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Bifactor Analysis and Construct Validity of the HADS: A Cross-Sectional and Longitudinal Study in Fibromyalgia Patients

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The dimensionality of the Hospital Anxiety and Depression Scale (HADS) is a current source of controversy among experts. The present study integrates a solid theoretical framework (Clark & Watson's, 1991, tripartite theory) and a fine-grained methodological approach (structural equation modeling; SEM) to examine the dimensionality and construct validity of the HADS in fibromyalgia (FM) patients. Using the HADS data of 269 Spanish patients with FM, we estimated the cross-sectional and, for the first time, longitudinal fit (autoregressive model) of 2 competing models (oblique 2-factor vs. bifactor) via confirmatory factor analysis. The pattern of relationships between the HADS latent dimensions and positive and negative affect (PA and NA) was analyzed using SEM. HADS reliability was assessed by computing the omega and omega hierarchical coefficients. The bifactor model, which accounted for the covariance among HADS items with regard to 1 general factor (psychological distress) and 2 specific factors (depression and anxiety), described the HADS structure better than the original oblique 2-factor model during both study periods. All latent dimensions of the bifactor model were temporally stable. The SEM analysis revealed a significant link between psychological distress and NA as well as between depression and low PA. Only the general factor of psychological distress showed adequate reliability. In conclusion, the HADS shows a clear bifactor structure among FM patients. Our results indicate that it is not recommendable to compute anxiety and depression scores separately because anxiety variance is tapped primarily by the broader construct of psychological distress, and both specific dimensions show low reliability.

Keywords: Hospital Anxiety and Depression Scale, negative affect, bifactor model, fibromyalgia, structural equation modeling

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Fibromyalgia (FM) is a prevalent, debilitating, and chronic syndrome of unknown etiology that is primarily characterized by chronic widespread pain, fatigue, disturbed sleep, and psychological distress (Wolfe et al., 1990, 2010). Among chronic pain conditions, FM is associated with the highest unemployment rate (6%), claims for incapacity benefits (up to 29.9%), and the greatest number of days of absence from work (Leadley, Armstrong, Lee, Allen, & Kleijnen, 2012). Depression is among the nine symptom domains to be assessed in FM treatment trials (Mease et al., 2009). According to a recent review (Boomershine, 2012), the Depression subscale of the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) should be considered the "gold standard" assessment of depression in patients with FM.

The HADS is a 14-item instrument that was originally developed to quantify the severity of anxiety and depressive symptoms in (nonpsychiatric) general hospitals or outpatient clinical settings (Zigmond & Snaith, 1983). One of the key characteristics of the HADS is that somatic manifestations (e.g., appetite disturbance,

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sleep problems, fatigue, and so on) of emotional disorders were deliberately excluded to avoid an overdiagnosis of anxiety and depression among patients with physical conditions. The HADS measures symptoms over the preceding week and includes seven interrelated items per subscale to assess symptoms of anxiety (HADS-A) and depression (HADS-D). Each item is answered using a 4-point (from 0 to 3) Likert-type scale. The HADS contains both positively and negatively formulated items to reduce acquiescent bias. Higher scores indicate more severe symptoms.

Over the last two decades, the psychometric properties and diagnostic accuracy of the HADS have been extensively examined in different populations, including patients with musculoskeletal complaints (Pallant & Bailey, 2005) and those with FM (Vallejo, Rivera, Esteve-Vives, & Rodríguez-Muñoz, 2012). Specifically, Pallant and Bailey (2005) found that, with one minor adjustment (removal of Item 7), the HADS has a two-factor structure and may be suitable for use as a screening instrument in rehabilitation settings with musculoskeletal patients. More recently, Vallejo et al. (2012) found that the HADS possesses adequate reliability and is a valid instrument for assessing anxiety and depression in FM patients. In 2002, 71 articles were reviewed to obtain information about the factor structure, internal consistency, case-finding ability, and construct validity of the HADS in clinical and nonclinical samples (Bjelland, Dahl, Haug, & Neckelmann, 2002). With regard to its internal structure, most of the reviewed studies used a principal component analysis, and the presence of two correlated factors (mean $r = .56$) was the most common result. In a recent meta-analysis (Brennan, Worrall-Davies, McMillan, Gilbody, & House, 2010), the authors concluded that, although the HADS is a useful screening tool, it is not superior to other instruments (e.g., the Beck Depression Inventory) with regard to identifying emotional disorders in populations with physical conditions.

The dimensionality of the HADS is a current source of controversy among experts (Coyne & van Sonderen, 2012a, 2012b; Norton, Sacker, & Done, 2012). A recent update (Cosco, Doyle, Ward, & McGee, 2012) of Bjelland et al.'s study systematically reviewed 50 articles in which the latent structure of the HADS was examined. These authors concluded that the structure remains unclear and that the subscale scores of the HADS should be interpreted with caution.

Recently, two studies evaluated the internal structure of the HADS using a confirmatory bifactor analysis ([CBFA] also known as a nested-factor model; Norton, Cosco, Doyle, Done, & Sacker, 2013; Xie et al., 2012). In CBFA, two types of latent factors are defined: The first is a general factor in which all items are allowed to load; the second is composed of specific factors in which the items are distributed by their content. In the case of the HADS, and in accordance with the Clark and Watson's tripartite model (Clark & Watson, 1991), the general factor represents the shared component of anxiety and depression (i.e., a general distress or negative affect factor), whereas the specific factors (depression and anxiety after partialing out the general negative affect factor) represent low positive affect (for depression) and hyperarousal (for anxiety). In common CBFA, all factors are mutually uncorrelated. CBFA not only helps to evaluate the internal structure of the instruments, commonly showing a superior fit to nonnested structures (Simms, Gras, Watson, & O'Hara, 2008), but also allows assessment of the reliability of the scores derived from the different factors. As a result, CBFA is used to determine whether the computation of the subscale scores is justifiable or whether only the total score should be computed and reported (Chen, West, & Sousa, 2006).

Xie and colleagues' CBFA yielded a better fit than other nonnested confirmatory factor analysis (CFA) models (Xie et al., 2012). The loadings for the general distress factor were larger than those for the specific (anxiety/depression) factors with regard to most items. Interestingly, these authors found that the general factor (but not anxiety or depression) was significantly correlated with pain severity. In other words, the general factor completely accounted for the association between pain and depression/anxiety.

Norton and collaborators re- and meta-analyzed data from 21 previous studies (Norton et al., 2013). Specifically, the eight commonly reported "best fitting" latent structures were reanalyzed using CFA, and two bifactor structures, one with two group factors (anxiety and depression) and another with three group factors (depression, anxiety, and restlessness), were analyzed. The within-sample analyses and the subsequent meta-CFA both revealed that the bifactor model with the general distress factor and two group factors provided the best fit. The inclusion of a factor that accounted for the wording of items also generally improved model fit. The substantive weight of the general distress factor in the HADS was demonstrated by the high amount of common variance that it explained ($\geq 70\%$ with and without an item-wording factor) and the moderate to high factor loadings for each item of the general factor. Therefore, the authors advised against using the HADS in clinical practice when the objective is to provide a specific analysis of anxiety or depression.

As noted above, the HADS has enormous clinical relevance in the assessment of FM patients because it is currently considered the "gold standard" for evaluating depression among these patients (Boomershine, 2012). In our opinion, it is of crucial importance to perform an exhaustive examination of the dimensionality and other psychometric properties of the HADS in order to confirm that it is really a good choice to measure psychological distress as well as to differentiate the symptoms of depression and anxiety in FM patients. With this goal in mind, we carried out a study with three main objectives. First, a psychometric perspective was taken to evaluate the internal structure of the HADS using CBFA. For the first time, the bifactor approach was fitted by longitudinally modeling the structure of the HADS. Specifically, we evaluated whether the HADS could be longitudinally modeled using a general factor of psychological distress (negative affect), as measured by all instrument items, and two specific factors (anxiety and depression), as measured by two item subsets. This autoregressive structural equation modeling (SEM) analysis was essential to determine the stability in the general and specific factors over time. Taking previous findings into account (Norton et al., 2013; Xie et al., 2012), we expected the bifactor model to be the best fitting model for both study periods (Hypothesis 1) as well as in the autoregressive SEM analysis (Hypothesis 2). It was hypothesized that all latent variables would be highly stable across time (Hypothesis 3). Second, we evaluated the reliability of the anxiety and depression scores beyond the reliability provided by the general factor. Third, given the theoretical view of mood and anxiety disorder research, we further tested Clark and Watson's (1991) tripartite model. This model provides clear expectations regarding the relationships among the latent factors and the measures of positive and negative affect. To our knowledge, only one previous study has used a bifactor model to test this theory (Simms et al., 2008). However, this study only analyzed the relationships between the general distress factor and other constructs and not the correlations between the specific factors and theoretically relevant variables. In the present work, we examined relationships for each of the latent HADS factors with positive and negative affect (Positive and Negative Affect Schedule [PANAS]), considered usual criterion variables in the domains of anxiety, depression, and psychological distress. Specifically, we expected that the latent factor of psychological distress (HADS) and the latent factor of negative affect (PANAS-NA) would strongly overlap given the strong theoretical redundancy between these constructs (Hypothesis 4). According to the tripartite theory (Clark & Watson, 1991), low PA is similar to anhedonia; thus, we expected a stronger correlation between PA and depression than between PA and anxiety (Hypothesis 5). The specific factors of depression and anxiety did not contain a general distress variance because it had been partialed out in the CBFA. Therefore, we expected that these specific factors would show nonsignificant or weak correlations with the PANAS-NA (Hypothesis 6).

Method

Design

In the present work, we used the data set of a 1-year, two-wave longitudinal multicenter study, whose main aim was to assess the predictive validity of some pain-related psychological constructs on pain and quality of life in patients with FM receiving treatment as usual. A detailed description of the study protocol can be found elsewhere (Maurel et al., 2011).

Setting and Sample

The potential participants comprised 312 patients with FM recruited by general practitioners from 24 primary care health centers in Aragon (Spain). To be included in the study, patients had to fulfill the 1990 American College of Rheumatology criteria for FM (Wolfe et al., 1990) according to a diagnosis made by a rheumatologist and sign an informed consent. The exclusion criteria were the presence of physical/mental conditions that would impede the patient from accurately answering the battery of measures, involvement in any compensation claims, and poor knowledge of the Spanish language. Two clinical psychologists administered a battery of instruments (including the HADS and PANAS) at Time 1 (T1). The instruments were completed during the visit in which they were assessed at the hospital to confirm the FM diagnosis. At the 1-year follow-up assessment (Time 2 [T2]), another two clinical psychologists administered the HADS to the same patients in the hospital (the PANAS was not administered at T2). All patients received treatment-as-usual (standard care). The treatment provided in Spain is mainly pharmacological and adjusted to the symptomatic profile of the fibromyalgic patient. In addition, doctors received the Consensus for the Treatment of Fibromyalgia accepted by the Spanish Health Ministry. Data collection was conducted between January 2009 and June 2011. Before providing informed consent, patients were given a general overview of the study aims and characteristics. The study followed Helsinki Convention norms and subsequent updates. The Ethical Review Board of the regional health authority approved the study protocol.

Of the 312 initially recruited patients, 11 (3.5%) were not referred by their general practitioners (GPs) to a rheumatologist; thus, their FM diagnosis was not confirmed. Furthermore, 17 patients (5.4%) were excluded because their rheumatologist's diagnosis was not FM. In addition, two patients (0.6%) were excluded for a severe Axis-I psychiatric disorder (opioid-use disorder), four patients (1.2%) were excluded for not understanding Spanish, and nine patients (2.8%) withdrew from the study. Therefore, at T1, the final sample comprised 269 FM patients. Table 1 displays participant characteristics at T1. One year later (T2), 209 FM patients completed the HADS again, and, as such, the response rate was 77.7%. This rate is in line with that reported in a recent longitudinal observational study (Robinson et al., in press) carried out with FM patients (response rate: 70.9% at 1 year; 1,205/1,700 FM patients).

After applying the common cutoff values (Zigmond & Snaith, 1983) for T1 (and T2), 18.2% (25.8%) of the participants were classified as possible cases (eight ≤ HADS-A ≤ 10) of anxiety, and 53.9% (45.5%) were classified as probable cases (11 ≤ HADS-A ≤ 21) of anxiety. In addition, 25.7% (22.0%) of the participants were classified as possible cases (eight ≤ HADS-D ≤ 10) of depression, and 25.3% (22.5%) were classified as probable cases (11 ≤ HADS-D ≤ 21) of depression. The prevalence of possible and probable cases of anxiety and depression in this

Table 1
Demographic and Clinical Characteristics of the Study Sample (n = 269 for T1; n = 209 for T2)

Variable	Value
Gender, *n* (females %)	257 (95.5%)
Age, *M* (*SD*; range)	52.13 (8.56; 31–70)
Years from FM diagnosis, *M* (*SD*; range)	7.73 (5.12; 1–30)
Marital status, *n* (%)	
Married/relationship	199 (74.0%)
Single	24 (8.9%)
Separated/divorced	35 (13%)
Widowed	11 (4.1%)
Educational level, *n* (%)	
No studies	8 (3.0%)
Primary school	126 (46.8%)
Secondary school	102 (37.9%)
University	33 (12.3%)
Employment status, *n* (%)	
Homemaker	34 (12.6%)
Unemployed	42 (15.6%)
Paid employment	68 (25.3%)
Paid employment but on sick leave	34 (12.6%)
Retired/pensioner	36 (13.4%)
Permanent disability	55 (20.4%)
Study measures, *M* (*SD*)	
HADS-A T1 (0–21)	10.75 (4.97)
HADS-D T1 (0–21)	7.71 (4.66)
HADS-A T2 (0–21)	10.38 (4.64)
HADS-D T2 (0–21)	7.25 (4.34)
PANAS-PA (0–50)	25.15 (8.43)
PANAS-NA (0–50)	24.07 (8.96)

Note. T1 = Time 1; T2 = Time 2; FM = fibromyalgia; HADS = Hospital Anxiety and Depression Scale; A = Anxiety; D = Depression; PANAS = Positive and Negative Affect Schedule; PA = positive affect; NA = negative affect.

primary health care sample is comparable to that reported by Vallejo et al. (2012) in Spanish patients with FM recruited from rheumatology clinics (anxiety: possible cases = 22.6%, probable cases = 57.1%; depression: possible cases = 21.2%, probable cases = 34.9%).

Measures

Participants completed a sociodemographic questionnaire, the HADS, and the PANAS (Watson, Clark, & Tellegen, 1988) as part of a paper-and-pencil battery of instruments.

Sociodemographic and clinical data. The following sociodemographic information was collected: gender, age, marital status, education level, and employment status. The clinical variables were years of FM diagnosis, pharmacological and nonpharmacological treatments, and referrals to specialized settings (rheumatology or pain clinics).

The HADS (Zigmond & Snaith, 1983). The Spanish version of the HADS was used (Herrero et al., 2003; Quintana et al., 2003; Tejero, Guimera, Farré, & Peri, 1986). Herrero et al. (2003) and Quintana et al. (2003) assessed the psychometric properties of the Spanish version in 385 adult general hospital outpatients with severe medical conditions and in 429 patients with five different diagnoses (and 256 controls), respectively. Both studies conducted principal component analysis and concluded that the Spanish HADS contains two factors and has sound psychometric properties. More recently, the HADS demonstrated to be a reliable (α of 0.83 and 0.87 for HADS-A and HADS-D, respectively) and useful tool for assessing the presence of anxiety and depression symptoms in a sample of 301 FM patients (Vallejo et al., 2012).

The PANAS (Sandín et al., 1999; Watson et al., 1988). The PANAS is a 20-item self-report measure that includes two 10-item mood scales: one for positive affect (PA; i.e., the extent to which a person experiences pleasurable engagement with the environment) and one for negative affect (NA; i.e., the extent to which a person feels distressed, upset, guilty, and so on). Respondents rate the extent to which they experienced each emotion within a specified time period (in the present study, e used the "in general" time frame) using a 5-point scale ranging from 1 (*very slightly or not at all*) to 5 (*very much*). The PANAS adopts a dimensional approach to affective states. The PA and NA scales were originally developed to assess orthogonal (i.e., independent) dimensions of affective experience rather than opposite poles of the same construct. The psychometric characteristics of the PANAS have received much investigative attention (Crawford & Henry, 2004; Sandín et al., 1999; Tuccitto, Giaccobi, & Leite, 2010). Furlong, Zautra, Puente, López-López, and Valero (2010) reported an internal consistency (α) of 0.87 for the PA scale and 0.85 for the NA scale in a sample of 130 Spanish FM patients recruited in a Spanish pain clinic.

Data Analyses

SPSS Version 19.0 and Mplus Version 7.0 (Muthén & Muthén, 1998–2012) were used to conduct the data analyses.

Dimensionality analyses. First, with regard to the HADS, two cross-sectional factor models were tested at T1 and T2: (a) a CFA using the original two-factor model proposed by Zigmond and Snaith (1983) and (b) a CBFA model positing that all items are saturated with a general latent factor of psychological distress and two specific factors of anxiety and depression that are uncorrelated.

Second, autoregressive models allow researchers to examine relationships over time, where each time point is linearly predicted by the previous time point. In the present study, two autoregressive SEM analyses were computed and compared (correlated two-factor vs. bifactor) to examine the association between each latent variable at T1 and its T2 counterpart across a 1-year time interval. The uniqueness of the repeated measures of the items was allowed to correlate. Only the homotraits from T1 were allowed to predict traits on T2; that is, for instance, depression at T1 was linked with depression at T2, but the weights from depression at T1 to anxiety and the general factor at T2 were fixed to zero. A standardized weight close to one (which, with single predictors equals a correlation coefficient) indicates that each score can be precisely predicted from its previous value, meaning that it is highly stable over time and hence depends on substantive factor. Correlations between T1 and T2 for each latent factor represent stability coefficients.

Third, the original two-factor model of the PANAS proposed by Watson and Clark (Watson et al., 1988), with some modifications (Crawford & Henry, 2004), was tested. The items drawn from the same category of Zevon and Tellegen's mood checklist were allowed to covary (Zevon & Tellegen, 1982). For PA, these item groups included (a) attentive, interested, and alert; (b) enthusiastic, excited, and inspired; (c) proud and determined; and (d) strong and active. For NA, these items groups included (a) distressed and upset, (b) hostile and irritable, (c) scared and afraid, (d) ashamed and guilty, and (e) nervous and jittery. In addition, the PA and NA factors were allowed to correlate. This model provided the best fit in a large sample of the general adult population in the United Kingdom (Crawford & Henry, 2004).

Construct validity analysis. SEM allows researchers to test the empirical link between all the HADS and PANAS latent dimensions. Using the T1 data, we examined the correlations between all the latent variables of the best fitting HADS factor model and the PANAS two-factor model to examine the pattern of relationships.

Given that factor loadings and standard errors are underestimated when using maximum likelihood estimation with categorical variables (Wang & Cunningham, 2005), we applied mean- and variance-corrected weighted least squares (WLSMV) to test the fit of the alternative factor structures of the HADS and PANAS as well as for the structural equation models described above. In addition to the chi-square test, the following fit indices were analyzed (the values in parentheses denote goodness-of-fit standards according to Schermelleh-Engel, Moosbrugger, & Müller, 2003): the Tucker–Lewis Index (TLI), the comparative fit index (TLI and CFI $\geq$ .95 indicate an *acceptable* fit, and $\geq$ .97 indicate a *good* fit), and the root-mean-square error of approximation (RMSEA) with 90% confidence intervals (RMSEA $\leq$ .08 indicates an *acceptable* fit and $\leq$ .05 indicates a *good* fit). With regard to missing data, a total of 269 and 209 FM patients had complete HADS data at T1 and T2, respectively. For the longitudinal models, the default approach in Mplus to handle missing data with the WLSMV estimator was used (Asparouhov & Muthén, 2010).

Reliability estimates. When computing CBFA models, two types of reliability estimates can be computed: omega and omega hierarchical (Brunner, Nagy, & Wilhelm, 2012). *Omega* refers to the reliability of a summed score given all the factors that comprise that score. *Omega hierarchical*, which can be equal to or smaller than omega, refers to the reliability of a summed score composed of only one construct. With regard to the general factor, the difference between omega and omega hierarchical provides information regarding the reliability of the total score derived from its specific factors. For the specific factors, omega hierarchical provides information regarding the capacity of the subscale scores to reliably measure the variance due to the specific factors by themselves, beyond reliability provided by the general factor. Low omega hierarchical values advise against the use of subscale scores.

Results

Descriptive Statistics

Descriptive statistics were computed for all the HADS items in both study periods (see Table 2).

Dimensionality Analyses

Cross-sectional HADS models. The chi-square test revealed that the tested models did not fit the data. As expected, however, the other fit indices for the bifactor model (Model 2) were better than those obtained for the original oblique two-factor model

Table 2
Mean (M), Standard Deviation (SD), and Factor Loadings (λ) for All HADS Items in T1 and T2

	Time 1 (n = 269)				Time 2 (n = 209)			
		M1	M2			M1	M2	
HADS Spanish version[a]	*M* (*SD*)	λ	λ general	λ specific	*M* (*SD*)	λ	λ general	λ specific
HADS-Anxiety								
1. Me siento tenso/a o nervioso/a [I feel tense or "wound up"]	1.84 (0.87)	.67	.65	*.18*	1.72 (0.84)	.78	.70	.31
3. Siento una especie de temor como si algo malo fuera a suceder [I get a sort of frightened feeling as if something awful is about to happen]	1.23 (1.14)	.73	.75	*−.10*	1.22 (1.06)	.72	.68	.21
5. Tengo la cabeza llena de preocupaciones [Worrying thoughts go through my mind]	1.71 (1.01)	.78	.78	*.08*	1.60 (0.97)	.74	.76	*.07*
7. Soy capaz de permanecer sentado/a tranquilo/a y relajado/a [I can sit at ease and feel relaxed]	1.51 (0.94)	.61	.55	.46	1.45 (0.87)	.56	.46	.36
9. Experimento una desagradable sensación de « nervios y hormigueos » en el estómago [I get a sort of frightened feeling like "butterflies" in my stomach]	1.43 (0.92)	.70	.68	*.14*	1.51 (0.95)	.67	.62	.25
11. Me siento inquieto/a como si no pudiera parar de moverme [I feel restless as if I have to be on the move]	1.61 (0.91)	.68	.62	.52	1.45 (0.82)	.59	.38	.92
13. Experimento de repente sensaciones de gran angustia o temor [I get sudden feelings of panic]	1.48 (0.97)	.89	.91	*−.11*	1.44 (0.98)	.88	.85	.21
HADS-Depression								
2. Sigo disfrutando de las cosas como siempre [I still enjoy the things I used to enjoy]	1.19 (0.82)	.82	.58	.60	1.02 (0.72)	.84	.49	.74
4. Soy capaz de reírme y ver el lado gracioso de las cosas [I can laugh and see the funny side of things]	0.85 (0.87)	.83	.63	.54	0.88 (0.84)	.88	.62	.61
6. Me siento alegre [I feel cheerful]	1.04 (0.85)	.82	.58	.60	0.93 (0.81)	.85	.56	.66
8. Me siento lento/a y torpe [I feel as if I'm slowed down]	2.07 (0.92)	.66	.56	.24	1.92 (0.87)	.54	.37	.38
10. He perdido el interés por mi aspecto personal [I have lost interest in my appearance]	0.88 (0.93)	.70	.54	.43	0.93 (0.90)	.67	.55	.36
12. Espero las cosas con ilusión [I look forward to enjoyment to things]	1.02 (0.95)	.87	.61	.65	1.01 (0.94)	.78	.43	.71
14. Soy capaz de disfrutar con un buen libro o con un buen programa de radio o televisión [I can enjoy a good book or radio or TV programme]	0.75 (0.97)	.71	.58	.36	0.55 (0.83)	.76	.63	.36

Note. T1 = Time 1; T2 = Time 2; HADS = Hospital Anxiety and Depression Scale; M1 = Model 1; M2 = Model 2. Nonsignificant ($p > .05$) factor loadings are shown in italics.
[a] The original wording of items in English is shown in brackets.

(Model 1) over both T1 and T2, which provides strong support for the adequacy of the bifactor model with regard to the sample data and supports Hypothesis 1. As can be seen in Table 3, unlike the correlated two-factor model, the bifactor structure exhibited "good" goodness-of-fit values (CFI and TLI ≥ .97 and RMSEA ≤ .05) in both study periods.

The standardized factor loadings obtained in the bifactor and the two-factor models during each study period are displayed in Table 2. The interfactor correlations for the CFA models were .74 and .63 for T1 and T2, respectively. The item loadings on the general factor of the bifactor model were all moderate to large at T1 (M = .64, range = .54–.91) and T2 (M = .58, range = .37–.85). The results notably differed between anxiety and depression with regard to the specific factors. For anxiety, five of the seven items (1, 3, 5, 9, and 13) at T1 presented nonsignificant loadings on their specific factor, and the factor loadings ranged from –.11 to .17 (unsigned M = .17); Item 5 at T2 did not significantly load onto the anxiety specific factor (p = .44) with factor loadings within the .07–.93 range (M = .33). The loading on the general factor was higher than that on the specific factor for 13 of the 14 anxiety items (seven items each at T1 and T2). In contrast, all factor loadings on the specific depression factor were moderate to large and reached significance at T1 (M = .49, range = .24–.65) and T2 (M = .55, range = .36–.74). The loadings of the 14 depression items were greater for the specific factor than the general factor in half of the comparisons.

For T1 (and T2), the general factor explained 71.5% (58.6%) of the common variance, whereas the specific factors explained 28.5% (41.4%). When only the anxiety items were considered, the specific factor accounted for 13.6% (29.3%) of the common variance, whereas the specific factor explained 36.5% (47.5%) of this common variance with regard to the depression items. These results suggest that the depression-specific factor reflects residual variance not accounted for by the general factor, whereas the general factor mostly explains the anxiety variance.

Autoregressive HADS models. Again, the chi-square test did not support the models. As a whole, however, the SEM analysis indicated that the bifactor model provided a better fit to the data than the two-factor model (see Table 3). Both models had fit indices over the recommended thresholds. Model comparisons based on a practical improvement to the model-fit approach (TLI difference ≥ .01; Gignac, 2007) provided strong support for the bifactor model (TLI = .99 vs. .97). The superiority of the bifactor model provided support to Hypothesis 2.

The standardized factor loadings and the relationships among the latent factors for the autoregressive bifactor model are presented in Figure 1. These factor loadings were consistent with those obtained in the cross-sectional models, and the same comments also apply here. The lagged relationships were high for the general factor and the specific depression factor (.82 and .80, respectively) but moderate for the anxiety-specific factor (.64). Our results partially support Hypothesis 3 because the specific anxiety dimension of the HADS had adequate (not high) stability over time.

Construct Validity using Clark and Watson's (1991) Tripartite Theory as a Framework

Although the PANAS two-factor model had a poor fit according to the chi-square test, the other fit indices were acceptable (RMSEA = .07, TLI = .96, and CFI = .97). The item loadings with regard to their respective factors were high (PA and NA ranges from .66 to .88 and from .71 to .81, respectively). Although the correlation between the NA and PA factors was moderate (r = –.56, p < .001), this value is clearly greater than the commonly reported correlation between affectivity dimensions and the theoretically expected relation.

Second, an SEM analysis was computed to assess the construct validity of the HADS bifactor structure. As shown in Table 3, all fit indices were within acceptable limits (CFI and TLI ≥ .95 and RMSEA ≤ .08). The pattern of the relationships between the latent factors of the HADS and PANAS is shown in Figure 2. Both PA and NA were significantly associated with the general psychological distress factor of the HADS but in opposite directions (–.63 and .81, respectively). As Hypothesis 4 predicted, the highest correlation was found between NA and the HADS general factor.

Table 3
Fit Statistics for Latent Structure Models for HADS and PANAS Data in FM Patients

Model	χ^2	*df*	RMSEA [90% CI]	TLI	CFI
HADS (Cross-sectional - T1)					
M1 Correlated two-factor model (Zigmond & Snaith, 1983)	167.129	76	.07 [.05, .08]	.97	.98
M2 Bifactor model (Norton et al., 2013)	90.437	63	.04 [.02, .06]	.99	.99
HADS (Cross-sectional - T2)					
M1 Correlated two-factor model (Zigmond & Snaith, 1983)	161.501	76	.07 [.06, .09]	.96	.97
M2 Bifactor model (Norton et al., 2013)	81.242	63	.04 [.00, .06]	.99	.99
HADS (Autoregressive - T1 & T2)					
M1 Correlated two-factor model (Zigmond & Snaith, 1983)	498.598	330	.04 [.04, .05]	.97	.98
M2 Bifactor model (Norton et al., 2013)	363.520	305	.03 [.01, .04]	.99	.99
PANAS (Cross-sectional - T1)					
Correlated two-factor model + covariated errors (Crawford & Henry, 2004)	381.973	156	.07 [.07, .08]	.96	.97
Construct validity					
HADS (M2) & PANAS	905.318	493	.06 [.05, .06]	.96	.96

Note. HADS = Hospital Anxiety and Depression Scale; PANAS = Positive and Negative Affect Schedule; FM = fibromyalgia; RMSEA = root-mean-square error of approximation; 90% CI = 90% confidence interval of the RMSEA; TLI = Tucker–Lewis index; CFI = comparative fit index; T1 = Time 1; M = model; T2 = Time 2.

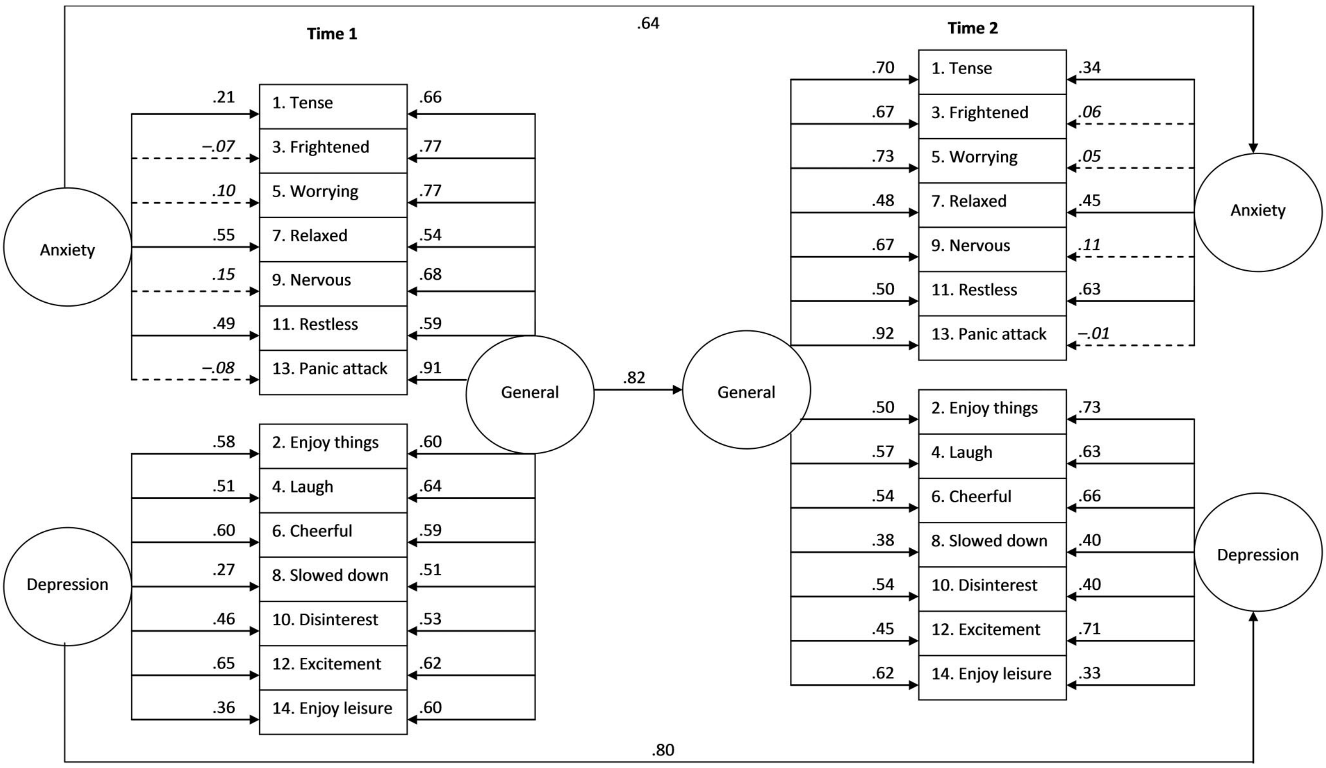

Figure 1. Stability over time (1 year) of the Hospital Anxiety and Depression Scale bifactor structure. Nonsignificant factor loadings are given in italics and indicated by dashed lines.

PA was most highly correlated with the depression factor (–.54), and none of the correlations between NA and the specific factors were significant, which supports Hypotheses 5 and 6, respectively.

Reliability

According to the CBFA results, the omega estimates for the total, anxiety, and depression scores of the HADS were the same for T1 and T2: .94, .90, and .91, respectively. The omega hierarchical revealed the following values for the same components above: .81, .05, and .38 for T1, and .72, .19, and .47 for T2. The difference between omega and omega hierarchical in both time periods suggests that there is not a substantial influence of the specific factors on the reliability of the HADS total score. Furthermore, when the general factor is partialed out, the capacity of the subscales to reliably measure the variance due to the specific factors of anxiety and depression is considerably low.

Discussion

As we expected, the HADS bifactor model provided better fit to the sample data than the original oblique two-factor solution at T1 and T2, which supports Hypothesis 1. Our results are in line with those obtained from other anxiety/depression instruments, such as the Inventory of Depression and Anxiety Symptoms (Simms et al., 2008), the State-Trait Anxiety Inventory-trait version (STAI; Bados, Gómez-Benito, & Balaguer, 2010), the Revised Children's Manifest Anxiety Scale (Brodbeck, Abbott, Goodyer, & Croudace, 2011), the Hopkins Symptom Checklist 25 (Al-Turkait, Ohaeri, El-Abbasi, & Nagury, 2011), the Depression Anxiety Stress Scales-21 (Osman et al., 2012), and the Composite International Diagnostic Interview (Simms, Prisciandaro, Krueger, & Goldberg, 2012). In all cases, the bifactor model fit the data well and outperformed the traditional first-order and second-order factor structures.

The dearth of scientific literature concerning the stability of the latent dimensions of the HADS prioritized this research topic. The time between measures (1 year) must be considered when evaluating the findings reported above. Our study is the first to demonstrate that the HADS general and depression latent factors have high stability over time, whereas the stability of the anxiety factor is moderate over time. As expected (Hypothesis 2), the fit indices for the autoregressive bifactor model were better than those obtained for the autoregressive two-factor model. The difference in temporal stability between the specific factors is very difficult to interpret due to the absence of previous studies addressing this issue in clinical or nonclinical samples. Any clinical interpretation (e.g., greater temporal oscillation of anxiety symptoms compared with depression symptoms in FM patients) of these findings might be considered speculative.

Recently, several authors have recommended abandoning the use of the HADS (Coyne & van Sonderen 2012a, 2012b; Zakrzewska, 2012). Our results offer some insight concerning the valid inferences about the HADS scores, both for the total and subscale scores. The total score is a reliable measure of negative affect, although a small portion of variance can be attributed to specific factors. Negative affect is a core component of both mood and

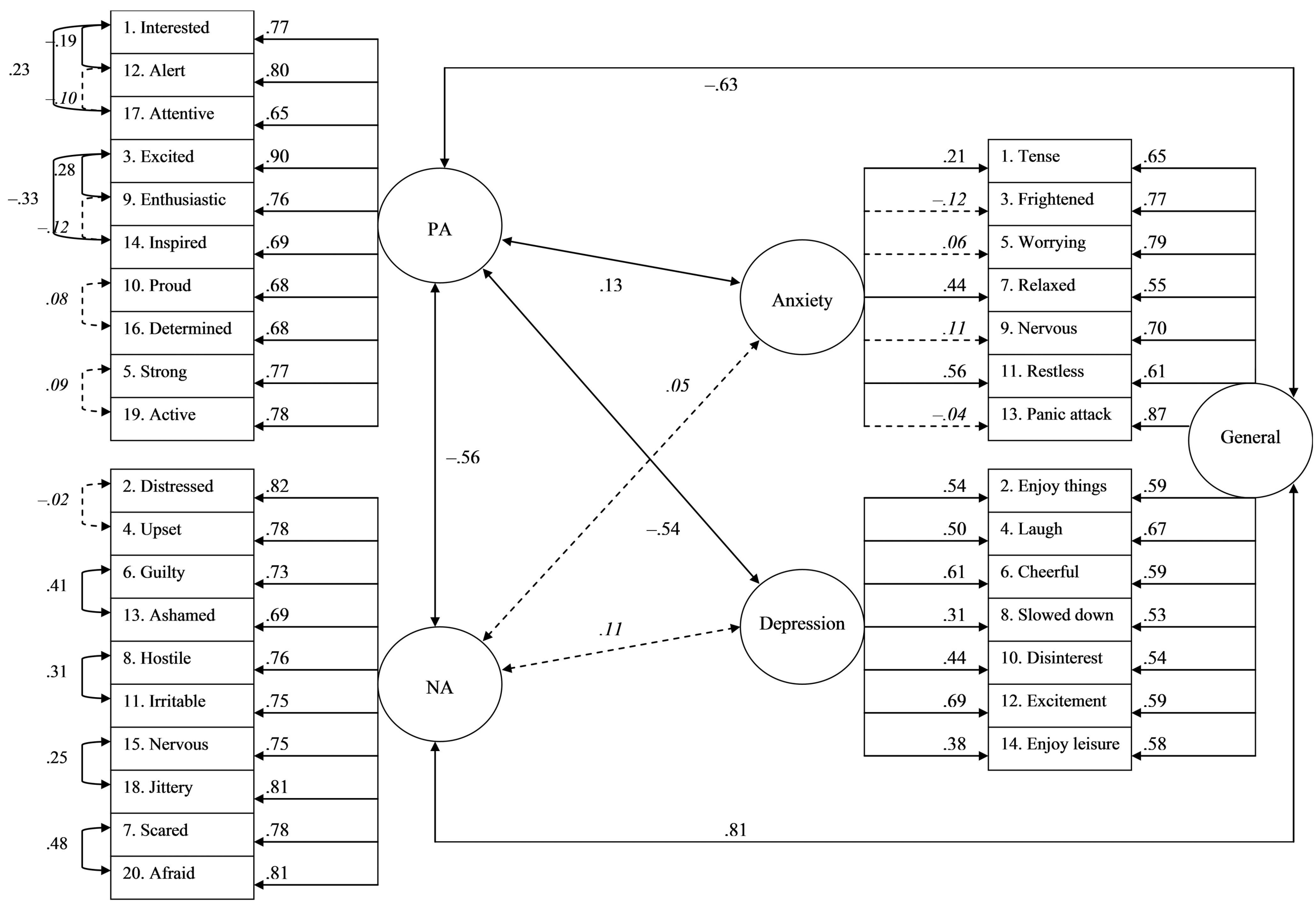

Figure 2. Construct validity of the Hospital Anxiety and Depression Scale (HADS) bifactor structure. Nonsignificant correlations, factor loadings, and covariated errors are given in italics and indicated by dashed lines. The left part of the figure shows Positive and Negative Affect Schedule (PANAS) items, and the right part shows HADS items. PA = positive affect; NA = negative affect.

anxiety disorders. Due to the omega hierarchical values of this study, clinicians and researchers should understand that they are interpreting measures of negative affect when anxiety and depression scores are reported and interpreted. Given our results, it is not surprising that the total score can be more useful in detecting specific disorders compared with the subscale scores because increasing test length improves reliability. If the correct detection of anxiety and depression is required, then longer tests with high-loading items on the general and specific factors are needed (Watson, 2009). The HADS is a 30-year-old measure, and we cannot expect it to contain all the theoretical and assessment updates regarding depression and anxiety that have been made since 1983.

The present work also provided support for the construct validity of the bifactor solution of the HADS in patients with FM by exploring relationships between its latent factors and PA and NA as measured by the PANAS. Our analysis confirmed the HADS bifactor structure using Clark and Watson's (1991) tripartite theory of anxiety and depression as a reference. We demonstrated that the variance of the HADS items can be divided into three components: specific hyperarousal (anxiety), specific low-positive affect (depression), and a shared component of general negative affect, which is considered a "somewhat 'muddy' area in the middle where symptoms common to both syndromes overlap" (Roberts, Bonnici, MacKinnon, & Worcester, 2001, p. 380). Therefore, the present SEM analysis was the first to test this theory by considering a CBFA model with specific factors. We found the expected strong positive association between general psychological distress and NA (Hypothesis 4). Although these instruments differ in response format and content, the general factor from the HADS and the NA component from the PANAS are equivalent constructs. The expected correlation between depression and low PA was obtained (Hypothesis 5). In addition, we found that specific factors were not correlated with NA (Hypothesis 6). Finally, we have found, for the first time, that PA and anxiety are significantly and positively associated (.13) when psychological distress is disentangled from anxiety. In other words, PA and anxiety usually correlate negatively (see, e.g., Crawford & Henry, 2004) because of the influence of the general factor of psychological distress. In our opinion, this counterintuitive finding deserves to be replicated in future studies.

Although we discussed our data with regard to Clark and Watson's (1991) theoretical framework, other theoretical models might also explain the results of the SEM analysis, such as Brown and Barlow's (2009) classification of emotional disorders. These authors emphasized the similarities of anxiety and mood disorder psychopathologies and gave them a common classification: emotional disorders (see also Brown, 2007). Furthermore, they stated that the similar psychopathologies are due to two genetic temperament dimensions that determine the etiology and course of emotional disorders: neuroticism/negative affect and extraversion/positive affect (Brown, 2007; Brown, Chorpita, & Barlow, 1998).

Although the sample sizes for both study periods were relatively small, our results might be generalizable because the sociodemographic characteristics of the study sample were very similar to those of FM individuals from the general population in Spain (Mas, Carmona, Valverde, Ribas, & EPISER Study Group, 2008), which provides a certain degree of external validity. Moreover, the findings reported here have theoretical and clinical implications for the assessment of patients with FM. In the upcoming primary health care version of the International Classification of Diseases-11 (the ICD-11-PHC), FM will be classified as part of bodily stress syndrome (BSS; Lam et al., 2013). This new diagnosis will group patients who might have previously been considered different (e.g., those with FM, chronic fatigue syndrome, irritable bowel syndrome, and so on). Frontline clinicians (e.g., GPs) will need reliable tools to identify possible/probable clinical cases of anxiety (i.e., cognitive overarousal) among patients with BSS who are characterized by elevated somatic overarousal. Unless the HADS is refined in the future, this instrument does not seem suitable to this task, given that its Anxiety subscale, which was created to measure cognitive overarousal, is unspecific and almost completely accounted for within the broader construct of general distress. In our opinion, the anxiety and depression items recently developed by the Patient-Reported Outcomes Measure Information System (PROMIS) Cooperative group (Pilkonis et al., 2011), particularly their short-form scales, are a better option due to their excellent internal consistency and construct validity. Importantly, the rationale-derived option of excluding somatic items (Zigmond & Snaith, 1983) was supported for these scales after a careful psychometric analysis with hundreds of available items. As far as we know, the U.S. National Institutes of Health is currently performing a field test of PROMIS item banks on > 3,500 FM patients. If PROMIS item banks demonstrate to be valid and reliable in FM patients, it is possible that they will progressively replace the "legacy" instruments—the Beck Anxiety Inventory (Beck, Epstein, Brown, & Steer, 1988), Beck Depression Inventory-II (Beck, Steer, & Brown, 1996), Center for Epidemiological Studies Depression Scale (Radloff, 1977), HADS, Patient Health Questionnaire (Kroenke & Spitzer, 2002), and STAI—that are currently used worldwide to assess emotional symptoms in these patients (D. A. Williams & Schilling, 2009).

The following limitations should be considered when interpreting our findings. The conclusions based on the present data must be considered preliminary until more factor analytic studies of the HADS in patients with FM are conducted. The reported correlation between PA and NA is much stronger than the typical value, and the expected relationship between these constructs is approximately orthogonal. Nevertheless, this result might be explained by the high presence of probable cases of anxiety among our FM patients at both study periods (53.9% at T1 and 45.5% at T2). According to J. Williams, Peeters, and Zautra (2004), people suffering from anxiety are characterized by their hypervigilance against possible threat, which imposes increased cognitive demands. These attentional demands on patients suffering from anxiety reduce the availability of cognitive resources needed to evaluate PA and NA separately, leading to a higher inverse correlation. As these authors point out, "One would expect, therefore, to find a significant inverse correlation between PA and NA factors in anxious populations" (Williams et al., 2004, p. 323). Another limitation that is important to acknowledge is the 23.3% of participants missing at T2. Missing data are very usual in prospective research among FM patients (e.g., Robinson et al., in press) and poses a threat to internal (loss of statistical power) and external (generalizability) validity. In addition, certain important psychometric aspects of the HADS with regard to patients with FM remain unknown and should be examined in the future—first, whether the HADS dimensionality varies across male and female FM patients. In our study, most participants were women (95.5%), so dimensionality and construct validity results may not fully apply to men. The second aspect is whether differences in HADS language translation might introduce variation regarding its factor structure and item loadings (Maters, Sanderman, Kim, & Coyne, 2013). Therefore, the HADS bifactor model should be replicated in a large, multinational sample of patients with FM. Third, we addressed the potential effect of the methods associated with the mixture of negatively and positively worded items. As expected, adding an item wording method factor slightly improved model fit, compared with the same model without a method factor.[1] We decided not to include this analysis as part of our objectives because of the existence of solid evidence that all viable HADS factor models improve their fit when a wording factor is incorporated (Norton et al., 2013; Schönberger & Ponsford, 2010; Wouters, Booysen, Ponnet, & Baron Van Loon, 2012). An interesting issue that Wouters et al. (2012) highlighted is that not all individuals are equally affected by item wording and that "different sociocultural populations may respond differently to negatively (or positively) worded items with poorer, younger and less-educated people being more susceptible to wording effects" (p. 2). In our opinion, those FM patients with "fibrofog" symptoms (e.g., forgetfulness, losing the train of thought, mixing up words, etc.) might constitute a particularly vulnerable group to item phrasing. However, we were unable to examine the specific relationship between fibrofog symptoms and method effects due to sample size limitations.

In conclusion, the present work supports the existence of a bifactor structure in the HADS. On the one hand, despite the multidimensionality of the HADS items, the total score reliably reflects variation on psychological distress if we bear in mind the omega hierarchical values of the general factor in the bifactor model (Reise, Bonifay, & Haviland, 2013). Moreover,

[1] Correlated two-factor model + Item wording method factor (T1: χ^2 = 141.634; RMSEA = .06 [.05, .08], TLI = .97, CFI = .98; T2: The Mplusmodel did not converge). Bifactor model + Item wording method factor (T1: χ^2 = 68.537; RMSEA = .03 [.00, .05], TLI = .99, CFI = .99; T2: χ^2 = 49.414; RMSEA = .00 [.00, .03], TLI = 1.00, CFI = 1.00).

it seems reasonable to compute the total score by summing the ratings on the 14 items given the moderate to large item loadings on the general factor at both assessment periods. In other words, no item removal seems necessary. On the other hand, it does not seem recommendable to compute anxiety and depression scores separately because anxiety variance is tapped primarily by the broader construct of psychological distress and both specific dimensions show low reliability. Notwithstanding, as Reise et al. (2013) pointed out, even when a unidimensional measurement model in an instrument might be good enough for practical purposes, there are occasions in which complex measurement models should be considered; for example, the use of a complex representation of the HADS structure was fully justified when the Clark and Watson's (1991) tripartite theory was tested owing to the unique association of general (psychological distress) and group factors (anxiety and depression) with relevant external criteria (positive and negative affect). Thus, we have demonstrated that CBFA is a useful technique not only for analyzing the psychometric properties of instruments but also for testing relevant theoretically derived hypotheses.

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