108.37 (d.f.=69) (P=0.0017)

Note.

¹ In the configural model, the same factorial structure (i.e., the same pattern of fixed and free factor loadings) were specified for each sample, and no equality constraints were imposed on model parameters across samples; however, all factor intercepts/means were constrained to zero for the purpose of identification. The model fit indices for the model are: CFI=0.96; TLI=0.95; RMSEA =0.04; SRMR= 0.05.

² Additional equality constraints were imposed on factor loadings, as well as on the common error covariance (e.g., Cov (Y5, Y8) in Ohio and Kentucky samples.

³ Additional equality constraints were imposed on intercepts of the observed variables.

Table 6

Comparisons of factor means among samples based on the second-order CFA with three first-order factors (SOM, DEP, and ANX) and one second-order factor (GSI)

Factor Means [/]	Ohio		Kentucky		Arkansas	
	Estimate	P-value	Estimate	P-value	Estimate	P-value
Somatization (SOM)	-	-	-0.14	0.020	-0.40	<0.001
Depression (DEP)	-	-	-0.06	0.519	-0.54	<0.001
Anxiety (ANX)	-	-	-0.20	0.034	-0.52	<0.001
Global Severity Index (GSI) of Distress	-	-	-0.07	0.161	-0.26	<0.001

Notes.

-: Ohio sample was treated as the reference sample for which factor intercepts/means are constrained to zeros. The estimates for Kentucky and Arkansas samples are the factor mean differences between the two samples and the reference sample.

[/]The means of the first-order factors (SOM, DEP, and ANX) and the second-order factor (GSI) were estimated using Approaches A and C, respectively (Byrne, 2006).