Research Article

Cross-national measurement invariance of the Patient Health Questionnaire-4 (PHQ-4) as a screening measure for depression and anxiety symptoms in 12 Latin American countries

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Abstract

The Patient Health Questionnaire-4 (PHQ-4) is a widely used instrument to measure symptoms of depression and anxiety in general, but not much is known about its cross-cultural utility in Latin America. The present study evaluated the measurement invariance of the PHQ-4 in adult samples (N = 5441) from 12 Latin American countries (Paraguay, El Salvador, Chile, Ecuador, Colombia, Uruguay, Peru, Mexico, Cuba, Guatemala, Argentina, and Bolivia). The two-factor structure presented a superior fit to the one-factor structure. This provides evidence to support a two-dimensional model of anxious and depressive symptomatology of the PHQ-4, with a good estimate of reliability. The configural, metric, scalar and strict invariance of the PHQ-4 was supported, suggesting that participants from all countries attribute the same meaning to the latent constructs anxiety and depression and their scores can be compared. Additionally, support was provided for the hypothesis that the presence of depressive symptoms significantly predicts subjective well-being. However, the presence of anxiety symptoms fails to significantly predict participants well-being. It is concluded that the PHQ-4 provides a largely comparable measure of anxiety and depression symptoms in a large sample of Latin American countries.

Keywords: Anxiety; depression; invariance; Latin America; Patient Health Questionnaire-4.

Table of Contents

Mental health is an essential aspect of global health. Its importance worldwide has grown, as mental health disorders have become the leading cause of disability, accounting for one of every six years lived with disability (World Health Organization, 2022). In Latin America, these disorders have experienced an increase in the last decade, which has been followed by a wide gap in their treatment. This situation is critical, as mental health disorders increase the risk of developing other diseases and contribute to intentional and unintentional injuries (Pan American Health Organization, 2023).

The growth in the prevalence of mental health disorders has been intensified by the COVID-19 pandemic. Latin America, in particular, has shown regional variations in mental health (Zhang et al., 2022). Before the pandemic of COVID-19, the prevalence rate of severe mental disorders in the Americas region ranged from 2% to 10% (Kohn et al., 2018). Specifically, annual prevalence rates of anxiety disorders and depression were reported to be 5.8% and 4.9% in the adult population (Caldas de Almeida & Horvitz-Lennon, 2010). A systematic review and meta-analysis study indicated that, during the pandemic, the prevalences of anxiety and depression increased to 35% and 35%, respectively, with South American countries having a higher prevalence of mental health symptoms compared to Central America (36% versus 28%, $p < 0.001$) (Zhang et al., 2022). However, symptoms of anxiety (LOR = -0.33; 95 % CI: -0.54, -0.12) and depression (LOR = -0.12; 95 % CI: -0.21, -0.04) were reported to have decreased across the pandemic worldwide (Cenat et al., 2022). In Latin America, it has been suggested that mental health during the pandemic had a complex dynamic, where the majority were resilient, but there were also vulnerable groups (younger, female and with pre-existing psychiatric diagnoses) who were more likely to deteriorate in mental health over time (Fernández et al., 2022).

Depressive and anxiety disorders are considered to be two of the leading causes of disability among people aged 15 to 49 years (Errazuriz & Crisostomo, 2021). However, in primary health care, detection rates for depression and anxiety are less than 50%, which generates a large number of undiagnosed and untreated patients (Christodoulaki et al., 2022). Appropriate screening for symptoms of anxiety and depression has been recommended as a step prior to initiating treatment, which is associated with improved patient outcomes (Clark, 2011; Katon & Roy-Byrne, 2007). Different instruments have been developed to improve the detection rates of depression and anxiety symptoms, such as the Beck Depression Inventory (BDI; Beck et al., 1961), the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) or the Depression Anxiety Stress Scale (DASS; Parkitny & McAuley, 2010). Even though these have

shown evidence of reliability and validity in the Latin American context (Hinz et al., 2014; Lopez et al., 2021; Mautong et al., 2021; Ruiz et al., 2017), their length generates greater time consumption and difficulties for their use by non-specialists (Christodoulaki et al., 2022). This has led to little use of these measures in clinical practice in primary care (Gilbody et al., 2002). In view of this, for some years now there have been brief measures aimed at improving the reliability and efficiency of the detection of anxiety and depression symptoms (Khubchandani et al., 2016).

An ultra-low screening measure is the Patient Health Questionnaire-4 (PHQ-4; Kroenke et al., 2009) composed of four items, which has demonstrated high sensitivity and specificity for detecting depression and anxiety (Stanhope, 2016). Of the four items, two measure the frequency of depressive symptoms (depressed mood and loss of interest), and the other two measure the frequency of anxiety symptoms (nervousness and uncontrollable worry). The PHQ-4 has been validated in different languages and countries worldwide (Christodoulaki et al., 2022; Ghaheri et al., 2020; Kazlauskas et al., 2023; Kim et al., 2021; Kliem et al., 2016; Kocalevent et al., 2014; López Guerra et al., 2022; Löwe et al., 2010; Materu et al., 2020; Wicke et al., 2022). Psychometric studies with the PHQ-4, conducted in different countries and sociodemographic groups, generally supported the presence of a two-factor structure (anxiety and depression), an adequate estimate of reliability and evidence of measurement invariance (MI) across different age groups, genders or others (Ahmadi et al., 2019; Christodoulaki et al., 2022; Ghaheri et al., 2020; Kazlauskas et al., 2023; Khubchandani et al. ., 2016; Kim et al., 2021; Kocalevent et al., 2014; Larionow & Mudło-Głagolska, 2023; Lenz & Li, 2022; López Guerra et al., 2022; Löwe et al., 2010; Mendoza et al., 2022; Mills et al. , 2015; Renovanz et al., 2019). Although the presence of two factors was constant, it has also been suggested that this factor structure would not be completely adequate (Kim et al., 2021). A study in Tanzania suggested that the four items of the PHQ-4 were grouped into a single factor (Materu et al., 2020).

Likewise, there is evidence of the relationship of PHQ-4 scores with lower levels of positive affects (Mendoza et al., 2022), meaning in life (Fong et al., 2023), meaning in life (López Guerra et al., 2022), well-being (Ghaheri et al., 2020) and quality of life (Renovanz et al., 2019), among others. In addition, the PHQ-4 was related to high levels of stress and negative affects (Mendoza et al., 2022), increased frequency of suicidal ideation (Fong et al., 2023), poor sleep quality, subjective fatigue and lack of concentration (Lahlouh & Mustafa, 2020), psychological inflexibility (López Guerra et al., 2022), hopelessness and distress (Kocalevent et al., 2014; Mills et al., 2015).

Even though to date only two studies have validated the PHQ-4 for samples from Colombia (Kocalevent et al., 2014) and Ecuador (López Guerra et al., 2022), their findings cannot be generalized to the entire Latin American context, given the cultural differences. It has been suggested that culture and social contexts determine how people conceptualize and express emotional problems (Ali et al., 2022). The use of the PHQ-4 in samples from different countries, from Latin America and other continents, has further revealed the importance of this questionnaire, but has also raised concerns about measurement invariance (MI). There is a limited number of studies on the MI of the PHQ-4 across countries. Many researchers assume that when they administer the PHQ-4 in different countries, they are assessing the same construct in all samples in the same way and assume that the questionnaire is invariant across groups (Byrne, 2016). However, differences in prevalence rates of anxiety and depression between countries do not necessarily represent real differences. Even if the same symptoms appear in all countries, methodological problems may lead to false conclusions about cross-cultural differences (Bowden & FoxRushby, 2003; van de Vijver & Tanzer, 2004). Cross-country comparisons require instruments with guaranteed comparability of measurements before reliable conclusions can be drawn (Boer et al., 2018). To our knowledge, only one previous study evaluated the MI of the PHQ-4 in seven European countries (Austria, Croatia, Georgia, Germany, Lithuania, Portugal and Sweden) which indicated the presence of partial scalar measurement invariance across countries (Kazlauskas et al., 2023).

MI refers to the equivalence of measurement in different conditions, such as different countries (Baumgartner & Steenkamp, 1998), and is considered as a property of a measuring instrument (Davidov et al., 2014). Therefore, MI makes it possible to examine whether instruments can measure the same construct in different conditions or observed groups (Horn & McArdle, 1992). This implies that the same construct definition and behaviors are presented in the same way in each country. In this sense, it is necessary to have instruments that are cross-culturally invariant in samples from different countries, and that are short and easy to apply, to evaluate symptoms of depression and anxiety. Therefore, the present study aimed to examine the evidence of validity based on the internal structure, based on the relationship with other variables, reliability and cross-country MI of the PHQ-4 in samples from 12 Latin American countries. Based on the only study of cross-national invariance of the PHQ-4 (Kazlauskas et al., 2023), it was hypothesized that the PHQ-4 has a two-factor structure, which provides reliable scores and is invariant across countries. Also, due to evidence relating both depressive, anxious symptoms and well-being (Kinderman et al., 2015; Malone & Wachholtz, 2018, Topp et al., 2015), it was hypothesized that

anxiety and depressive symptoms, as measured by the PHQ-4, negatively predict well-being. This would provide evidence of validity based on the relationship with other variables.

This multinational study would provide information on the comparability of PHQ-4 data obtained in different countries. Giving evidence of the MI of the PHQ-4 is important for an objective comparison of means between groups from different countries. The lack of evidence of MI would suggest that the differences in anxiety and depression means between countries reflect differences in measurement errors and not the true differences between groups. In other words, only when the PHQ-4 items are invariant will we be certain that the differences in anxiety and depression scores in the Latin American context are due to differences between countries and not to measurement errors. Furthermore, the inclusion of several Latin American countries will not only support the universality of the PHQ-4 but will also allow for more rigorous cross-cultural studies.

Method

Participants

A total of 5441 people from 12 Latin American countries (Paraguay, El Salvador, Chile, Ecuador, Colombia, Uruguay, Peru, Mexico, Cuba, Guatemala, Argentina and Bolivia) were selected through a non-probabilistic convenience sample according to the following inclusion criteria: 1) being of legal age, 2) being a resident in each of the participating countries, 3) providing informed consent to participate in the study. The number of participants was determined by using the Soper (2023). The number of observed ($n = 4$) and latent ($n = 2$) variables in the model, the anticipated effect size ($\lambda = 0.3$), the desired probability ($\alpha = 0.05$) and the statistical power level ($1\text{-}\beta = 0.95$) were indicated. Based on these data, a recommended number of participants of 400 individuals was suggested. Although there are countries with a sample size smaller than recommended, another study has suggested that sample sizes in the range of 100 to 200 may be sufficient to adequately estimate the model parameters. Therefore, the sample sizes of all countries are adequate (Meade & Lautenschlager, 2004).

Table 1 indicates the highest mean age belongs to participants from Guatemala ($M = 40.9$; $SD = 11.9$ years) and Argentina ($M = 42.3$; $SD = 15.2$ years); while, the lowest mean age belongs to participants from Cuba ($M = 24.6$; $SD = 6.8$ years) and Ecuador ($M = 29$; $SD = 10.6$ years). The majority of participants in all countries are women. In addition, there is a higher proportion of married people in most countries (> 50%). Regarding educational level, the majority of participants completed university studies, except in El Salvador (29.6%), Colombia (37.7%), Uruguay (45%),

Cuba (42.7%) and Argentina (49.7%), where the proportion is much lower than 50%. On the other hand, although most of the participants have a permanent job, there is a significant group of them in all countries who are unemployed (16.9% - 51.2%). It can also be seen that the majority of participants reside in an urban area (> 70%). Further details of the sociodemographic characteristics of the participants in each country are shown in Table 1.

Instruments

Sociodemographic data. A form was prepared specifically for this study to obtain information on age, sex, marital status, educational level, area of residence and type of work in each participating country.

The Patient Health Questionnaire-4 (PHQ-4; Kroenke et al., 2009). The PHQ-4 detects the frequency of the main symptoms of a depression and anxiety disorder during the last 2 weeks. It consists of four items, combining the two items of the PHQ-2 (Löwe et al., 2005) and two items of Generalized Anxiety Disorder Scale- 2 ítems (GAD-2; Kroenke et al., 2007). The first two items measure the frequency of depressive symptoms ("Little interest or pleasure in doing things" and "Feeling depressed or hopeless") and the last two items measure the frequency of anxiety symptoms ("Feeling nervous, anxious or on edge" and "Not being able to stop or control worry"). Each of the PHQ-4 items has four Likert-type response options, ranging from 0 = not at all to 3 = almost every day. The total score ranges from 0 to 12, where higher scores indicate a higher frequency of depressive and anxiety symptoms. For this study, the Spanish version was used, validated in Ecuador by López Guerra et al. (2022). Reliability was optimal for the total scale (α = 0.879; ω = 0.880) and its two factors: anxiety (α = 0.838; ω = 0.838) and depression (α = 0.779; ω = 0.780).

WHO-5 well-being index (WHO-5; World Health Organization, 1998). The WHO-5 evaluates general subjective well-being during the last 2 weeks. It consists of 5 items: (1) "I have felt cheerful and in good spirits", (2) "I have felt calm and relaxed", (3) "I have felt active and energetic", (4) "I have woken up feeling good and rested"]; (5) "My daily life has had interesting things for me". Each item has four Likert-type response options, ranging from "0 = never" to "3 = always". The sum of the scores for each item generates a total WHO-5 score ranging from 0 to 15, where higher scores would indicate greater subjective well-being. For this study, we used the WHO-5 version, which has demonstrated evidence of validity and MI in general population samples from a number of Latin American countries which showed adequate reliability indices in each of the countries evaluated ($\alpha \geq 0.94$; $\omega \geq 0.77$) (Caycho-Rodríguez et al., 2023)

Table 1.

Sociodemographic characteristics of the participants

Sociodemographic Data	Paraguay (*n* = 918)	El Salvador (*n* = 741)	Chile (*n* = 555)	Ecuador (*n* = 477)	Colombia (*n* = 414)	Uruguay (*n* = 322)
Age (M ± SD)	31.4 ± 10.8	29.2 ± 8.8	36.4 ± 11.8	29 ± 10.6	30 ± 12.8	38.3 ± 13.7
Sex, *n* (%)						
Male	219 (23.9%)	279 (37.7%)	135 (24.3%)	144 (30.2%)	111 (26.8%)	85 (20.9%)
Female	699 (76.1%)	462 (62.3%)	420 (75.7%)	333 (69.8%)	303 (73.2%)	322 (79.1%)
Marital Status *n* (%)						
Married	603 (65.7%)	543 (73.3%)	266 (47.9%)	328 (68.8%)	298 (72%)	188 (46.2%)
Cohabitant	209 (22.8%)	130 (17.5%)	155 (27.9%)	97 (20.3%)	66 (15.9%)	89 (21.9%)
Divorced	27 (2.9%)	12 (1.6%)	43 (7.7%)	34 (7.1%)	15 (3.6%)	44 (10.8%)
Single	72 (7.8%)	54 (7.3%)	87 (15.7%)	14 (2.9%)	29 (7%)	80 (19.7%)
Widowed	7 (.8%)	2 (.3%)	4 (.7%)	4 (.8%)	6 (1.4%)	6 (1.5%)
Level of Education, *n* (%)						
Complete university	488 (53.2%)	219 (29.6%)	370 (66.7%)	245 (51.4%)	156 (37.7%)	183 (45%)
Incomplete university	308 (33.6%)	296 (39.9%)	107 (19.3%)	135 (28.3%)	129 (31.2%)	120 (29.5%)
Technical studies complete	20 (2.2%)	34 (4.6%)	44 (7.9%)	12 (2.5%)	39 (9.4%)	42 (10.3%)
Technical studies incomplete	1 (.1%)	9 (1.2%)	8 (1.4%)	3 (.6%)	7 (1.7%)	1 (.2%)
High school complete	80 (8.7%)	111 (15%)	22 (4%)	75 (15.7%)	72 (17.4%)	35 (8.6%)
Secondary incomplete	17 (1.9%)	49 (6.6%)	3 (.5%)	6 (1.3%)	6 (2.4%)	25 (6.1%)
Primary school complete	4 (.4%)	12 (1.6%)	1 (.2%)	1 (.2%)	1 (.2%)	1 (.2%)
Primary incomplete	0 (0%)	11 (1.5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Area de residence, *n* (%)						
Urban	811 (88.3%)	584 (78.8%)	482 (86.8%)	358 (75.1%)	383 (92.5%)	393 (96%)
Rural	107 (11.7%)	157 (21.2%)	73 (13.2%)	119 (24.9%)	31 (7.5%)	14 (3.4%)
Type of work, *n* (%)						
Permanent job	509 (55.4%)	395 (53.3%)	319 (57.5%)	176 (36.9%)	134 (32.4%)	289 (71%)
Temporary job	156 (17%)	92 (12.4%)	81 (14.6%)	72 (15.1%)	68 (16.4%)	26 (6.4%)
Unemployed	253 (27.6%)	254 (32.4%)	155 (27.9%)	229 (48%)	212 (51.2%)	92 (22.6%)
Sociodemographic Data	Perú (*n* = 371)	México (*n* = 343)	Cuba (*n* = 378)	Guatemala (*n* = 342)	Argentina (*n* = 316)	Bolivia (*n* = 264)
Age (M ± SD)	31.7 ± 10.9	33.1 ± 13.3	24.6 ± 6.8	40.9 ± 11.9	42.3 ± 15.2	39.1 ± 14.3
Sex, *n* (%)						
Male	119 (32.1%)	116 (33.8%)	127 (37.1%)	121 (35.2%)	68 (21.5%)	76 (28.8%)
Female	252 (67.9%)	227 (66.2%)	215 (62.9%)	223 (64.8%)	248 (78.5%)	188 (71.2%)
Marital Status *n* (%)						
Married	241 (65%)	191 (55.7%)	226 (66.1%)	139 (40.4%)	148 (46.8%)	136 (51.5%)

Cohabitant	70 (18.9%)	113 (32.9%)	46 (13.5%)	151 (43.9%)	89 (28.2%)	82 (31.1%)
Divorced	17 (4.6%)	19 (5.5%)	14 (4.1%)	28 (8.1%)	29 (9.2%)	32 (12.1%)
Single	41 (11.1%)	15 (4.4%)	55 (16.1%)	20 (5.8%)	41 (13%)	9 (3.4%)
Widowed	2 (.5%)	5 (1.5%)	1 (.3)	6 (1.7%)	9 (2.8%)	5 (1.9%)
Level of Education, *n* (%)						
Complete university	216 (58.2%)	178 (51.9%)	146 (42.7%)	208 (60.5%)	157 (49.7%)	173 (65.5%)
Incomplete university	105 (28.3%)	95 (27.7%)	172 (50.3%)	74 (21.5%)	87 (27.5%)	63 (23.9%)
Technical studies complete	21 (5.7%)	45 (13.1%)	11 (3.25)	22 (6.4%)	32 (10.1%)	15 (5.7%)
Technical studies incomplete	8 (2.2%)	4 (1.2%)	2 (.6%)	6 (1.7%)	4 (1.3%)	0 (0%)
High school complete	16 (4.3%)	20 (5.8%)	5 (1.5%)	23 (6.7%)	28 (8.9%)	7 (2.7%)
Secondary incomplete	4 (1.1%)	1 (.3%)	6 (1.8%)	10 (2,9%)	4 (1.3%)	5 (1.9%)
Primary school complete	0 (0%)	0 (0%)	0 (0%)	1 (.3%)	4 (1.3%)	1 (.4%)
Primary incomplete	1 (.3%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Area de residence, *n* (%)						
Urban	329 (88.7%)	320 (93.3%)	301 (88%)	320 (93%)	300 (94.9%)	255 (96.6%)
Rural	42 (11.3%)	23 (6.7%)	41 (12%)	24 (7%)	16 (5.1%)	9 (3.4%)
Type of work, *n* (%)						
Permanent job	155 (41.8%)	162 (47.2%)	237 (69.3%)	232 (67.4%)	203 (64.2%)	110 (41.7%)
Temporary job	77 (20.8%)	64 (18.7%)	15 (4.4%)	54 (15.7%)	43 (13.6%)	61 (23.1%)
Unemployed	139 (37.5%)	117 (34.1%)	90 (26.3%)	58 (16.9%)	70 (22.2%)	93 (35.2%)

Procedure

An online questionnaire was developed through the Google Forms©. The questionnaire was divided into three parts. In the first part, the objectives of the study and the informed consent were presented. Only participants who gave informed consent agreed to the remaining two parts. In the second part, the sociodemographic card was presented, and finally, in the third part, the PHQ-4 and WHO-5 were presented. The online questionnaire was distributed through social networks, such as Facebook, Instagram, WhatsApp, and email. The data collection procedure was the same in each of the 12 participating countries.

All recommendations for reporting results of questionnaires and online surveys were followed (CHERRIES) (Eysenbach, 2004; López-Rodríguez, 2019). The study protocol was reviewed and approved by the Department of Medical Psychology of the National University of Asuncion (Paraguay; approval number: 001_011_2023), which ensured compliance with the ethical aspects of this type of research, such as anonymity and voluntary participation, confidentiality of the data and the possibility of leaving the study whenever they wished.

Data analysis

The factor structure of the PHQ-4 scale was evaluated through a Confirmatory Factor Analysis (CFA), for which the Diagonally Weighted Least Squares with Mean and Variance corrected (WLSMV) estimator was used since the items presented less than five response categories (Li, 2016). It is essential to mention that a polychoric correlation matrix was calculated to perform the CFA since the items were ordinal. The following indexes were used to evaluate the fit of the models studied: Root mean squared error of approximation (RMSEA), Standardized root mean square residual (SRMR), Comparative fit index (CFI) and Tucker Lewis index (TLI). For the RMSEA and SRMR indexes values less than .08 were considered acceptable (Kline, 2016). For the CFI and TLI indexes, values greater than .95 were considered adequate (Schumacker & Lomax, 2015). Regarding the reliability of the scale, the omega coefficient (McDonald, 1999) and Alpha Cronbach (Cronbach, 1951) was used, where a value greater than .70 is considered adequate (Viladrich et al., 2017). The method developed by Feldt et al. (1987) was used to calculate possible differences in the level of reliability.

To evaluate the factorial invariance of the scale according to the country to which the participants belong, Multi-group Confirmatory Factor Analysis (MGCFA) was used, where a sequence of hierarchical variance models was proposed: (1) configural invariance, (2) metric invariance, (3) scalar invariance and (4) strict invariance. To compare the sequence of models, the differences

in the CFI (ΔCFI) were used, where values less than <.010 show the invariance of the model between groups (Chen, 2007). The RMSEA (ΔRMSEA) was also used, where differences less than <.015 evidenced the invariance of the model between groups (Chen, 2007).

Regarding the validity of the scale in relation to other variables, an SEM model was proposed. In this model, the PHQ-4 scale has a significant impact on the level of satisfaction with life. The WLSMV estimator was used to estimate the model and the same adjustment indicators used in the CFA were taken into account.

All statistical analyses were performed using the "lavaan" package (Rosseel, 2012) for the AFC and the SEM model. The package "semTools" (Jorgensen et al., 2018) was used to estimate factorial invariance. Also, the "cocron" library was used to calculate the differences in reliability between the countries (Diedenhofen & Musch, 2016). In all cases, the RStudio environment (RStudio Team, 2018) for R (R Core Team, 2019) was used.

Results

Descriptive Analysis

Table 2 shows that the participants answered all the response categories of the four items. However, the majority of respondents in all countries chose the first two response categories and few chose the higher response categories. It is also observed that in the polychoric correlation matrix all items correlate positively and significantly with each other ($p < .01$), this result occurs in all countries. These results are important, since they suggest the presence of groups of intercorrelated items.

Table 2.

Descriptive analysis of the items in the studied countries

Region - Country	Ítems	Pattern of response				Polycorrelation matrix			
		C1	C2	C3	C4	PHQ1	PHQ2	PHQ3	PHQ4
Paraguay (*n* = 918)	PHQ1	40.3%	34.6%	15.1%	9.9%	1			
	PHQ2	45.3%	30.9%	14.5%	9.3%	.84	1		
	PHQ3	47.5%	27.2%	14.6%	10.7%	.74	.74	1	
	PHQ4	49%	27.9%	13.8%	9.3%	.69	.70	.88	1
El Salvador (*n* = 741)	PHQ1	39.3%	31%	17.8%	11.9%	1			
	PHQ2	39.5%	35.4%	13.8%	11.3%	.84	1		
	PHQ3	42.9%	26.5%	16.7%	13.9%	.74	.75	1	
	PHQ4	42.6%	31.6%	14.4%	11.3%	.70	.73	.86	1
Chile (*n* = 555)	PHQ1	20.4%	36.9%	24.3%	18.4%	1			
	PHQ2	31.5%	34.4%	19.5%	14.6%	.87	1		
	PHQ3	32.4%	34.2%	18.2%	15.1%	.70	.70	1	
	PHQ4	28.5%	35.7%	19.5%	16.4%	.69	.64	.86	1
Ecuador (*n* = 477)	PHQ1	35%	35.4%	19.7%	9.9%	1			
	PHQ2	37.5%	36.1%	17.8%	8.6%	.86	1		
	PHQ3	32.3%	36.7%	19.9%	11.1%	.74	.76	1	
	PHQ4	36.5%	32.1%	20.8%	10.7%	.70	.73	.88	1
Colombia (*n* = 414)	PHQ1	37.2%	33.1%	19.8%	9.9%	1			
	PHQ2	41.5%	33.8%	13.5%	11.1%	.87	1		
	PHQ3	42.3%	27.3%	20%	10.4%	.68	.71	1	
	PHQ4	46.4%	27.5%	15.2%	10.9%	.67	.71	.88	1
Uruguay (*n* = 407)	PHQ1	37.6%	40%	14.3%	8.1%	1			
	PHQ2	47.4%	36.9%	10.1%	5.7%	.81	1		
	PHQ3	53.1%	29.5%	11.1%	6.4%	.68	.72	1	
	PHQ4	52.3%	29.7%	11.5%	6.4%	.60	.62	.82	1
Perú (*n* = 371)	PHQ1	34.2%	38%	19.9%	7.8%	1			
	PHQ2	42.6%	32.1%	15.9%	9.4%	.84	1		
	PHQ3	39.6%	34.5%	18.1%	7.8%	.72	.77	1	

Region - Country	Ítems	Pattern of response				Polycorrelation matrix			
		C1	C2	C3	C4	PHQ1	PHQ2	PHQ3	PHQ4
México (n = 343)	PHQ4	42%	32.9%	16.2%	8.9%	.66	.73	.84	1
	PHQ1	27.1%	39.9%	19.8%	13.1%	1			
	PHQ2	35.9%	35%	16.9%	12.2%	.85	1		
	PHQ3	34.4%	29.7%	22.4%	13.4%	.71	.70	1	
	PHQ4	37.3%	31.5%	17.2%	14%	.66	.65	.84	1
Cuba (n = 342)	PHQ1	46.8%	31.3%	9.6%	12.3%	1			
	PHQ2	47.4%	31.9%	10.2%	10.5%	.83	1		
	PHQ3	52%	27.8%	11.4%	8.8%	.65	.67	1	
	PHQ4	49.1%	29.8%	12.6%	8.5%	.58	.57	.76	1
Guatemala (n = 344)	PHQ1	35.8%	34.3%	18%	11.9%	1			
	PHQ2	45.1%	27%	19.2%	8.7%	.86	1		
	PHQ3	48%	28.8%	13.7%	9.6%	.75	.78	1	
	PHQ4	49.1%	30.2%	13.4%	7.3%	.72	.77	.88	1
Argentina (n = 316)	PHQ1	27.5%	45.9%	14.9%	11.7%	1			
	PHQ2	38.3%	38.6%	12.7%	10.4%	.86	1		
	PHQ3	38.3%	37.3%	13.3%	11.1%	.73	.70	1	
	PHQ4	39.2%	37.3%	12.7%	10.8%	.69	.64	.86	1
Bolivia (n = 264)	PHQ1	23.9%	40.5%	20.8%	14.8%	1			
	PHQ2	28.4%	43.6%	18.2%	9.8%	.85	1		
	PHQ3	29.2%	41.3%	15.2%	14.4%	.70	.79	1	
	PHQ4	34.1%	36%	16.7%	13.3%	.61	.69	.80	1

Note: C1 = None; C2 = Several days; C3 = More than half of the days; C4 = Almost every day.

Validity based on the internal structure and reliability of the scale

Table 3 shows that the original model with two related factors (model 1) demonstrates adequate adjustment indexes in all countries. In addition, it is observed that all the items present high factorial weights in the factor to which they belong. However, the relationship between both factors was found to be high (.77 - .87). In view of this, the performance of a unidimensional model (model 2) for the PHQ-4 scale was proposed. This model showed poor fit indices to the data in all countries. Therefore, model 1 proved to be the model that best explains the factorial structure of the scale and will therefore be used in the following psychometric analyses.

Table 3.

Fit indices of the different scale models in the countries of the Americas

Country	Adjustment index							Factorial weight (λ)				Φ	Reliability		
	χ^2	df	*p*	CFI	TLI	SRMR	RMSEA [90%CI]	An1	An2	De3	De4	F1~F2	F1 (α/ω)		F2 (α/ω)
Model 1															
Paraguay (*n* = 918)	.004	1	.950	1.00	1.00	.005	.000 [.000 – .003]	.91	.92	.97	.91	.84	.86	.86	.89 .89
El Salvador (*n* = 741)	.639	1	.424	1.00	1.00	.076	.000 [.000 – .090]	.90	.93	.95	.91	.87	.86	.86	.88 .88
Chile (*n* = 555)	4.56	1	.033	.99	.99	.007	.080 [.019 – .161]	.95	.92	.95	.91	.80	.88	.89	.88 .88
Ecuador (*n* = 477)	.059	1	.807	1.00	1.00	.001	.000 [.000 – .076]	.91	.95	.96	.92	.84	.87	.87	.89 .89
Colombia (*n* = 414)	.454	1	.501	1.00	1.00	.002	.000 [.000 – .113]	.91	.96	.94	.93	.80	.88	.88	.89 .89
Uruguay (*n* = 407)	.346	1	.557	1.00	1.00	.003	.000 [.000 – .110]	.88	.92	.97	.84	.80	.84	.84	.84 .85
Perú (*n* = 371)	2.29	1	.130	1.00	.99	.005	.059 [.000 – .164]	.88	.95	.95	.89	.86	.86	.87	.87 .86
México (*n* = 343)	.000	1	.993	1.00	1.00	.000	.000 [.000 – .000]	.93	.92	.95	.88	.80	.87	.87	.87 .87
Cuba (*n* = 342)	1.39	1	.237	1.00	.99	.005	.034 [.000 – .153]	.91	.91	.94	.82	.77	.86	.85	.80 .81
Guatemala (*n* = 344)	1.02	1	.312	1.00	1.00	.003	.008 [.000 – .143]	.90	.95	.95	.93	.87	.88	.88	.89 .89
Argentina (*n* = 316)	.559	1	.455	1.00	1.00	.004	.000 [.000 – .134]	.95	.90	.96	.89	.81	.89	.87	.88 .87
Bolivia (*n* = 264)	.017	1	.897	1.00	1.00	.001	.000 [.000 – .074]	.87	.98	.96	.84	.84	.87	.87	.84 .84
Model 2															
Paraguay (*n* = 918)	163.35	2	.000	.99	.96	.060	.297 [.259 – .336]	.88	.88	.93	.90	–	.89		.95
El Salvador (*n* = 741)	119.37	2	.000	.99	.96	.051	.282 [.240 – .326]	.88	.89	.91	.89	–	.90		.94
Chile (*n* = 555)	106.38	2	.000	.99	.95	.079	.307 [.259 – .358]	.91	.90	.89	.89	–	.89		.96
Ecuador (*n* = 477)	109.28	2	.000	.99	.96	.057	.336 [.284 – .391]	.88	.89	.93	.91	–	.90		.95
Colombia (*n* = 414)	99.69	2	.000	.98	.95	.083	.344 [.288 – .403]	.89	.92	.90	.92	–	.89		.98
Uruguay (*n* = 407)	64.35	2	.000	.98	.93	.067	.277 [.221 – .337]	.84	.88	.91	.83	–	.88		.92
Perú (*n* = 371)	73.16	2	.000	.99	.96	.051	.310 [.252 – .373]	.87	.91	.90	.88	–	.89		.93
México (*n* = 343)	79.26	2	.000	.98	.94	.070	.336 [.275 – .401]	.89	.88	.89	.87	–	.88		.94
Cuba (*n* = 342)	73.29	2	.000	.97	.90	.073	.323 [.262 – .389]	.88	.88	.85	.78	–	.85		.91
Guatemala (*n* = 344)	52.39	2	.000	.99	.97	.049	.271 [.211 – .337]	.88	.92	.92	.92	–	.91		.95
Argentina (*n* = 316)	65.74	2	.000	.98	.95	.073	.318 [.255 – .386]	.92	.88	.90	.88	–	.89		.95
Bolivia (*n* = 264)	47.31	2	.000	.99	.96	.057	.293 [.225 – .369]	.87	.93	.89	.83	–	.89		.93

Note. [a] = Negative Error Variances/variances are negative; χ2 = Chi square; df = degrees of freedom; SRMR: Standardized Root Mean Square Residual; TLI = Tucker-Lewis Index; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation; BIC = Sample-size adjusted Bayesian; Model 1 = Two-dimensional model; Model 2 = Unidimensional model; Φ = Relationship between dimensions; An = Anxiety dimension; De = Depression dimension

In the present study the Anxiety (ω = .84– .89) and Depression (ω = .81– .89) dimensions evidenced adequate internal consistency indices across countries (see Table 3). In addition, possible differences in the level of reliability between the countries were studied. The results showed no significant differences in the level of reliability in the Anxiety dimension between countries (χ2(11) = 7.38; p = .767). However, significant differences were evident in the level of reliability of the Depression dimension between the countries (χ2(11) = 25.49; p = .008).

Factor invariance by country

Table 4 shows that the factor structure of the scale has shown evidence of being strictly invariant for all countries in the sequence of invariance models proposed: metric invariance (ΔCFI = .000; ΔRMSEA = .005), scalar invariance (ΔCFI = -.001; ΔRMSEA = .010) and strict invariance (ΔCFI = -.002; ΔRMSEA = .014).

Table 5.
Factor invariance models of the PHQ-4 scale across countries

Invariance models	χ^2	p	TLI	CFI	SRMR	RMSEA [90%CI]	$\Delta\chi^2$	Δdf	p	ΔCFI	ΔRMSEA
Configural	93.29	.001	.999	.999	.003	.038 [90%CI .024 – .052]	–	–	–	–	–
Metric	119.36	.002	.999	.999	.004	.034 [90%CI .021 – .046]	23.63	22	.367	.000	-.004
Scalar	190.09	.000	.999	.999	.005	.044 [90%CI .035 – .054]	34.72	22	.041	-.001	.010
Strict	366.09	.000	.998	.997	.014	.058 [90%CI .051 – .066]	79.03	44	.001	-.002	.014

Validity based on the relationship with other variables

Taking into account the literature review, an SEM model was proposed to evaluate the relationship between the PHQ-4 scale and well-being. It was evidenced that the structural model presents adequate fit indices (χ2(24) = 960.02; p < .001; RMSEA=.084 [CI90% .080 - .089]; SRMR = .026; CFI=.99; TLI=.99) and the measurement models are adequately represented by their items. Figure 1 shows that the depression dimension significantly predicts the degree of well-being (-.66; *p* = .000). However, the anxiety dimension fails to significantly predict the level of well-being of the participants (-.01; *p* = . .838).
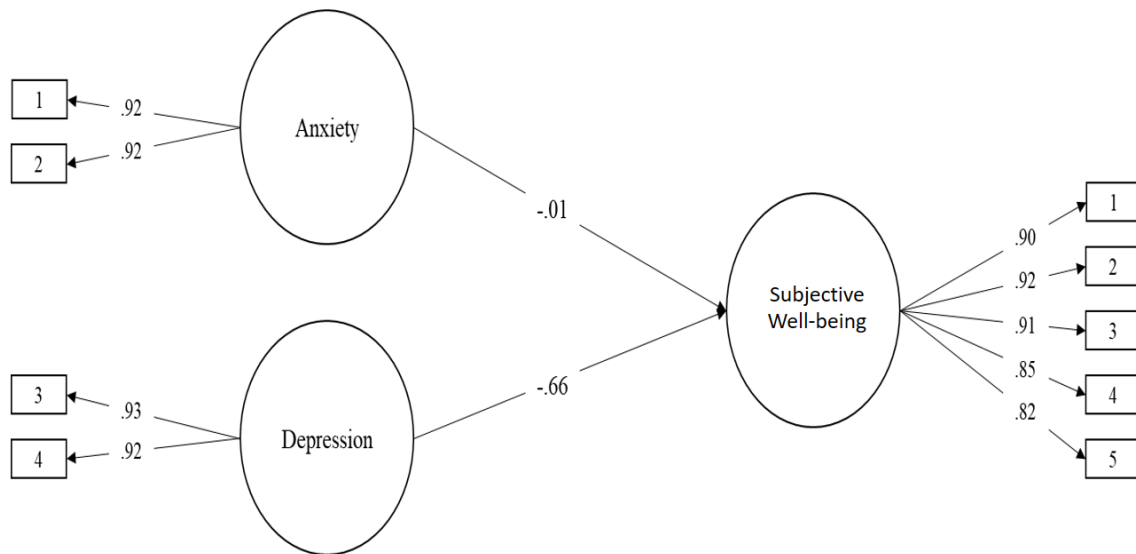
Figure 1. Predictive model of the PHQ-4 scale on the level of life satisfaction.

Discussion

According to the available literature, this is the first study to evaluate the internal structure, reliability and MI of the PHQ-4 as a screening measure of anxiety and depression symptoms in a large group of Latin American countries. Overall, the PHQ-4 demonstrated good psychometric properties in all countries; while, IM tests indicated that the factor structure and factor loadings of the PHQ-4 items were similar in all participating countries.

First, the results indicated that the PHQ-4 fits the proposed theoretical structure, since the two-factor structure presented a superior fit to the one-factor structure. This provides evidence that supports a two-dimensional model of anxious and depressive symptomatology. This finding is in agreement with previous studies reported in different cultural contexts (Ahmadi et al., 2019; Christodoulaki et al., 2022; Ghaheri et al., 2020; Kazlauskas et al., 2023; Khubchandani et al., 2016; Kim et al., 2021; Kocalevent et al., 2014; Larionow & Mudło-Głagolska, 2023; Lenz & Li, 2022; López Guerra et al., 2022; Löwe et al., 2010; Mendoza et al., 2022; Mills et al., 2015; Renovanz et al., 2019). Although the AFC indicated that the PHQ-4 has two dimensions (anxiety and depression), this finding needs further investigation, taking into account previous evidence also indicating the presence of a single factor. Regarding reliability, this was optimal as evidenced

by the values of the McDonald's ω coefficients for the anxiety and depression dimensions. This is similar to that reported by other previous psychometric studies (Ahmadi et al., 2019; Christodoulaki et al., 2022; Ghaheri et al., 2020; Kazlauskas et al., 2023; Khubchandani et al., 2016; Kim et al., 2021; Kocalevent et al., 2014; Larionow & Mudło-Głagolska, 2023; Lenz & Li, 2022; López Guerra et al., 2022; Löwe et al., 2010; Mendoza et al., 2022; Mills et al., 2015; Renovanz et al., 2019). All this shows that the items measure both dimensions with a higher degree of accuracy.

The results of the tests of configural, metric, scalar, and strict invariance by country show that the PHQ-4 is invariant among the participating countries. Specifically, configural invariance is supported, indicating that the two-factor structure of the PHQ-4 is the same in all 12 countries. It seems that people in the 12 Latin American countries conceptualize anxiety and depression in a similar way, reflected by two factors. Likewise, the metric invariance test showed that the factor loadings were equal in all groups, which allowed us to compare the regression coefficients and covariance between different countries. In this sense, the associations between the PHQ-4 and other variables can be compared between individuals in the countries evaluated, since the change of one unit in one group is equivalent to the change in one unit in the other. Similarly, the results of the scalar invariance test show that the intersections were similar across countries, which would indicate that participants from all countries shared the same metrics and the same scale origin. Accordingly, they have the same score on the latent factors and the observed variables. This would suggest that the means of the factors can be compared between countries, as measured with the PHQ-4, and valid inferences can be made about the possible differences found (Milfont & Fischer, 2010). Finally, there was evidence of strict invariance, which indicates that the error variances are the same in all countries; therefore, the latent variables are measured with similar degrees of error between groups (van de Schoot et al., 2012). It is worth mentioning that with scalar invariance it is already possible to make comparisons between countries, however, in this study strict invariance was achieved, which ensures that the conclusions are more accurate and consistent.

The IM findings would indicate that participants in each of the countries attribute the same meaning to the latent constructs, anxiety and depression, and their scores can be compared. This is important, although the different ways in which the culture and idiosyncratic characteristics of each country can impact how people experience psychological symptoms. It has been suggested that this may be explained by the fact that the PHQ-4 items were originally selected on the basis

that they represented global symptoms of anxiety and depression that are present in different cultural contexts (Kroenke et al., 2009). Consequently, it is expected to find more similarities between the core psychological experiences, as expressed in the PHQ-4 items, than between disparate psychological experiences (Lenz & Li, 2022).

Additionally, the findings provide quantitative support for the hypothesis that the presence of depressive symptoms significantly predicts subjective well-being. However, the presence of anxiety symptoms fails to significantly predict participants' well-being. This difference has been observed before, where the association between depression and well-being holds over anxiety symptoms (Leising et al., 2013). Individuals who reported a higher frequency of depressive symptoms showed significant decreases in subjective well-being scores. It has been suggested that this finding may be explained by a shared variance in negative affect (Krieger et al., 2014). That depression, and not anxiety, significantly predicts well-being suggests that assessing depressive symptoms may have more practical utility for the assessment and development of well-being. In addition, it would allow preventive measures to be taken before the onset of depressive symptoms and help reduce healthcare costs (Fledderus et al., 2012; Grant et al., 2013; Keyes, 2007). These results provide partial support for the hypothesis of the predictive ability of depressive and anxiety symptoms on well-being.

Strengths and limitations

This study was the first to evaluate the MI of the PHQ-4 in Latin American countries and presented important strengths. First, the findings contributed to increasing the scope and application of the PHQ-4 in the Latin American context. This is important given recent evidence that the questionnaire is theoretically aligned with the measurement of symptoms of depression and anxiety (Stanhope, 2016). In addition, the study used a relatively large sample size from Latin American countries. Finally, a solid statistical analysis was performed, which took into account the ordinal nature of the PHQ-4 items.

However, the study is not free of limitations that should be considered when interpreting the results. First, the study included mostly participants from South American countries (8 of the 12 participating countries). Future studies should evaluate the MI of the PHQ-4 in even more diverse countries in the region and in other languages (such as Portuguese spoken in Brazil or Jamaican English). Second, the samples included in the study were selected by non-probability convenience sampling, which meant that the samples were not representative at the national level in each country. This limited the generalizability of the findings of the sample to the population.

Future studies should use samples obtained through probability sampling techniques to support the generalizability of the PHQ-4. Third, the samples varied in total sample size and sociodemographic characteristics (e.g., the proportion of women was higher than that of men in all countries). These differences in sociodemographic variables between country samples could further reduce the generalizability of our findings. However, previous studies established MI of the PHQ-4 between different age groups, genders, or others (Ahmadi et al., 2019; Christodoulaki et al., 2022; Ghaheri et al., 2020; Kazlauskas et al., 2023; Khubchandani et al., 2016; Kim et al., 2021; Kocalevent et al., 2014; Larionow & Mudło-Głagolska, 2023; Lenz & Li, 2022; López Guerra et al., 2022; Löwe et al., 2010; Mendoza et al., 2022; Mills et al., 2015; Renovanz et al., 2019). This would indicate that the possible confounding effects of these sociodemographic discrepancies were probably insignificant. Even so, it is recommended that future cross-national studies with the PHQ-4 employ more balanced samples with respect to sociodemographic variables in the participating countries. Fourth, an online survey was used to collect the necessary information for the study, which has the advantage of being an inexpensive and fast method, but could generate a self-selection effect of the participants, where only those who have access to the Internet could answer the questionnaire.

Fifth, suggested cut-off points for assessing IM may vary among different studies, according to different characteristics such as the type of variable or the number of participants. Although the recommendations of Chen (2007) were followed in this study, there are other more stringent criteria, such as considering a ΔCFI of 0.002 (Meade et al., 2008), or using alternative methods, such as dropping the ΔCFI to assess IM (Kang et al., 2016), which could generate different results than those reported in this study. Sixth, the use of self-report measures to assess symptoms of anxiety, depression, and subjective well-being could have generated the presence of social desirability biases in the participants. Seventh, the placement of the PHQ-4 and WHO-5 items in the online questionnaire could have been a potential limitation, because the items referring to negative emotional experiences were placed first and then the well-being items. Future studies could compare multiple versions of the online questionnaire with different item presentation orders to assess possible order effects on measurement (Rasinski et al., 2012).

Eighth, the optimal cut-off score to identify the possible presence of severe anxiety and depression was not determined. However, it should be kept in mind that the study was focused at the population level and not at the individual level, i.e., the objective was to determine the internal structure, reliability and MI of the PHQ-4 across countries. Having cut-off scores is

important to identify the number of cases with possible severe levels of anxiety and depression in a specific population, but these should be determined after having clear evidence of their internal structure, i.e., the number of dimensions assessed by the PHQ-4. In addition, the determination of optimal cut-off points requires the administration of a clinical interview, i.e., a standard measure for mental disorders. This would not be possible in population-based studies with a large sample size, as is the case in the present study. Finally, as mentioned, this study focused on the factor structure of the PHQ-4 and the MI; however, including other measures of anxiety and depression would have provided more information on the sensitivity or specificity of the PHQ-4.

Implications

The study provided evidence to consider that participants from the 12 Latin American countries perceived and interpreted the meaning of the PHQ-4 items in a similar way. Having evidence of cross-national MI of PHQ-4 scores opens new opportunities for its use in Latin America and allows for meaningful interpretations of cross-cultural comparisons of anxiety and depression symptoms between different Latin American countries and correlations with external variables. In this way, the differences in the scores of the PHQ-4 dimensions between countries are real differences and do not reflect some artificial effect associated with variations in the interpretations of the items by the participants. Furthermore, the metric invariance results give confidence to use the PHQ-4 in large epidemiological studies and to quickly determine the relationship between symptoms of anxiety, depression and other mental health indicators such as well-being within predictive models and mediation analyses. It can also be used as an early detection tool to identify groups at higher risk of experiencing high levels of anxiety and depression. This is important considering the comorbidities and long-term outcomes related to mental health symptoms in Latin America (Merchán-Hamann et al., 2012; Manrique-Millones et al., 2021; Whiteford & Baxter, 2013). The PHQ-4 can serve health professionals in different Latin American countries as a brief measure to monitor progress and assess general symptoms of depression and anxiety, as well as to evaluate whether or not an intervention has had an effect in reducing levels of anxiety and depression. Finally, the wide use of the PHQ-4 in Latin American countries may favor the development of public repositories of mental health data in this region. This is important since it is necessary to have current and regional data describing mental health disparities and needs. In addition, having this systematization of information would allow public health officials and health professionals to identify opportunities to develop initiatives that promote the wellbeing and development of Latin Americans.

Conclussion

As mentioned above, this study represented a first attempt to evaluate the MI of the PHQ-4 cross-culturally in the Spanish language and in the Latin American context. Despite the limitations, it is concluded that the PHQ-4 provides a largely comparable measure of anxiety and depressive symptoms in a large sample of Latin American countries. This provides preliminary and promising evidence for the use of the PHQ-4 in a broader context of primary care practice and research activities.

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