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AUTORES

Olga Malas
Medical Emergency System
Psychology Area - Department of Health
Generalitat of Catalonia (Spain)
malas.tolsa@outlook.es

María-Dolores Tolsá
Departament of Experimental Medicin
Universitat de Lleida, Spain
mariadolores.tolsa@udl.cat

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Depression, Anxiety and Stress Scales (DASS-21): Factor structure, reliability, invariance and validity of the Catalan Version

Olga Malas, María-Dolores Tolsá

Abstract

The aim of this study was to analyse the evidence of validity, invariance and reliability of the Catalan version of the 21-item Depression, Anxiety and Stress Scale (DASS-21), using the confirmatory factor analysis (CFA) and exploratory structural equation modelling (ESEM) approach. Then, to reassess the best structure obtained in a different validation sample. The items tested correspond to those in the original version of the DASS-21, after transcultural adaptation. The questionnaire was applied to a non-clinical sample of adults (*n*= 716), of both sexes and a mean age of 40.94 years (SD= 15.21). For study, the sample was randomly-split into two groups: calibration sample, and cross-validation sample. In first subsample nine models were tested. As the first-order three-factor CFA model was the most parsimonious, with well-defined factors that were also supported in terms of their reliabilities (α and ω) and validities, it was selected as the preferred model. The invariance between genders was tested using the total sample. Considering all findings, the Catalan version of DASS-21 is invariant, reliable and shows construct validity, making it a suitable instrument for use in research in the Catalan adult population.

Keywords

DASS, Catalan, anxiety, depression, stress, validity, reliability.

Escala de depressió, ansietat i estrès (DASS-21): estructura factorial, fiabilitat, invariància i validesa de la versió catalana

Resum

L'objectiu d'aquest estudi ha estat analitzar la validesa, invariància i fiabilitat de la versió catalana de l'escala de depressió, ansietat i estrès de 21 ítems (DASS-21) utilitzant un enfocament basat en l'anàlisi factorial confirmatòria (CFA) i l'anàlisi d'exploració d'equacions de models estructurals (ESEM), per reavaluar tot seguit la millor estructura obtinguda en una mostra de validació diferent. Els ítems assajats es corresponen amb els de la versió original de la DASS-21, prèvia adaptació transcultural. El qüestionari s'ha aplicat a una mostra no clínica d'adults (n = 716), d'ambdós sexes i d'una edat mitjana de 40,94 anys (DE = 15,21). Per a l'estudi, la mostra s'ha dividit aleatòriament en dos grups: mostra de calibració i mostra de validació encreuada. En la primera submostra s'han provat nou models. S'ha seleccionat el model CFA de tres factors de primer ordre perquè és el més parsimoniós, amb factors definits que també estan emparats en termes de fiabilitat (α i ω) i validesa. La invariància entre gèneres s'ha provat utilitzant la mostra total. Considerant totes les troballes, la versió catalana de DASS-21 és invariant, fiable i mostra validesa de constructe; és un instrument vàlid per utilitzar-lo en recerca en població adulta catalana.

Paraules clau

DASS, català, ansietat, depressió, estrès, validesa, fiabilitat.

Escala de Depresión, Ansiedad y Estrés (DASS-21): estructura factorial, confiabilidad, invarianza y validez de la versión catalana

Resumen

El objetivo de este estudio fue analizar la validez, invarianza y fiabilidad de la versión catalana de la Escala de Depresión, Ansiedad y Estrés de 21 ítems (DASS21-) utilizando un enfoque basado en el análisis factorial confirmatorio (CFA) y el análisis exploración de ecuaciones de modelos estructurales (ESEM), para, seguidamente, reevaluar la mejor estructura obtenida en una muestra de validación diferente. Los ítems ensayados se corresponden con los de la versión original del DASS-21, previa adaptación transcultural. El cuestionario se aplicó a una muestra no clínica de adultos (n = 716) de ambos sexos y una edad media de 40,94 años (DE = 15,21). Para el estudio, la muestra se dividió aleatoriamente en dos grupos: muestra de calibración y muestra de validación cruzada. En la primera submuestra se probaron nueve modelos. Se seleccionó el modelo CFA de tres factores de primer orden por ser el más parsimonioso, con factores bien definidos que también estaban respaldados en términos de confiabilidad (α y ω) y validez. La invariancia entre géneros se probó utilizando la muestra total. Considerando todos los hallazgos, la versión catalana de DASS-21 es invariante, confiable y muestra validez de constructo; por tanto, es un instrumento adecuado para su uso en investigación en población adulta catalana.

Palabras clave

DASS, catalán, ansiedad, depresión, estrés, validez, fiabilidad.

INTRODUCTION

Depression, anxiety and stress are common mental disorders in the population (e.g., Charlson et al., 2019; Roca et al., 2009), and the second cause of illness in western societies (Roca et al., 2009). Its diagnosis requires a psychopathological clinical interview, but there is consensus that the integration of questionnaires within the interview facilitate and improve its detection (e.g.: Goldberg et al., 1988; Mergl et al., 2007). The 21-items Depression, Anxiety, and Stress Scale (DASS-21; Lovibond & Lovibond, 1995a) is one of the most applied for this issue, and has been translated at more than 45 languages (Lovibond, 2017).

Conceptually depression and anxiety are very different, but in practice they tend to overlap, since they usually appear simultaneously (Sanderson et al., 1990). Unlike traditionally self-report scales that predominantly measure the common factor of negative affectivity (Watson & Clark, 1984), highly related to the symptoms and diagnosis of both depression and anxiey (Brown et al., 1997; Clark & Watson, 1991); the DASS-21 is based on the tripartite model of psychopathology (Clark & Watson, 1991). This model posits that there are specific components to anxiety (as physiological hyperarousal) and depression (as low positive affectivity) but add, in addition a common factor, or stress, a set of symptoms that can be differentiated from depression and anxiety, as a state of activation and persistent tension (Crawford & Henry, 2003). The DASS and its short version DASS-21 were developed to discriminate between depression, anxiety and stress as distinct states of negative affectivity (Lovibond & Lovibond, 1995b); where their subscales measure core symptoms of depression (such as dysphoria, hopelessness, devaluation of life, self-depreciation, lack of interest, anhedonia and inertia), anxiety (such as autonomic arousal, skeletal muscle effects, situational anxiety and subjective experience of anxiety and panic) and stress (such as difficulty relaxing, nervous arousal, agitation, irritability and impatience) (Willemsen et al., 2011).

The DASS-21, is commonly applied in Spanish-Catalan countries (see psychological care website of the Department of Health of the Generalitat of Catalonia (www.gestioemocional.catsalut.cat), in their Catalan versions. Catalan is the ninth most spoken language in the European Union - a similar level to Swedish, Greek or

Portuguese (Institut Ramon Llull, 2021). The language commonly known as Spanish is actually the Castilian language and Catalan is another Spanish language, with its own entity. Although the two languages coexist in Catalan-Spanish Countries, Catalan is seen as the mother tongue. The literature review indicates that the Catalan version is not validated. The cultural variations can influence the experience and emotional expression of depression and anxiety, including symptomatology and symptom interpretation (Ballenger et al., 2001; Norton, 2007). Authors have recommended that practitioners either avoid use of non-native language in assessment questionnaires or carry out translations directly with adequate validation (Oei et al, 2013). In addition to a good translation, a good interpretation is needed, because a word or phrase spoken or written in one language may have a completely different meaning in another (Ebo et al., 2007). It is necessary to ensure conceptual equivalence to avoid biases related to the construct or the items as well as method-related bias, as a result of administering problematic instruments (Van de Vijver & Hambleton, 1996). All of this has given rise to the publication of guides to carry out the adaptations. One of the most followed is the one proposed by Beaton et al. (2000), in which naive native translators and content-expert native translators participate independently, as well as those responsible for the study who consolidate, analyze and validate conceptual equivalence and other issues to ensure adaptation to the study sample.

Several models have been propossed and tested for the internal structure of the DASS-21. The first and most studied was based on the oblique three-factor model including three correlated factors as depression, anxiety, and stress. Although this model showed good reliability and validity in different lenguages and contexts, and in clinical and non-clinical sample (e.g.: Antony et al., 1998; Asghari et al., 2008; Bados et al., 2005; Bibi el at., 2020; Bottesi et al., 2015; Ciobanu et al., 2018; Crawford & Henry, 2003; Ruiz et al., 2017; Sinclair et al., 2012; Oei et al., 2013), there have been mixed results regarding the factor structure, warranting the need to further studies on matter. As an example, Henry & Crawford (2005) obtained a quadripartite structure (general factor plus specific factors of depression, anxiety and stress). Apostolo et al. (2006), obtained a structure of two factors (anxiety plus stress and depression). On the other hand, some describe substantial variations in loading and weight of items in the construct. As an example, Norton (2007) or Oei et al. (2013), in studies between different racial groups, observed that the item loads were invariant, or that the items were distributed differently among the factors, concluding that it could be due to the cultural differences of the groups analyzed.

In the search for more adjusted models, the bifactorial models has been proposed. Also unidimensional or bifactorial structures with collapsed factors. These exploratory structural equation modeling (ESEM) are based on a transdiagnostic conceptualization more consistent with the high comorbidity rates of anxiety and depression disorders (e.g.: Brown et al., 2001), and with the shared variance of symptoms of depression, anxiety, and stress (e.g.: Osman et al., 2012; Sinclair et al., 2012). These models try to combine the advantages of exploratory factor analysis with those of confirmatory factor analysis, by allowing the presence of cross-loading between items. The ortogonal (uncorrelated) bifactor model is the most analysed. In this model, all items simultaneously load onto a general factor - conceptualized as general or affective distress (Daza et al., 2002; Osman et al., 2012; Sinclair et al., 2012)- , which reflects the common variance shared by the items, and also load onto their respective subscale or specific factor (Holzinger & Swineford, 1937). This model has demonstrated a better fit than the oblique three-factor solution (Zanon et al., 2020). Other less studied models were the unidimensional one-factor model, in which all items loading onto one general distress factor (Daza et al., 2002; Crawford & Henry, 2003); and a higher, second-order model, including items loading onto the depression, anxiety, and stress subscales, which then subsequently load onto a general, second-order factor, or underlying general factor (Daza et al., 2002; Crawford & Henry, 2003; Osman et al., 2012) which attempts to integrate the moderate to high interfactor correlations found among certains depression, anxiety, and stress items (Clara et al. 2001; Crawford & Henry 2003).

Regarding the internal consistency of the scale and its subscales, published studies report similar values regardless of the group analyzed. The Chrombach's alpha coefficients estimates in clinical and non clinical samples, from different cultural contexts, range between 0.83 and 0.94 for the Depression scale, between 0.70 and 0.87 for the Anxiety scale, between 0.82 and 0.91 for the Stress scale (Antony et al., 1998; Bados et al., 2005; Bottesi et al., 2015; Henry & Crawford, 2005; Norton, 2007; Osman et al., 2012; Sinclair et al., 2012; Wang et al., 2016); and between 0.92 and 0.96 for the total scale (Daza et al., 2002; Henry & Crawford, 2005; Wang et al., 2016) . But, must be consider that, when a bifactor model demonstrates the best fit, this indicates that each item contains variance due to the shared general factor and its specific factor; and that, reliability of raw subscale scores would be influenced also by reliability of the general factor, which could inflate their internal consistency, diminishing the validity of the raw total and subscale scores (Rodriguez et al., 2016). For this reason, some authors propose ancillary bifactor indices of model-based reliability are thus used (i.e.: coefficient ω), and the Explained Common Variance (ECV) to examine the proportion of variance in the composite scores accounted for by each factor (Muthén et al., 1987; Rodriguez et al., 2016); and decide whether it is appropriate use, in the

structural equation modelling, a raw total and subscale scores, or specify a single, unidimensional general distress latent variable (Kyriazos et al., 2018; Shaw et al. 2017; Zanon et al, 2020).

Although there are several studies that indicate measurement invariance between genders for the three-factor model of DASS-21 (e.g.: Kyriazos et al., 2018; Norton, 2007; Zanon et al., 2020), gender has been described as a risk factor for depression, anxiety and stress (e.g., Gancedo-Garcia, 2020; Tolsá & Malas, 2021). Therefore, checking for gender invariance is common practice.

To date, the oblique three-factor model has been tested in Spain applying the Castillian version (Bados et al., 2005; Ruiz et al., 2017), but not the Catalan one. The other models neither in Castilian nor in Catalan have been tested. In this way, the objective of this study was to analyse - using confirmatory factor analysis (CFA) and exploratory structural equation modelling (ESEM) - the factor structure and their validity, reliability and gender invariance of the Catalan version of the DASS-21 Scales in a non-clinical general population sample. Reassessing the best obtained structure in a different validation sample.

METHOD

Participants

The sample comprised 716 adults, with ages ranging between 18 and 82 years (M = 40.94 years; *SD* = 15.21 years), 44.3% males, 54.4% females and 1.3% others. Table-1 shows additional background information. The descriptive statistics of the data (see Table-2) indicate that the sample can be considered non-clinical.

Instruments

Sociodemographic information. The participants were asked about age, gender, marital situation and cohabitation, study levels, month income, and mother tongue.

Table 1. Demographic characteristics of study population

	Total	Subsample1	Subsample 2	Comparisons
Age	**M: 40.94 (*SD*: 15.21)**	**M: 40.34 (*SD*: 15.39)**	**M: 41.28 (*SD*: 15.15)**	**t-tes: .980, *p*: .589**
Sex				
Males	44.3%	46.4%	44.0%	χ^2/df = 0.521, *p*: .720
Females	54.4%	52.5%	55.1%	
Other	1.3%	1.1%	0.9%	
Marital situation				
Coupled	48.9%	51.6%	44.9%	χ^2/df = 1.034, *p*: .409
Single	40.4%	38.5%	43.3%	
Separate/Divorced	9.3%	7.7%	9.7%	
Widower	1.5%	2.2%	2.0%	
Cohabitation				
Living with dependents	35%	39.3%	33.7%	χ^2/df = 2.284, *p*: .058
Training				
Student	8.8%	8.7%	8.9%	χ^2/df = 1.122, *p*: .326
Compulsory studies	8.2%	7.4%	8.6%	
Intermediate level studies	22.4%	24.0%	25.1%	
Higher technical studies	8.0%	7.7%	8.9%	
University studies	52.6%	52.2%	48.6%	
Annual income				
<12.000€	35.5%	35.3%	33.5%	χ^2/df = 1.2183, *p*: .207
<18.000€	16.3%	14.5%	17.1%	
<28.000€	22.8%	21.6%	24.6%	
<37.000€	11.6%	12.3%	12.0%	
>37.000€	14.2%	16.4%	12.0%	
Total sample	**716**	**366**	**350**	

Note: M: Mean; *SD*: Standard deviation.

Depression, Anxiety and Stress scale (DASS-21: Lovibond & Lovibond, 1995a; Antony et al., 1998): The scale measures depression, anxiety, and stress, with 21 items (seven items for each category), with a four-point scale (0 to 3), on the presence of symptoms over the previous week. For each scale, the score can range from 0 to 21. The greater the score, the more severe the depression, anxiety and stress. The translation, and cross-cultural adaptation was done according to the guide proposed by Beaton et al. (2000). The English version was translated into Catalan by two independent translators (one expert, and other naive), to later draw up the first version by consensus. Then two other naive translators independently performed the back translation. The working group wrote the final version after analysing the English and Catalan versions, guaranteeing semantic, idiomatic, experiential and conceptual equivalence. This version was applied to 7 people with anxiety and/or depression, analysing possible writing problems, ambiguities, ease of understanding, etc. which made it possible to produce the final version in Catalan.

Goldberg Anxiety and Depression Scale (GADS: Goldberg et al., 1988). The Catalan version was applied (Malas & Tolsá, 2022). This instrument is composed of two subscales of 9 binary (yes/no) items everyone. The first subscale (1 to 9) is for anxiety; and the second subscale (19 to 18) for depression. Higher point values indicate a more severe problem with 9 as the highest possible value for each subscale. In each scale, the first four questions are conditioning questions, because two affirmative answers are required to continue with the subscale, but in research the full scale is usually applied, and that is how it was used in the present study. The scale reveals a Cronbach's α of 0.859 and 0.741 for the anxiety and depression subscales in the same analysed sample.

Procedure and ethics

Participants were recruited online, during September-October 2021, via message direct on two social networks (Facebook and Twitter). Age (> 18 years), and having Catalan as mother tongue were the only inclusion/exclusion criteria applied. Participation was completely voluntary. Participants were not compensated in any way for their participation. Individuals who clicked the survey link were debriefed on the first page with a description of the study and its aims. Verification that participant data would be recorded anonymously was provided, and a statement ensuring that they had the choice to stop participating in the survey at any point in time was also included. Participants digitally provided their informed consent by clicking to proceed to take part in the survey. Thus, to continue administering the questionnaires, each participant had to agree the terms of the study that complied with the Declaration of Helsinki.

Statistical analysis

Statistical analyses were conducted using the SPSS v.27 and AMOS v.24 package. The applied methodology is similar to that of Gomez et al. (2020), Johnson et al. 206, Kyriazos et al. (2018), Malas & Tolsá, 2021, and Zanon et al. (2020).

First, univariate and multivariate normality were calculated for total sample (n= 716), applying Kolmogorov-Smirnov test and skewness and kurtosis test. Also, psychometric data as Corrected item total correlation and α if element is removed. The results obtained report the suitability of the items and the need to apply non-parametric statistics.

To continue with the analysis, participants were randomly split into two equivalent subsamples. Demographic characteristics were studied via frequency analysis and descriptive calculation (total sample and sub-samples). The equivalence between the subsamples is given by the Fisher's Chi-square.

Confirmatory Factor Analysis (CFA), and Exploratory Structural Equation Modelling (ESEM) were applied in the first subsample (n= 366), testing nine alternative solutions. The fit to the underlying data were expressed by the indices of Chi-Square (x^2), Root Mean Square Error of Approximation (RMSEA), Tucker-Lewis's index (TLI), Incremental fit index (IFI), and Comparative Fit Index (CFI). For RMSEA the criteria used were: good fit: ≤ 0.06; acceptable= 0.07 to 0.08; Limited: 0.08 to 0.10; unfit: ≥ 0.10). For TLI, IFI and CFI: good fit: > 0.95; acceptable: 0.90 to 0.95; poor fit: ≤ 0.90 (Hu & Bentler,1995). The chi-square, and change in the RMSEA and CFI values were employed for examining differences in model fit. The invariance criteria used were ΔCFI≤ 0.01, and ΔRMSEA ≤ 0.015 (Chen, 2007). Range of Factor Loadings and Factor Intercorrelations were also analysed for final decision.

In the second subsample (n= 350), the optimal model that emerged from first subsample was cross-validated. Following, CFA was carried out to test for the measurement invariance using data from entire sample (n=716). Measurement invariance across gender was tested. To produce further information about the construct validity of the scale, with the entire sample (n= 716), reliability (Cronbach's α and McDonald's ω) and convergent validity analysis (average variance extracted: AVE) were performed. For α, values < 0.80 being preferable; for ω > 0.75 (Reise et al., 2013); and for AVE > 0.50 is needed (Reise et al., 2013; Zinbarg et al., 2005). To determine their concurrent and discriminant validity, correlations between the scores obtained by DASS-21 and those obtained with the GADS was carry out. Also, Fisher's Chi-square was determined to investigate sociodemographic differences.

Table 2. Descriptive statistics for items and total items (*n*=716)

	Mean	*SD*	Skew	Kurt	Kolmogorov-Smirnov		Corrected item total correlation	α if element is removed
					Z	*p*		
Q1	1.00	0.916	0.621	-0.453	0.228	<0.001	0.686	0.955
Q2	0.57	0.873	1.379	0.823	0.383	<0.001	0.468	0.957
Q3	0.58	0.853	1.353	0.882	0.369	<0.001	0.755	0.954
Q4	0.45	0.789	1.693	1.885	0.426	<0.001	0.656	0.955
Q5	0.86	0.976	0.849	-0.407	0.281	<0.001	0.718	0.954
Q6	1.06	0.971	0.574	-0.667	0.233	<0.001	0.667	0.955
Q7	0.39	0.785	2.052	3.295	0.450	<0.001	0.615	0.955
Q8	0.76	0.962	0.965	-0.275	0.325	<0.001	0.656	0.955
Q9	0.89	1.068	0.804	-0.746	0.308	<0.001	0.730	0.954
Q10	0.72	1.003	1.102	-0.127	0.357	<0.001	0.722	0.954
Q11	1.20	0.966	0.390	-0.812	0.234	<0.001	0.733	0.954
Q12	1.14	1.061	0.458	-1.046	0.212	<0.001	0.780	0.953
Q13	1.02	1.045	0.602	-0.899	0.248	<0.001	0.811	0.953
Q14	0.53	0.806	1.428	1.173	0.383	<0.001	0.611	0.956
Q15	0.48	0.860	1.653	1.571	0.426	<0.001	0.763	0.954
Q16	0.59	0.876	1.330	0.694	0.376	<0.001	0.721	0.954
Q17	0.62	0.981	1.397	0.634	0.385	<0.001	0.754	0.954
Q18	0.98	0.988	.696	-0.586	0.231	<0.001	0.720	0.954
Q19	0.65	0.937	1.255	0.416	0.359	<0.001	0.668	0.955
Q20	0.55	0.905	1.506	1.079	0.403	<0.001	0.722	0.954
Q21	0.55	0.944	1.614	1.324	0.410	<0.001	0.727	0.954

RESULTS

Descriptive statistics

Table-1 show the demographic characteristics for full sample, and for the two subsamples used in this study. There were no significant differences in demographic characteristics between the subsamples. Descriptive statistics for each item are presented in Table-2. For items, mean scores ranged from 0.39 to 1.20, and SD were less than 1.061. On a scale of 0 to 3, and based on the normative scores for the DASS-21 (Henry & Crawford, 2005) it can be considered that it is a non-clinical sample. For skewness and kurtosis, we find that many of the items fall within the ± 1.5 range, while the other items have higher values. Nonetheless, Kolmogorov-Smirnov normality test show that all items were distributed in a non-normal way (p< 0.001). On the whole, the participants in the present study can be seen as reasonably well adjusted, with no problematic levels of depression, anxiety, or stress.

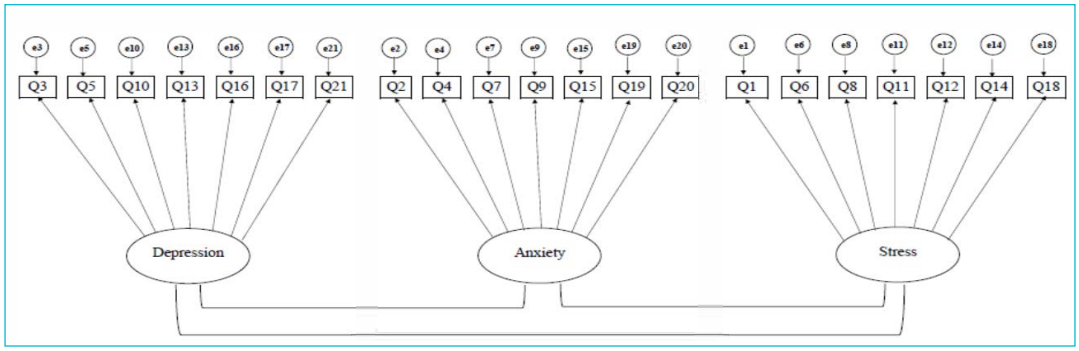
Data obtained for Cronbach's α if element is removed (< 0.949) and corrected item total correlation (0.452 to 0.792), suggest a satisfactory internal consistency for all items.

Assessment of Model Fit

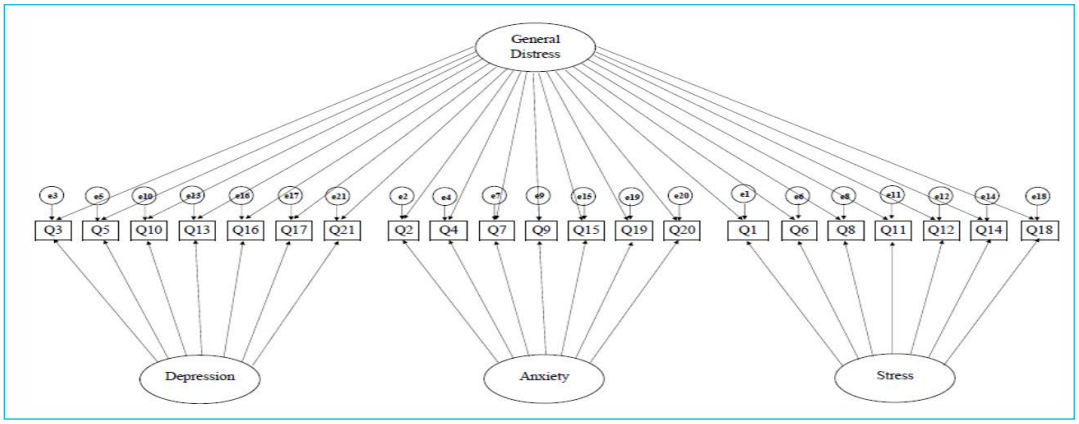
To evaluate the factor-structure the following models were tested:

- Model-1: Unidimensional model with a single latent General Distress factor (Brown, 2015).
- Model-2: A two-factor model (Lovibond & Lovibond, 1995b; Henry & Crawford, 2005) with Depression in one factor and Anxiety plus Stress combined in a second factor.
- Model-3: Three-factor model (Duffy et al., 2005) with Anhedonia (items 3, 10, 16, 21), Physiological hyper-arousal (items 2, 4, 7, 19) and Negative Affect (items 1, 5, 6, 8, 9, 11, 12, 13, 14, 15, 17, 18, 20).
- Model-4: Three-factor solution (Lovibond & Lovibond, 1995a), wherein items from each seven-item subscale (i.e., depression, anxiety, and stress) are set to load onto their respective first-order factor, and the three factors correlated with each other.
- Model-5: Bifactor three-factor model (Henry & Crawford, 2005), with a General Distress factor or Negative Affect factor, and the three specific factors proposed by Lovibond and Lovibond, 1995a. All four factors (i.e.,

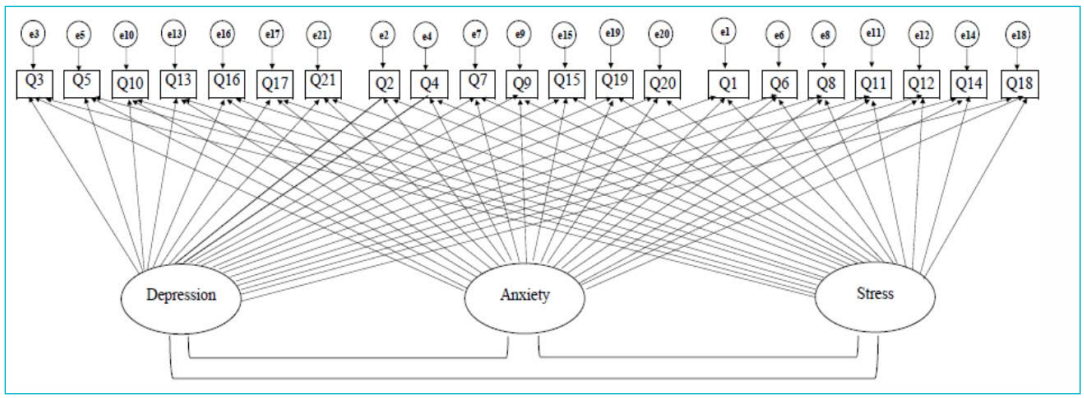
Figure-1. Some alternative models tested for DASS-21 represented as path diagrams



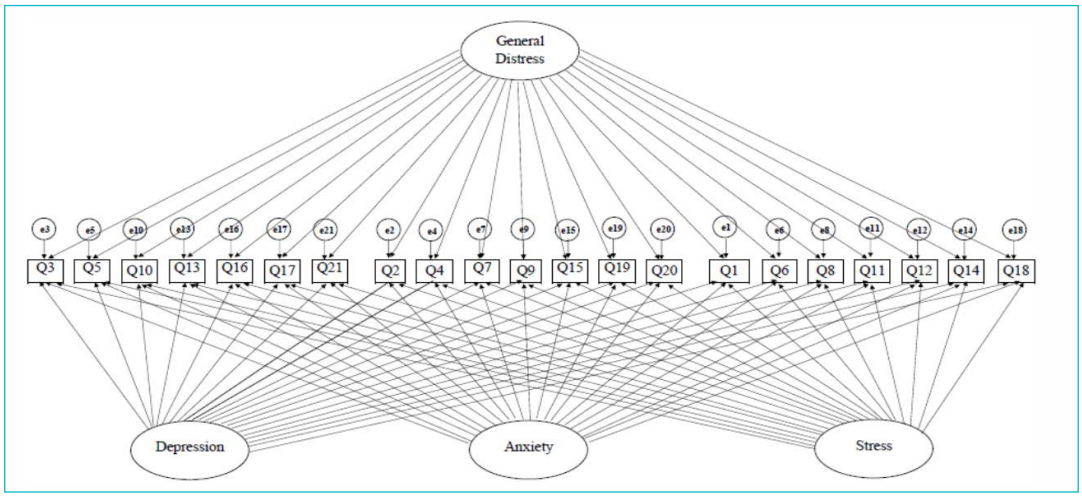
Model 4. Three-factor solution (Lovibond & Lovibond, 1995a)



Model 5. Bifactor three-factor model (Henry & Crawford, 2005)



Model 8. ESEM model from three-factor model (Lovibond & Lovibond, 1995b)



Model 9. Bifactor ESEM model based on ESEM model from three-factor model (Lovibond & Lovibond, 1995b)

depression, anxiety, stress, and the general factor) are uncorrelated with each other.

- Model-6: Tripartite model (Willemsen et al., 2011). A 2-factor bifactor model with all items loading on a General Distress factor and Depression and Anxiety as specific factors.
- Model-7: Two-factor Bifactor model with Depression in one factor and Anxiety plus Stress combined in a second factor (e.g.: Henry & Crawford, 2005).
- Model-8: ESEM model with the original structure (Lovibond & Lovibond, 1995b).
- Model-9: Bifactor ESEM model based on Model-8.

As Gomez et al. (2020), Johnson et al. 206, Kyriazos et al. (2018) or Zanon et al. (2020), a higher order model not was tested, because as indicated by Wang & Wang (2012) or Brown (2015), for a 3 first-order factor structure, like DASS-21, the second-order is just identified, therefore, judging model improvement, over the first order solution, is impossible.

Table-3 shows the fit values for all the DASS-21 models tested in the study. As can see, the Model-1 had an unacceptable fit (RMSEA > 0.10; TLI, IFI & CFI< 0.90); Model-2 and Model-3 a limited to unacceptable fit (RMSEA: 0.09 to 0.10; TLI, IFI & CFI< 0.90); and Model-6 and Model-7 a poor fit (RMSEA: 0.08 to 0.09; TLI, IFI & CFI > 0.85). The Model-4, Model-5, Model-8 and Model-9 present acceptable fit (RMSEA< 0.08; TLI, IFI & CFI> 0.90). In relation to approximate fit indices, the Model-4/Model-5 and the Model-8/Model-9 did not differ from each other in terms of ΔRMSEA values (< 0.015). However, the ΔCFI was greater than 0.01 for the comparison involving the Model-8/Model-9, not for Model-4/Model-5. Taken together, the findings can be interpreted as showing that the Model-9 showed better fit that the other analysed models.

For these four competing models, the factor loadings and factor intercorrelations was examined to select the optimal model. As can see in Table-4, only the factor loadings of the original 3-factor model (Model-4) showed acceptable loadings. In the other models, the loadings were unacceptable (from negative to positive values). Factor intercorrelations for Model-8 were higher than those for Model-4. This is contrary to expectations, since theoretically Model-8 by default allows cross loadings while Model-4 restricts them to zero, which should inflate the intercorrelations of the factors. Considering fit measures, loadings and factor correlations, the Model-4 (original three-factor model) finally showed an overall acceptable fit in the first subsample.

Cross-Validation in a Different Sample

After determining with first subsample that the original thee-factor model (Model-4) was the optimal model, a cross-validation followed to verify model fit in the second subsample (n= 350). As shown in Table-3, all fit statistics were acceptable and similarly to these obtained in first subsample. Also, as show in Table-4, the factor loadings and intercorrelations were adequate and comparable across the two subsamples.

Measurement Invariance

Measurement invariance across gender was determined. Then, configural invariance was tested in both gender groups concurrently (M1). Following, factor loadings were constrained to equality and model tested (M2). Then, all intercepts were forced to be equal (M3). Finally, error variances were constrained to equality (M4).

As can be seen in Table-5, the model had acceptable fit for both males and female sample. The model also showed acceptable fit for M1, suggesting that configural invariance was supported. Invariance were weak for M2 and M3, also for M4, suggested that strict measurement invariance is supported.

Table-3. CFA fit statistics (IC 90%)

	χ^2	*df*	χ^2/df	*p*	TLI	IFI	CFI	RMSEA	SRMR
Subsample-1									
Model-1	1054.84	189	5.581	0.000	0.916	0.828	0.827	0.112	0.054
Model-2	741.02	188	3.942	0.000	0.876	0.890	0.889	0.90	0.046
Model-3	771.24	186	4.146	0.000	0.868	0.884	0.883	0.093	0.046
Model-4	**605.48**	**186**	**3.255**	**0.000**	**0.905**	**0.917**	**0.916**	**0.079**	**0.042**
Model-5	**504.07**	**168**	**3.000**	**0.000**	**0.916**	**0.933**	**0.917**	**0.074**	**0.036**
Model-6	618.17	175	3.532	0.000	0.894	00.912	0.911	0.083	0.040
Model-7	628.07	168	2.567	0.000	0.885	00.909	0.908	0.087	0.038
Model-8	**389.97**	**153**	**2.549**	**0.000**	**0.935**	**0.953**	**0.953**	**0.065**	**0.026**
Model-9	**263.78**	**135**	**1,954**	**0.000**	**0.960**	**0.975**	**0.974**	**0.051**	**0.020**
Subsample-2									
Model-4	518.86	186	2.790	0.000	0.926	0.934	0.934	0.072	0.039

Table-4. Comparison of Factor Loadings and Factor Intercorrelations

	Range of Factor Loadings				Factor Intercorrelations		
	General	Depression (D)	Anxiety (A)	Stress (S)	D to A	A to S	D to S
Subsample-1							
Model-4		0.72 - 0.84	0.49 - 0.83	0.53 - 0.85	0.766	0.856	0.826
Model-5	0.43 - 0.79	-0.52 - 0.00	0.22 - 0.49	-0.03 -0.53			
Model-8		-1.50 - 1.35	-1.27 - 1.28	-3.26 - 0.73	0.839	0.941	0.950
Model-9	0.55 - 0.74	-0.21 - 0.46	-0.16 - 0.30	-0.11 - 0.30			
Subsample-2							
Model-4		0.73 - 0.84	0.46 - 0.81	0.60 - 0.86	0.768	0.865	0.804

Table-5. Fit measures of the nested models tested to validate measurement invariance (IC 90%)

	χ^2	*df*	χ^2/df	*p*	CFI	RMSEA	Model comparison	ΔCFI	ΔRMSEA
Males (n=318)	539.79	186	2.902	0.000	0.926	0.076			
Females (n=389)	645.54	186	3.471	0.000	0.920	0.078	F-M	-0.006	0.002
M1	1379.64	372	3.708	0.000	0.935	0.074			
M2	1432.52	390	3.673	0.000	934	0.073	M2-M1	-0.003	0.001
M3	1515.21	402	3.769	0.000	925	0.078	M3-M2	-0.009	0.005
M4	1648.82	436	3.781	0.000	921	0.072	M4-M3	-0.004	0.004

Table 6. Reliability and AVE convergent validity (*n*=716)

Scale/Subscale	Cronbach's α	McDonald's ω	AVE
Total scale	.957	.932	.569
Depression	.931	.844	.665
Anxiety	.879	.844	.506
Stress	.895	.857	.537

Reliability and validity

As can be seen in Table-6, the three-factor model of DASS-21 showed a good internal consistency, also good construct reliability. AVE were acceptable, explaining more than 56% of the variance of the indicators that compose the construct.

Concurrent and discriminant validity

To determine the concurrent and discriminant validity, the correlational analysis was carried out between the obtained scale and subscales against the GADS scales and subscales. The data obtained (see Table-7) reveal that there are strong correlation values between the concepts under analysis.

Differential functioning

The data analysis to determine the differential functioning capacity based on demographic data (see Table-8) indicates that the scale under analysis has good sensitivity, and can discriminate between subgroups based on sex (woman>man), marital status (single>coupled) or salary (lower>higher).

DISCUSSION

The aims set have been achieved. Considering the cross-validation findings (fit measures, factor loadings and factor intercorrelations), the original 3-factor model proposed by Lovibond & Lovibond (1995b) showed the best overall fit. A best fit was achieved by the 3-factor Bifactor model, confirming the Quadripartite model, proposed by Henry & Crawford (2005) and others. But factor loadings not supported the good fit index. This result agrees with the criticism of Joshanloo et al., (2017), according to which, the dimensionality only based on Bifactor models is doubtful because they always tend to show adequate fit

Similar results were registered for unidimensional or bifactorial structures with collapsed factors (ESEM models),

Table 7. Correlations (Spearman *Rho*) between DASS-17 and GADS (*n*=716)

	DASS-Anxiety	DASS-Depression	DASS-Stress	DASS-total
GADS-Anxiety	0.632**	0.603**	0.818**	0.724**
GADS-Depression	0.592**	0.732**	0.789**	0.704**
GADS-Total	0.663**	0.721**	0.871**	0.813**

** The correlation is significant at the .01 level (two-tailed).

Table 8. Differential functioning depending to demographic characteristics (*n*=716)

	Depression		Anxiety		Stres		Total	
	χ^2/df	*p*	χ^2/df	*p*	χ^2/df	*p*	χ^2/df	*p*
Age (range)	0.961	.607	1.032	.398	0.929	.593	0.863	.925
Gender	2.020	**<.001**	1.599	**.023**	2.728	**.002**	1.524	**.003**
Marital status	1.771	**<.001**	1.946	**<.001**	3.927	**<.001**	1.522	**<.001**
Dependent in charge	1.233	.143	1.446	.060	1.448	.152	0.897	.716
Studies level	0.986	.514	1.375	.020	0.994	.529	1.042	.348
Monthly incoming	1.303	**.020**	1.426	**.011**	2.004	**.002**	1.252	**.013**

that presented the best good fit index, but loadings were unacceptable. These results were consistent with those of other investigators (e.g.: Kyriazos et al., 2018; Osman et al., 2012; Zanon, 2020). In other hand, with ESEM model, contrary to expectations, the correlation factors have not been reduced. Despite that unifactorial models with cross-loadings constrained to zero typically result in inflated CFA factor correlations (Kyriazos et al., 2018).

The findings are consistent with past studies that have compared the factor structure of the DASS-21 using CFA/ESEM. For Bifactor three-factor model Bifactorial CFA or the factor loadings were unsatisfactory. Gomez et al. (2020), Johnson et al. 206, Kyriazos et al. (2018) aor Zanon et al. (2020), found that although the ESEM models showed best fit -compared to CFA models-, but factors was poorly defined; the improvement was not sufficient to justify the loss of parsimony; or the factor loadings were unsatisfactory. Consequently, as with the findings of the present study, they concluded most support for the original three-factor CFA model.

For select model, factor loadings, item intercepts, as well as error variances, found to be invariant across gender, suggesting that strict measurement invariance can be supported. In other hand, analysis suggested that the three-factor model of DASS-21 can discriminate between subgroups based on sex (woman>man), marital status (single>coupled) or salary (lower>higher), in light of these variables representing factors risk for anxiety and depression (e.g., Gancedo-Garcia, 2020; Tolsa & Malas, 2021).

Reliability was more than adequate, suggesting that the 21-items were answered consistently, similarly to the original DASS-21. The Chrombach's alpha coefficients were in line with these estimates in samples from different cultural contexts by other researchers (e.g.:Antony et al., 1998; Bados et al., 2005; Bottesi et al., 2015; Henry & Crawford, 2005; Norton, 2007; Osman et al., 2012; Sinclair et al., 2012; Wang et al., 2016). Omega reliability and convergent validity measured by Average Variance Extracted were equally substantial and comparable to other (Kyriazos et al., 2018). Findings on convergent and discriminant validity are generally in line with other research findings (Antony et al., 1998; Brown et al., 1997; Clara et al., 2001; Henry & Crawford, 2005).

Although, the present study adopted the CFA 3-factor model as the preferred model for DASS-21, this model is not without limitations. First, the fit indices of the model were only acceptable. Second, the factors present a high correlation index. The result was consistent with that obtained by Bados et al. (2005) for the Castilian version in a sample of Spanish students, who concluded that the three-factor model was acceptable but not good enough. Consequently, it is possible that the description and/or content of the items the DASS-21 may not be appropriate. Further refinement studies could be recommended.

Limitations and conclusion

Regarding limitations, first of all, because the DASS-21 is a self-report questionnaire, it is possible the ratings may have been influence by the method used to collect them, thereby subjecting participants to common method variance effect. Second, the ethic approval did not enable the gathering of participants information before inviting

them to enrol in the study. Thus, it is likely that the final sample examined in the study may not be representative of the general population. Furthermore, as the research involved a community sample, it may be questionable how the results may apply to clinical samples. Third, it is the subjects who declare that they have Catalan as their mother tongue. For psychometric validation in terms of culture and language- since there are areas, within the Catalan Countries, where Catalan is not used correctly- it is crucial that all participants use correct Catalan as their mother tongue. This information is, therefore, subject to self-report biases.

Given these limitations, the results of the study may be viewed as preliminary. All and that, this study validates, for the Catalan version of DASS-21, the original three-factor model proposed by Lovibond & Lovibond (1995b); provide evidence of its psychometric properties and measurement invariance across gender. The results provide support for its use in research settings in the Catalan adult population.

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