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Using the Center for Epidemiologic Studies Depression Scale to assess depression in women with HIV and women at risk for HIV: Are somatic items invariant?

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Abstract

Compared with women in the general population and with men diagnosed with HIV/AIDS, the prevalence of depression among women living with HIV/AIDS is elevated. Although symptoms of HIV may overlap with somatic symptoms of depression, little research has explored how well screening tools accurately assess depression, rather than symptoms of HIV/AIDS, among women. The present study examined the utility of a widely used tool for assessing depression symptoms among women living with HIV/AIDS. Data are from the Women's Interagency HIV Study (WIHS), a multi-site, longitudinal cohort study of women living with HIV/AIDS (n=1329) and seronegative women (n= 541) matched on key risk factors for HIV/AIDS. Confirmatory Factor Analysis (CFA)-based measurement invariance tests of the Center for Epidemiologic Studies Depression Scale (CES-D) were conducted to determine whether women with and without HIV responded to the scale similarly. Results supported measurement invariance of CES-D scores. Findings suggest that the CES-D can be used to assess for burden of depression symptoms among women diagnosed with HIV/AIDS.

Public Significance Statement: This study suggests that, despite overlap in some symptoms of HIV and some symptoms of depression, scores on the Center for Epidemiologic Studies Depression Scale (CES-D) reflect symptoms of depression equally well for women who are HIV-positive and for women who are HIV-negative. This suggests that clinicians and researchers can meaningfully compare CES-D scores between women in these two groups.

Keywords: HIV/AIDS, somatic complaints, depression, women, CFA, measurement invariance

Using the Centers for Epidemiologic Studies Depression Scale to assess depression in women with HIV and women at risk for HIV: Are somatic items invariant?

Depression is the leading neuropsychiatric complication in HIV-infected populations, with prevalence rates ranging between 20 and 40 percent (Do et al., 2014; Nanni, Caruso, Mitchell, Meggiolaro, & Grassi, 2015; Rabkin, 2008; Centers for AIDS Research Social and Behavioral Science Research Network, 2011). The prevalence of clinical depression among HIV-infected persons is two to four times higher than in the general population (Nanni et al., 2015). Mirroring the general population, higher rates of depression have been found in HIV-positive women compared to HIV-positive men (Cook et al., 2002; Ickovics et al., 2001; Nanni et al., 2015).

Biological and psychosocial factors are associated with clinical depression among HIV-infected individuals. Biologically, HIV virus may cause a release of inflammatory cytokines leading to cytokine-induced sickness behavior, which is similar to symptoms of depression (e.g., psychomotor retardation, anhedonia, appetite suppression; Kelley et al., 2003; Readler, 2011). Further, HIV infection may alter tryptophan, which indirectly affects serotonin production (the neurotransmitter targeted by many antidepressant medications) (Danzter, O'Connor, Lawson, & Kelley, 2011; Schroecksnadel et al., 2008). Psychosocial factors experienced by many HIV-infected individuals such as marginalization, HIV-related stigma, social isolation, substance abuse, and trauma histories can lead to higher rates of depression (Centers for AIDS Research Social and Behavioral Science Research Network, 2011; Nanni et al., 2015).

Moderate to severe depression is associated with high-risk behaviors that contribute to increased risk of contracting HIV (Hutton, Lyketsos, Zenilman, Thompson, Erbelding, 2004; O'Cleirigh et al., 2013). Depression severity is associated with faster disease progression, higher

AIDS-related mortality, and decreased adherence to medication among HIV-infected women and men (Cook et al., 2002; Leserman et al., 2002). If screened and diagnosed, depression is often a treatable condition. Despite known links between HIV diagnosis and depression, those with both conditions often do not receive the treatment that they need. For instance, in the Women's Interagency HIV Study (WIHS), which serves as the platform for this analysis, fewer than half of women with diagnoses of both HIV and depression reported receiving adequate treatment for their depression (Cook et al., 2014).

The interpretations of a number of screening tools have been validated for use in primary care settings to assess symptoms of depression (Centers for AIDS Research Social and Behavioral Science Research Network, 2011), though few have measures have been examined in HIV-infected populations. Consistent measurement across different groups is vital, as it forms the basis for accurately interpreting results and comparing scores between people. There is reason to investigate whether measures of depression assess the disorder equally well in people with HIV relative to people without HIV. Adequate screening and differential diagnosis of depression among individuals with HIV may be complicated by somatic symptoms (e.g., concentration difficulties, appetite difficulties, sleep disturbance) that are common to both HIV and depression. Including somatic items in the assessment of individuals with HIV may result in misleadingly high estimates of depression, which are attributable to poor HIV disease management. Perkins and colleagues (1995) found that in their sample, asymptomatic HIV-positive homosexual men and HIV-negative homosexual men had similar levels of somatic complaints (specifically, insomnia and fatigue). They concluded that somatic complaints among asymptomatic HIV-positive individuals reflected true depression (Perkins et al., 1995). However, Kalichman, Rompa, and Cage (2000) reported among HIV-positive adults, removing somatic

items from the Beck Depression Inventory [BDI] and the Center for Epidemiologic Studies Depression Scale [CES-D] improved their clinical utility for symptomatic HIV-positive people by enhancing specificity in assessing symptoms indicative of depression.

Although these studies provide important information about the relationship between somatic symptoms and depression for adults with HIV, neither address whether somatic items on depression scales measure the same construct for women with and without HIV. Kalichman and colleagues' (2000) sample included only HIV-positive adults, a third of whom were women, while Perkins and colleagues' (1995) study was restricted to asymptomatic (HIV-positive and HIV-negative) men. Compared to men, women report somatic symptoms of depression at higher rates, and are more likely to be classified through formal diagnostic criteria as having "somatic depression," in which at least three somatic symptoms are endorsed (Silverstein, 2002). This different pattern of symptom endorsement has been cited as a driving force of the gender imbalance in depression rates (Silverstein et al., 2013). Given the potential for somatic symptoms associated with HIV infection to elevate depression scores, along with women's tendency to endorse such symptoms at a higher rate, it is critical to explore the influence of somatic complaints on depression ratings among *women* with and without HIV, rather than solely compare women to men. Such an investigation can determine whether assessment of depression, in general, and somatic symptoms of depression, in particular, is substantially different for HIV-positive and HIV-negative women; this may provide additional information about effective depression screening in HIV-positive women.

The goal of the current study was to psychometrically analyze a well-validated depression screening tool (CES-D; Radloff, 1977) in HIV-positive and HIV-negative women, with an emphasis on somatic symptoms of depression. A multiple-group confirmatory factor

analysis approach was used to examine measurement invariance (configural, metric, scalar) across the two groups. Based on the somatic features associated with HIV infection, we expected scalar noninvariance for somatic items of depression, such that an HIV-positive woman with the same level of depression as an HIV-negative woman would be *more* likely to endorse somatic symptoms of depression (e.g., concentration difficulties, appetite problems), as measured by the CES-D.

Method

Participants

Participants were enrolled in the Women's Interagency HIV Study (WIHS), a multi-site cohort study of HIV disease progression in women. Initial WIHS recruitment occurred at 6 U.S. sites: Brooklyn, Bronx, Chicago, Los Angeles, San Francisco/Bay Area, and Washington, D.C. The sample is consistent with the demographic distribution of women with HIV in the United States, and is primarily comprised of African-American (57.3%) and Hispanic/Latina women (27.3%). Women enrolled in WIHS provide written informed consent to participate in study visits every six months. These visits include self-report measures assessing demographic features, health status, psychosocial functioning, service utilization, physical and gynecological exams, and serologic and salivary samples. All WIHS study procedures have been approved by the Institutional Review Boards (IRBs) at each site. Full details of the WIHS study are available elsewhere (Barkan et al., 1998; Bacon 2005).

Data for the present analyses are derived from 1,870 women (71.1% HIV-positive, 28.9% HIV-negative) who completed the CES-D during a study visit occurring between October 1, 2006 and March 31, 2007 (Table 1). This visit was chosen because it coincided with the

introduction of a menopause questionnaire that assessed somatic and mental health complaints, which was used to compare somatic symptom endorsement with the depression measure.

Measures

Depression. Depression symptoms were assessed using the Center for Epidemiologic Studies Depression Scale (CES-D, Radloff, 1977). The CES-D is a 20-item self-report measure of depression symptoms, and includes items that evaluate affective (e.g., depressed mood), cognitive (e.g., feelings of worthlessness), and somatic (e.g., loss of appetite) symptoms of depression. Each item is rated using a 4-point Likert scale to indicate how frequently the symptom occurred in the past week (0=rarely/less than 1 day, 3=most of the time/5-7 days). Four positively valenced items are reversed prior to scoring. Scores range from 0 to 60, with higher scores indicating a greater degree of depression symptoms. A cut-off score of ≥ 16 is a widely used indicator for likely clinically meaningful depressive symptoms (Radloff, 1977; Schulberg, Saul, McClelland, Ganguli, Christy, & Frank, 1985). The CES-D has been used extensively throughout community and clinical samples (Chwastiak, Ehde, Gibbons, Sullivan, Bowen, & Kraft, 2002; Ottenbacher et al., 2012; Zimmerman & Coryell, 1994). The psychometric properties of the scale scores have generally been good, though the factor structure of the CES-D has been a subject of contention with varying numbers of factor solutions being reported and supported in the literature (Carleton et al., 2013) and with limited evidence of the unidimensionality of the full CES-D relative to a shortened version of the scale (Levine, 2013).

Auxiliary somatic and health symptoms. Additional somatic and affective questions were introduced in visit 25 as part of a menopause stage and screening questionnaire (Rubin et al., 2014) used in the Study of Women's Health Across the Nation (SWAN). Thirteen questions assessed the frequency of experiencing each symptom (e.g., back pain, vaginal complaints,

dizziness, sleep disturbance, memory concerns, mood disturbance, headaches) over the past two weeks on a Likert scale (1=not at all, 2= 1-5 days, 3= 6-8 days, 4= 9-13 days, 5= every day). We included these questions prior to CFA analyses as a check for participants' consistency in responding about somatic complaints and mood throughout the interview.

Data Analysis

Preliminary analyses explored attrition, variable distributions, sample characteristics, overlap between the CES-D and auxiliary somatic items, and simple correlations using SPSS Version 19 for Macintosh (IBM, 2010). In line with prior work demonstrating variable factor structures for the full 20-item CES-D, we tested one-, two-, and four-factor models (Carleton et al., 2013). All CFA models were analyzed using Mplus 7.1 (Muthén & Muthén, 1998-2012), and robust weighted least square mean and variance (WLSMV) estimation with theta parameterization was used to account for the categorical nature of the CES-D (Garrido, Abad, & Ponsoda, 2016).

Once the optimal number of factors was obtained, we used this model to assess for measurement invariance between HIV-positive and HIV-negative women. Consistent with Millsap and Yun-Tein's (2004) recommended procedure, measurement invariance was assessed in a series of progressively stringent steps. First, a configural model was tested to determine whether the same factor pattern was present in both groups (e.g., same number of factors with the same indicators) and whether it fit each group sufficiently well. In this baseline model, the factor loadings of the scaling indicators were set to 1 for both groups, the first two thresholds of the scaling indicators were constrained to be equal across both groups (the third threshold was free to vary across scaling indicators), the first threshold of the additional indicators were constrained to be equal across groups (with the other two free to vary), and residual variances

were constrained in the HIV-negative group, while they were freely estimated in the HIV-positive group. Second, metric invariance was assessed such that factor loadings were constrained to be equal across both groups. If there is no difference in fit between the metric model and the configural model, then metric invariance is supported. Third, we tested scalar invariance by constraining item thresholds to be equal across groups; if the fit of this model is not significantly different from the fit of the metric model, then scalar invariance is supported. Although it is possible to assess for invariance between residual variances, many methodologists consider this to be impractical and overly stringent, thus we did not perform this test (Brown, 2006; Raju, Laffitte, & Byrne, 2002). If invariance is not supported at any step (e.g., metric, scalar), the source of noninvariance can be determined by examining modification indices (MI) provided by Mplus, and freeing constrained parameters (e.g., loadings, thresholds) until partial invariance is satisfied at that level. Additional analyses were conducted in a sub-sample of HIV-positive women in which measurement invariance was assessed between women likely to be symptomatic (CD4 count <200) and asymptomatic (CD4 count >200).

Goodness of fit was evaluated using several indices because they provide unique and balancing information when examining model fit (e.g., absolute fit, relative fit, adjustments for parsimony). A model is considered to fit the data well when there is a statistically non-significant chi-square statistic, a Root Mean Square Error of Approximation (RMSEA) below 0.06, and a Comparative Fit Index (CFI) or Tucker-Lewis Index (TLI) above 0.95 (Hu & Bentler, 1999). Bayesian information criterion (BIC) values provide another method of comparing non-nested models, though they are unavailable when using the WLSMV estimator. We computed BIC values to compare the competing factor models using Maximum Likelihood (ML) estimation, and present this information alongside fit values obtained from the WLSMV estimator. To

statistically compare models, the DIFFTEST option for WLSMV estimators, which relies on robust chi square tests, was used because standard chi square difference tests do not provide accurate estimates with categorical predictors (Asparouhov & Muthen, 2006). However, some researchers have found that changes in CFI and RMSEA provide better comparisons between nested models than chi square difference tests due to the influence that sample size has on the chi square statistic and on its tendency to be upwardly biased, resulting in rejecting correctly specified models in large samples (Meade, Johnson, & Braddy, 2008; Savalei & Rhemtulla, 2013). Generally, ΔCFI <.01 and ΔRMSEA <.015 supports invariance. Given the strengths and weaknesses of each fit index, we examined measurement invariance using all three indices.

Results

Inclusion-exclusion Comparisons

In preliminary analyses, we examined whether participants with depression data at visit 25 (n=1870) differed in substantive ways from those who were excluded from analyses due to missing depression data (n=208). The women with depression data were slightly younger (*M*=42.90, *SD*=9.28) than those without it (*M*=44.37, *SD*=9.86), $t(2076) = 2.14$, $p=.03$. The two groups did not differ with regard to HIV status, marital status, race/ethnicity, level of education, or on any other auxiliary somatic symptom indicators (all *p*'s>.17).

Sample Description

Table 1 provides a full description of the analytic sample. HIV-positive women in the sample were, on average, 44 years old (*SD* = 8.7, range: 23-78) and the HIV-negative women were, on average, 40 years old (*SD* = 10.1, range: 23-74). Women in either group were most likely to have completed grades 7-11 (HIV-positive: 33.0%; HIV-negative: 34.2%), completed high school (HIV-positive: 29.2%; HIV-negative: 32.9%), or completed some college (HIV-

positive: 24.3%; HIV-negative: 25.1%). Small proportions of women in either group reported having no education or reported completing college. With regard to relationship status, the greatest proportion of women reported having never been married (HIV-positive: 30.5%; HIV-negative: 40.3%) or being legally/common-law married (HIV-positive: 21.2%; HIV-negative: 21.4%).

Prevalence of Depressive Symptoms & Auxiliary Somatic Complaints

Mean depressive symptom scores for HIV-positive (n=1329, *M*= 13.74, *SD*= 12.82, range: 0-59) and HIV-negative (n=531, *M*= 13.12, *SD*= 12.29, range: 0-59) women were comparable, $t(1868) = -0.96$, $p=.34$ (Table 1). More than a third of HIV-positive (37.3%) and HIV-negative (33.5%) women were classified as having likely depression (CES-D ≥16) at visit 25. HIV-positive (*M*= 5.46, *SD*= 4.96, range: 0-21) and HIV-negative (*M*= 5.36, *SD*= 4.71, range: 0-21) women did not differ with regard to endorsing the items that assess somatic symptoms of depression, $t(1868) = -0.40$, $p=.69$.

To examine consistency in responding to questions about depression and somatic complaints, we conducted correlations between the CES-D total depression score, CES-D somatic items score, and the auxiliary somatic complaints of the menopause questionnaire. Both the CES-D total depression score ($r=0.72$, $p<.001$) and CES-D somatic items summed score ($r=0.63$, $p<.001$) showed the strongest association with participants' response to the menopause questionnaire item addressing feeling "blue or depressed." Beyond this, the total CES-D depression score was most related to mood changes ($r=0.53$, $p<.001$), feeling fearful for no reason ($r=0.46$, $p<.001$), and forgetfulness ($r=0.45$, $p<.001$). The CES-D somatic items were primarily associated with mood changes ($r=0.49$, $p<.001$), forgetfulness ($r=0.43$, $p<.001$), and poor sleep quality ($r=0.42$, $p<.001$).

Dimensionality of the CES-D

Consistent with findings from earlier studies suggesting a variety of well-fitting factor structures for the full 20-item CES-D, we examined single-factor, two-factor, and four-factor solutions to assess the underlying dimensionality of the measure (Table 2). A single factor CFA demonstrated poor model fit, $\chi^2(170) = 3318.02$, $p<.001$, RMSEA = .099 [90% CI: .096 - .102], CFI = .932, TLI = .924, BIC = 90555.90. A two-factor solution, modeling a general depression factor and a positive affect factor demonstrated adequate fit, $\chi^2(169) = 1476.35$, $p<.001$, RMSEA = .064 [90% CI: .061 - .067], CFI = .972, TLI = .968, BIC = 89555.81. A four-factor solution including general depression, positive affect, somatic symptoms, and interpersonal problems factors provided the best fit to the data, $\chi^2(164) = 1106.87$, $p<.001$, RMSEA = .055 [90% CI: .052 - .058], CFI = .980, TLI = .977, BIC = 89273.52. The four-factor solution demonstrated a significant improvement in fit over the two-factor solution, $\Delta\chi^2(5) = 247.90$, $p<.001$. Modification indices in the four-factor model suggested that the residuals between "Crying spells" and "Felt sad" on the Affective Depression factor be declared; this resulted in an improved model, $\chi^2(163) = 867.43$, $p<.001$, RMSEA = .048 [90% CI: .045 - .051], CFI = .985, TLI = .982, $\Delta\chi^2(1) = 153.30$, $p<.001$. Thus, this final four-factor model was retained for all measurement invariance analyses. McDonald's (1999) omega was used to estimate the reliability coefficients of each factor's scores. Reliability estimates were acceptable for the Somatic (ω=.875), Affective Depression (ω=.944), Positive Affect (ω=.870), and Interpersonal (ω=.850) factors' scores.

The four-factor model was fitted for both HIV-positive and HIV-negative women. The fit values for HIV-positive women were $\chi^2(163) = 688.53$, $p <.001$, RMSEA = .049 [90% CI: .045 - .053], CFI = .984, TLI = .982. For HIV-negative women, the values were $\chi^2(163) = 355.48$, p

<.001, RMSEA = .047 [90% CI: .040 - .053], CFI = .985, TLI = .983. Although the WLSMV chi-square values suggested poor fit, the remaining fit indices indicated good fit for both groups of women. Table 3 displays the standardized factor loadings and thresholds for HIV-positive and HIV-negative women for this solution.

Measurement Invariance

HIV-positive vs. HIV-negative women. The fit indices for the configural model were, $\chi^2(326) = 1011.37$, $p < .001$, RMSEA = .047 [90% CI: .044 - .051], CFI = .985, TLI =.983, with the chi square value indicating poor fit and the other indices demonstrating good fit. Taken together, these findings suggest that the CES-D has the same pattern of item-factor loadings for women with and without HIV. For the full metric invariance model, the fit indices were $\chi^2(344) = 1178.97$, $p < .001$, RMSEA = .051 [90% CI: .048 - .054], CFI = .982, TLI =.980. Although the chi-square difference test results were statistically significant ($\Delta\chi^2(18) = 148.46$, $p < .001$) between the configural and metric models, the changes in CFI (ΔCFI = -.003) and RMSEA (ΔRMSEA = .004) supported invariance and suggest that the unstandardized factor loadings on the CES-D were comparable for HIV-positive women and HIV-negative women. The full scalar invariance model resulted in the following fit: $\chi^2(380) = 1108.49$, $p < .001$, RMSEA = .045 [90% CI: .042 - .048], CFI = .985, TLI =.985. All three change indexes supported invariance in threshold loadings on the CES-D between HIV-positive and HIV-negative women ($\Delta\chi^2(36) = 47.73$, $p = .09$, ΔCFI = .003, ΔRMSEA = -.006).

HIV-positive women: Symptomatic vs. Asymptomatic. We also tested measurement invariance across HIV-positive women who were likely to be symptomatic (CD4 count <200) and those likely to be asymptomatic (CD4 count >200). The fit indices for the configural model were, $\chi^2(326) = 775.47$, $p < .001$, RMSEA = .046 [90% CI: .042 - .050], CFI = .985, TLI =.983,

with the chi square value indicating poor fit and the other indices suggesting good fit. For the full metric invariance model, the fit indices were $\chi^2(344) = 841.51$, $p < .001$, RMSEA = .047 [90% CI: .043 - .051], CFI = .984, TLI =.982. Although the chi-square difference test results were statistically significant ($\Delta \chi^2(18) = 75.16$, $p < .001$) between the configural and metric models, the changes in CFI (ΔCFI = -.001) and RMSEA (ΔRMSEA = .001) supported invariance and suggest that the unstandardized factor loadings on the CES-D were comparable for HIV-positive women likely to be symptomatic (CD4 <200) and those likely to be asymptomatic (CD4 >200). The full scalar invariance model resulted in the following fit: $\chi^2(380) = 836.63$, $p < .001$, RMSEA = .043 [90% CI: .039 - .047], CFI = .985, TLI =.985. Consistent with the model comparing women with and without HIV, all three change indexes supported invariance in threshold loadings on the CES-D between likely asymptomatic and likely symptomatic HIV-positive women ($\Delta \chi^2(36) = 46.70$, $p = .11$, ΔCFI = .001, ΔRMSEA = -.004).

Discussion

This study assessed the psychometric properties of a widely used depression screening measure, the CES-D, in a mixed sample of HIV-infected women and HIV-negative women matched on key risk factors for HIV. Our results supported the four-factor model of the CES-D, relative to a two-factor and single factor model, which is consistent with a preponderance, though not all, of other studies' findings (Carleton et al., 2013). The primary goal of the present study was to examine whether the CES-D assessed depression equivalently in women with and without HIV. In our examination of measurement invariance across these groups, we found that the CES-D scores were invariant across HIV-positive and HIV-negative women. Additional analyses demonstrated that CES-D scores were also invariant across HIV-positive women who

were likely symptomatic (CD4 count <200) and HIV-positive women who were likely asymptomatic (CD4 count >200).

To our knowledge, this is the first psychometric evaluation of measurement invariance of the CES-D in a mixed sample of HIV-positive and HIV-negative women. Prior work examining the influence of somatic complaints on depression scores among HIV-positive adults have relied on correlational and regression-based analyses, which cannot provide information about the item-level true scores or identify sources of noninvariance in the way that CFA can. Further, prior work has focused only on HIV-positive adults (Kalichman et al., 2000), has excluded women (Perkins et al., 1995) or have limited their assessment of somatic symptoms (Perkins et al., 1995).

Our findings of measurement invariance, though distinct, echo some important recommendations from previous works' implications. Perkins and colleagues (1995) cautioned against automatically attributing somatic complaints from HIV-positive adults to their HIV-infection without considering the potential for depression. Our results demonstrated that items assessed via the CES-D, including those assessing somatic complaints, operated equivalently for women with and without HIV, and for HIV-positive women with likely asymptomatic and symptomatic presentations. Thus, based on our findings, clinicians and researchers can infer that scores on the CES-D for HIV-positive women can be compared to CES-D scores for HIV-negative women. Our results provide evidence that HIV-positive and HIV-negative women were responding to the CES-D in equivalent manners and that they were endorsing comparable response categories for roughly equivalent levels of depression, across the factors assessed by the CES-D. Still, it is important to note that our findings do not explain the cause of depression

among women with or without HIV. Our findings do not suggest that somatic complaints associated with HIV bear no influence on symptoms of depression among HIV-positive women. It may be the case that somatic complaints associated with HIV/AIDS contribute to depression symptoms, including somatic complaints of depression, even with measurement invariance of somatic item scores across HIV-positive and HIV-negative women.

Limitations

Our results should be interpreted in light of several limitations. The CES-D is a widely used instrument, but it is not the sole instrument used in assessing symptoms of depression. Our findings relate to the psychometric properties of the CES-D with a sample of HIV-positive women, but may not reflect the properties of other widely used depression instruments. Further, we relied upon CFA-based measurement invariance tests to assess whether the CES-D operated differently for women with and without HIV. Other methods, such as item-response theory with tests of differential item functioning, exist to examine the same phenomenon. Although our findings supported measurement invariance, an IRT-based analysis could find instances of differential item functioning due to differences in how both methods approach this question (e.g., linear vs. nonlinear models; see Raju et al., 2002). Thus, our results do not represent the final declaration of measurement equivalence in assessing depression in women with and without HIV.

The demographic composition of WIHS participants reflects the face of HIV among U.S. women. However, this is not a representative sample, and our results may not generalize to women with and at risk for HIV who live in other parts of the country or who are unable to participate in WIHS. Generally, rates of depression are higher among HIV-positive women than HIV-negative women. In our sample, HIV-positive and HIV-negative women reported

equivalent levels of depression symptoms. Work examining depression in representative samples highlights the heightened prevalence of depression among women, low-income adults, and ethnic and racial minorities, with all of these factors operating in tandem (Walsh, Levine, & Levav, 2012; Jackson-Triche et al., 2000). Given that the HIV-negative women in the sample represent women at-risk for HIV, many of whom have additional psychosocial stressors, their depression scores may be elevated and not be generalizable to other HIV-negative women. Likewise, HIV-positive women in our sample may be healthier than HIV-positive women not involved in WIHS, given that many of the women in WIHS are linked to active HIV care. Further, these results are specific to the role of HIV in symptoms of depression, and may not generalize to women living with different medical illnesses. Separate investigations with those populations should be conducted.

Our investigation focused on women, to the exclusion of men. While it is critical to understand how HIV-status may affect the measurement of depression using rating scales in women, it is also important to understand how gender and HIV-status may function jointly and separately to differentially influence assessment of depression. Future work should examine measurement invariance of CES-D scores in a sample of HIV-positive and HIV-negative men and women to determine whether comparisons of CES-D scores across these four groups are appropriate.

Conclusions

The burden of depression is significant among women in the U.S. Over a third of the women in our sample, HIV-positive and HIV-negative, reported elevated and clinically relevant symptoms of depression, which may translate into extended periods of treatable suffering, financial burden, and negative health impact. This study used CFA to examine measurement

invariance in the assessment of depression symptoms among women with and without HIV. Further, it extends the literature regarding the psychometric and measurement properties of CES-D scores, which are used extensively in research and in clinical practice. Our analyses provide encouraging support for the use of the CES-D to examine symptoms of depression among HIV-positive women. The finding of measurement invariance suggests that comparisons of CES-D scores between HIV-positive and HIV-negative women are meaningful.

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Table 1

Sample descriptive information

	HIV-Positive (n=1329)		HIV-Negative (n=541)	
	M / %	SD / n	M / %	SD / n
Age	44.0	8.7	40.2	10.1
Race/Ethnicity				
Black (Non-Hispanic/Latino)	56.3	748	59.9	324
White (Non-Hispanic/Latino)	13.2	175	9.2	50
Hispanic/Latino	27.8	369	26.2	142
Asian/Pacific Islander	0.6	8	1.5	8
Native American/Alaskan Native	0.3	4	1.3	7
Other	1.9	25	1.8	10
Highest Level of Education				
None	0.7	9	0.2	1
Completed Grades 1-6	5.5	73	0.9	5
Completed Grades 7-11	33.0	438	34.2	184
Completed High School (Grade 12)	29.2	387	32.9	177
Some College	24.3	323	25.1	135
Completed College (4 years)	5.4	71	5.4	29
Attended/Completed Graduate	2.0	26	1.3	7
School				
Marital Status				
Never Married	30.5	405	40.3	218
Legally/Common-Law Married	21.2	282	21.4	116
Not Married, Living with Partner	9.9	132	10.9	59
Divorced/Annulled	11.5	153	6.5	35
Separated	9.6	128	9.1	49
Widowed	10.9	145	5.2	28
Other	6.3	83	6.7	36
Overall Depression Score (CES-D)	13.7	12.8	13.1	12.3
Somatic Symptoms Depression Score (CES-D)	5.5	5.0	5.4	4.7
Menopause Symptoms Questionnaire				
Back Pain	2.2	1.4	2.1	1.4
Vaginal Dryness	1.4	1.0	1.3	0.8
Feeling “blue” or Depressed	1.9	1.2	1.8	1.1
Dizzy Spells	1.3	0.7	1.2	0.6
Forgetfulness	1.8	1.2	1.7	1.1
Frequent Mood Changes	1.9	1.2	1.9	1.4
Heart Pounding or Racing	1.4	0.9	1.4	0.8
Feeling Fearful for No Reason	1.3	0.8	1.2	0.7
Headaches	1.7	1.0	1.6	0.9
Breast Pain/Tenderness	1.2	0.7	1.2	0.7
Vaginal Irritation/Itching	1.2	0.7	1.2	0.6

Vaginal Discharge	1.2	0.7	1.3	0.8
Vaginal Soreness/Pain	1.2	0.6	1.1	0.5
Trouble Falling Asleep	2.3	1.6	2.2	1.5
Waking Up Several Times Per Night	3.0	1.6	2.7	1.6
Waking Up Earlier than Planned To	2.5	1.6	2.2	1.5
Sleep Quality	2.2	1.0	2.1	0.9

Note. Menopause questions are rated for past 2 weeks on a 5-point scale (1=not at all, 5=everyday). Sleep quality item refers to past month on 4-point scale (1=very good, 4=very bad).

Table 2

Item Mapping for Tested Models

Item	1-Factor	2-Factors	4-Factors
1. Bothered by things*	DA	DA	SC
2. Appetite was poor.	DA	DA	SC
3. Can't shake off the blues.*	DA	DA	DA
4. Just as good as others.*	DA	PA	PA
5. Trouble concentrating.	DA	DA	SC
6. Felt depressed.	DA	DA	DA
7. Everything was an effort.	DA	DA	SC
8. Hopeful about the future.	DA	PA	PA
9. Life has been a failure.	DA	DA	DA
10. Fearful.	DA	DA	DA
11. Sleep was restless.	DA	DA	SC
12. Happy.	DA	PA	PA
13. Talked less than usual.	DA	DA	SC
14. Felt lonely.	DA	DA	DA
15. People were unfriendly.*	DA	DA	IP
16. Enjoyed life.	DA	PA	PA
17. Had crying spells.	DA	DA	DA
18. Felt sad.	DA	DA	DA
19. People disliked me.	DA	DA	IP
20. Could not get going.	DA	DA	SC

Note. DA = depressed affect, PA = positive affect, SC = somatic complaints, IP = interpersonal problems; *scaling indicator.

Table 3

Standardized factor loadings and thresholds for the four-factor model for HIV-positive and HIV-negative women

	HIV-positive				HIV-negative			
CES-D Items	λ	τ1	τ 2	τ 3	λ	τ 1	τ 2	τ 3
Somatic Complaints								
1. Bothered by things	.79	.26	.87	1.27	.75	.20	.81	1.18
2. Poor appetite	.68	.35	.95	1.33	.63	.54	.1.17	1.49
5. Trouble concentrating	.77	.15	.87	1.32	.79	.18	.87	1.26
7. Everything was an effort	.58	-.06	.46	.74	.41	-.13	.34	.62
11. Restless sleep	.70	-.15	.50	.90	.70	-.12	.55	.93
13. Talked less than usual	.67	.29	.96	1.36	.60	.32	.81	1.28
20. Could not get going (amotivation)	.82	.28	.99	1.33	.84	.48	1.10	1.50
Depressed Affect								
3. Could not shake the blues	.89	.94	1.35	1.41	.89	.36	1.02	1.41
6. Felt depressed	.90	.09	.82	1.13	.91	.13	.74	1.21
9. My life had been a failure	.81	.62	1.20	1.55	.82	.71	1.19	1.50
10. I felt fearful	.79	.53	1.22	1.53	.77	.68	1.27	1.68
14. Felt lonely	.80	.23	.87	1.20	.79	.30	.94	1.26
17. Crying spells	.82	.37	1.02	1.38	.81	.44	.94	1.35
18. Felt sad	.92	.07	.90	1.21	.91	.11	.83	1.26
Positive Affect								
4. Just as good as others	.68	.72	1.17	1.34	.61	.54	.81	1.34
8. Hopeful about future	.66	.21	.56	1.17	.73	.32	.70	1.17
12. I was happy	.95	.11	.52	1.23	.92	.14	.57	1.21
16. I enjoyed life	.83	.36	.72	1.36	.84	.46	.86	1.50
Interpersonal Problems								
15. People unfriendly	.82	.62	1.28	1.59	.77	.70	1.28	1.72
19. Felt people disliked me	.92	.73	1.30	1.59	.92	.76	1.27	1.63

Note. λ = factor loading; τ = threshold.