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Trends

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Translation, cultural adaptation, and validation of the Brazilian Portuguese version of the Higher Education Stress Inventory (HESI-Br)

Short title: HESI-Br validation

João Pedro Gonçalves Pacheco[1,2], Mauricio Scopel Hoffmann[3,4,5], Luiza Elizabete Braun[6], Isabella Poletto Medeiros[7], Damaris Casarotto[8], Simone Hauck[4,9], Fabio Porru[10], Michael Herlo[8], Vitor Crestani Calegaro[3,8]

1. Graduate Program in Health Sciences, Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brazil.
2. Psychiatry Residency Program, Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brazil.
3. Department of Neuropsychiatry, Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brazil.
4. Graduate Program in Psychiatry and Behavioral Sciences, Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brazil.
5. Care Policy and Evaluation Centre, London School of Economics and Political Science, London, United Kingdom.
6. School of Medicine, Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brazil.
7. School of Psychology, Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brazil.
8. Coordenadoria de Ações Educacionais (CAEd), Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brazil.
9. Psychodynamic Psychiatry Research Laboratory, Hospital de Clínicas de Porto Alegre, Porto Alegre, RS, Brazil
10. Department of Public Health, Erasmus University Medical Center, Rotterdam, the Netherlands.

Correspondence: João Pedro Gonçalves Pacheco. Graduate Program in Health Sciences, Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brazil. Av. Roraima nº 1000, prédio 26, sala 1430, Cidade Universitária, Bairro Camobi, Santa Maria, RS, Brazil. CEP: 97105-900. Phone: +5555997238466. E-mail address: joaopgp123@gmail.com.

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Abstract

Objective

There are no validated instruments to measure education-related stress in Brazilian university students. Thus, we aimed to translate and test internal reliability, convergent/discriminant validity, and measurement equivalence of the Higher Education Stress Inventory (HESI).

Methods

The translation protocol was carried out by two independent translators. The instrument was culturally adapted after a pilot version that was administered to 36 university students. The final version (HESI-Br) was administered to 1021 university students (Mean age = 28.3, SD = 9.6, 76.7% female) via an online questionnaire that extended from September 1 to October 15, 2020. Factor structure was estimated using exploratory factor analysis (EFA) in the first half of the data set. We tested the best EFA-derived model with confirmatory factor analysis (CFA) in the second half. Convergent/discriminant validity was tested using the Depression, Anxiety and Stress Scale (DASS-21). Sex, age groups, period of study, family income and area of study were used to test measurement equivalence.

Results

EFA suggested five factors: career dissatisfaction; faculty shortcomings; high workload; financial concerns; and toxic learning environment. CFA supported the 5-factor model (15 items), but not a higher order factor, suggesting multidimensionality. All 5 factors presented acceptable internal reliabilities, with Cronbach's $\alpha \geq .72$ and McDonald's $\omega \geq .64$. CFA models indicate that HESI-Br and DASS-21 assess different but correlated underlying latent constructs, supporting discriminant validity. Equivalence was ascertained for all tested groups.

Conclusions

The 15-item HESI-Br is a reliable and invariant multidimensional instrument for assessing relevant stressors among university students in Brazil.

Keywords: Psychological Stress; University; Education; Psychometrics; Factor Analysis

Introduction

Psychological stress is high among university students globally, with estimates that may reach 99.2%.[1–5] While moderate level of psychological stress may increase individuals' resilience,[6] the exposure to high level of stress is associated with mental health problems (e.g., insomnia, depression, anxiety, and burnout)[5,7–9] and worse academic outcomes (e.g., lower GPA, higher dropout).[10–12] Moreover, multiple factors are associated with psychological stress among students, including academic overload,[5,13] uncertainty and insecurity about the future,[13] low income,[2] lack of self-esteem and motivation.[5] However, there are still few scales validated for screening students under high levels of psychological stress related to the higher education setting.

The Higher Education Stress Inventory (HESI)[7] was developed in 2005 aiming to provide a reliable tool to measure stress in higher education level students.[7] Originally inspired by the Perceived Medical School Stress (PMSS),[14] the scale aims to measure the presence of psychological stress in settings other than medical schools. In that sense, it was constructed to capture many of the stressors that students are exposed to in higher education, such as the ones mentioned above (e.g., academic overload, etc.). The HESI has previously been used to assess stress levels among Swedish[7] and Korean[8] medical students, Jordanian nursing students,[15] Ugandan university students[16] and physicians in their first postgraduate year.[17] Currently, the scale is validated for Arabic [15] and Korean populations [8]. Total HESI score has been associated with depressive symptoms [7,8], which have an estimated pooled prevalence that vary from 24.4% to 42.6% among university students [18–21].

In Brazil, the rate of university enrollment increased by 283.4% over the past 20 years. With more than 8.6 million people [22,23] in the higher educational setting, there is a need to assess stress among Brazilian university students. Additionally, students living in low- and middle-income countries, such as Brazil, are affected from additional socioeconomic factors, such as lower income and higher discrimination.[24] These factors ultimately might impact in higher stress in university students.[2,3,25]

To our knowledge, no instrument focusing on measuring academic stress among university students has been validated for the Brazilian population. Thus, our research aimed to 1) translating the HESI scale into Brazilian Portuguese, 2) performing its cultural adaptation, 3) testing its structure and internal reliability, 4) testing its convergent/discriminant validity and 5) testing its measurement equivalence among different group characteristics in a large sample of university students from Brazil.

Methods

Recruitment and data collection

The development of the Brazilian Portuguese version of the HESI (HESI-Br) is part of the COVIDPsiq study, consisting in a longitudinal survey on mental health in the context of the COVID-19 pandemic. Full details can be found elsewhere.[26] Briefly, COVIDPsiq aimed to follow-up post-traumatic, depressive and anxiety symptoms during the COVID-19 pandemic in Brazilians. The survey was performed from April 2020 to February 2021 in 4 waves of assessment, using a non-probabilistic convenience sample. The dissemination of the research was carried out through social media platforms, corporative mailing list, digital and press media. Data were collected using the SurveyMonkey online platform. The choice of an electronic survey was based on the possibility to reach more participants while respecting social isolation restrictions in Brazil. The research was approved by the Human Research Ethics Committee of Federal University of Santa Maria (CAAE: 30420620.5.0000.5346).

Participants

The criteria for participation in the research for the validation of the scale were: (a) being a native Brazilian or residing in Brazilian territory; (b) be over 18 years of age; (c) have access to digital equipment; (d) be literate; (e) be a university student (at any level, e.g., undergraduate, graduate, postgraduate). All individuals participated voluntarily and provided online informed consent. In total, the survey period covered approximately eleven months. The questionnaire for each phase remained available for one month on average. The third phase, in which the HESI-Br was applied, extended from September 1 to October 15, 2020. A total of 2303 respondents participated in the third phase of the larger longitudinal study. Of these, 1021 were university students and answered the questions related to HESI-Br. The sociodemographic data of the sample are displayed in Table 1.

Table 1. University students' sociodemographic characteristics

Students' characteristics	Sample (n = 1,021)
Age, mean (SD), y	28.3 (9.6)
Missing, n	3
Gender	
Male, n (%)	235 (23.0)
Female, n (%)	783 (76.7)

Missing, n (%)	4 (0.3)
Family income	
Low (BRL 0 to 2,004), n (%)	223 (21.8)
Middle (BRL 2,005 to 8,640), n (%)	502 (49.2)
High (BRL 8,641+), n (%)	292 (28.6)
Study level	
Bachelor, n (%)	619 (60.6)
Residency, specialization, n (%)	132 (12.9)
Masters, doctorate or post-doc positions, n (%)	267 (26.2)
Missing, n (%)	3 (0.3)
Area of study	
Technology and exact sciences, n (%)	250 (24.5)
Health-related sciences, n (%)	379 (37.1)
Social sciences, education and arts, n (%)	380 (37.2)
Missing, n (%)	12 (1.2)
DASS-21 scores	
Depression subscale, mean (SD)	13.7 (11.3)
Anxiety subscale, mean (SD)	10.0 (9.7)
Stress subscale, mean (SD)	17.2 (10.7)

Note: DASS-21: Depression, Anxiety and Stress Scale. BRL: Brazilian Real (Currency Unit).

Measures

Depression, Anxiety and Stress Scale (DASS-21)

Based on the tripartite model of depression and anxiety, the DASS-21 is a short version from the DASS-42, both developed by Lovibond & Lovibond (1995)[27]. It is an instrument that measures the symptomatology of three domains (depression, anxiety, and stress). It has 21 items using a four-point Likert scale (0 = 'strongly disagree'; 3 = 'strongly agree'). The DASS-21 was translated into Brazilian Portuguese and validated in patients from two hospitals in Southern Brazil.[28] A recent study[29] examined the psychometric properties of the DASS-21 in eight countries, including Brazil, suggesting that the DASS-21 is best represented with a general distress factor. A second-order model had acceptable fit according to Zanon et al.,[29] and was used to test HESI-Br convergent/discriminant validity.

Higher education stress inventory (HESI) - Original version

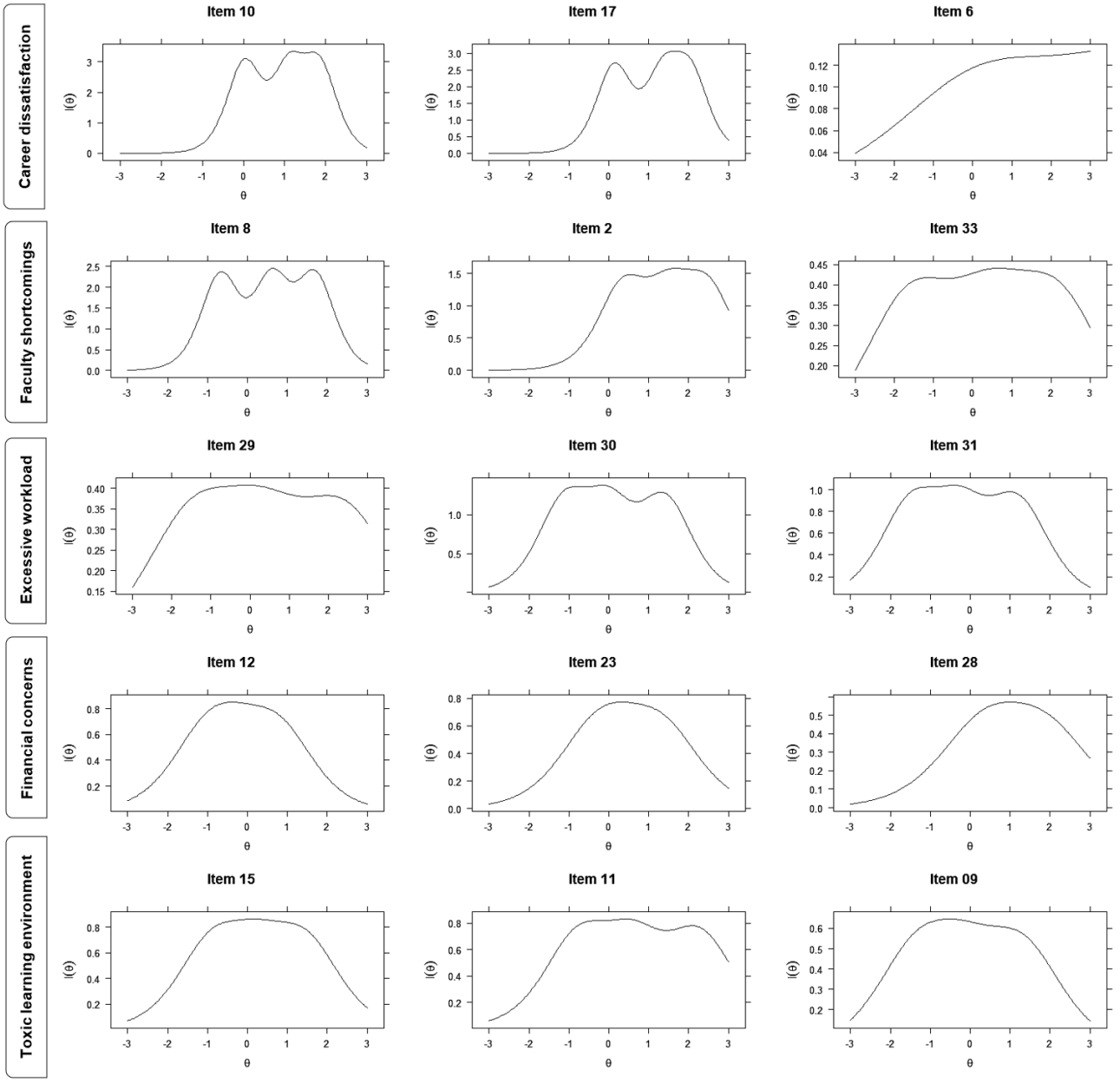
Originally inspired by the PMSS,[14] the HESI aims to assess the presence of educational stress in university students.[7] It is a 33-item self-report instrument that uses a four-point Likert scale, ranging from 1 (does not apply at all) to 4 (applies perfectly). Ten items are reversed because they indicate the absence of stress. Therefore, higher scores indicate higher educational stress levels.

The original HESI factor analysis identified a model of 24 items with seven factors. The factors also presented low to acceptable α values and were identified as: (I) Worries about future competence (α = 0.78), (II) Non-supportive climate (α = 0.71), (III) Faculty shortcomings (α = 0.69), (IV) Workload (α = 0.62), (V) Insufficient feedback (α = 0.65), (VI) Lack of commitment (α = 0.62), (VII) Financial concerns (α = 0.59).[7]

Translation and cross-cultural adaptation

Translation and cross-cultural adaptation were conducted in eight steps, according to the ISPOR Guidelines [30] and the permission from the original author. Permission to publish the final instrument in its entirety was also obtained from the original author. The translation from English to Brazilian Portuguese was made by two independent Brazilian professionals, both specialized in psychiatry and fluent in English. Initially, the original HESI was translated into Portuguese by (1) the first and second translator. (2) After a comparative work between the translations, they reached a consensus version. (3) This version was sent to a third psychiatrist, with extensive knowledge in English, who evaluated and improved the translated version. Next, (4) the HESI-Br was back-translated into English by a professional translator and compared to the original version by the translators in step 1. Therefore, (5) the Brazilian version was adapted according to the differences found in the back-translation. Then, (6) cross-cultural adaptation was made using a pilot version of the scale, to which 36 students responded via Google Forms and could comment on any difficulties they had with specific items. Subsequently, a video conference was held with nine undergrad students who are part of the COVIDPsiq project, for further information on how to improve the understandability (cognitive interview). A final culturally adapted version, the HESI-Br (available in the online-only supplementary material), was applied to university students who participated in the third phase of the large longitudinal study. A flowchart of the process is available in Supplementary Figure 1.

Figure 1. Item information curves for the HESI-Br.



Legend: I(θ), item information, in which the apex of the curve corresponds to the difficulty parameter (β); (θ), standardized latent construct.

Statistical analyses

First, ten positive-oriented items of the translated version of the HESI scale (Q2, Q6, Q8, Q10, Q13, Q17, Q19, Q26, Q27 and Q33) were reverse-coded. The frequency of response per item is provided in Supplementary Table 1. Second, the EFA and CFA were performed in randomly split halves of the data set. Item response theory (IRT) analyses were performed on the CFA sample.

Analyses of measurement equivalence and convergent/discriminant validity with DASS-21 were conducted on the whole data set. The flowchart of data analysis plan is provided in Supplementary Figure 2.

Exploratory factor analysis (EFA)

For the EFA, we used the first half of the data set (n = 511). The Kaiser–Meyer–Olkin (KMO) statistic verified the sampling adequacy for the analysis, and the result was evaluated according to Kaiser (1974).[31] A limit of .5 KMO values was considered acceptable for individual items. Bartlett's test of sphericity [32] was used to evaluate if correlations between items were sufficiently large for factor analysis. A parallel analysis was conducted using weighted least squares as factoring method (scree plot is depicted in Supplementary Figure 3).

EFA was conducted on a polychoric matrix of the 33 items with oblimin rotation. The best structure was selected based on the following criteria: (a) items with fewer cross-loadings, (b) items with factor loadings >.3 and (c) factors with at least 3 items per factor. The best model was further filtered to keep the number of items per factor equal across the factors, based on the items with the highest factor loadings.

Confirmatory factor analysis (CFA)

The CFA was conducted on the second half of the data set (n = 510). It was carried out using delta parameterization and weighted least squares with diagonal weight matrix with standard errors and mean- and variance-adjusted chi-square test statistics (WLSMV) estimators. Global model fit was evaluated with root mean square error of approximation (RMSEA), comparative fit index (CFI), Tucker–Lewis index (TLI) and standardized root mean-square residual (SRMR) indices. Values of RMSEA lower than 0.060 and CFI or TLI values higher than 0.950 indicate a good-to-excellent model.[33] SRMR lower or equal than 0.100 indicate adequate fit, and lower than 0.060 in combination with previous indices indicate good fit [33]. Using the EFA-derived model, we tested if a correlated or a second-order version of the model better represents the HESI factor structure. A $\chi 2$ test was performed to test the difference between models. Factor reliability was examined using Cronbach's α [34] and McDonald's ω.[35]

Multidimensional item response theory analysis

Item information (IIC) and characteristic curves (ICC) were generated using Graded Response Model for polytomous analysis and quasi-Monte Carlo expectation maximization

(QMCEM) as estimation algorithm. These curves are based on the 2-parameter IRT model, which are the parameter α (item discrimination) and β (item difficulty).

Parameter α represents the rate at which the probability of answering a response category changes, given the construct level. It is the slope of the item characteristic curve, which is constant for all categories of the same item. Item discrimination helps to differentiate individuals with similar levels of the latent construct because it marks where, in the latent construct, the probability of answering items increases. Parameter β indicate the 50% probability of endorsing a given category or higher in the latent construct (i.e., thresholds τ) in each HESI-Br item (e.g., from “Totally disagree” to “Somewhat disagree”). Therefore, it informs the construct level that is necessary to change from one category to another. Parameter β is calculated by τ/λ, in which λ is the standardized factor loading of a given item.

IIC is calculated by multiplying the probability of answering a response category multiplied by the probability of not answering it, which is represented in the y-axis. The apex of the information curve is where the parameter β is located (x-axis). Item information curves represent the capability of each HESI-Br item to inform on the latent construct of academic stress and can discriminate those items that are more important to capture the information. ICC depicts the parameter α in the slopes of each response category curve, the probability of endorsing a given category (y-axis) and the parameter β (x-axis). IIC and ICC are relevant because, as an example, items may inform little on the lower end of the distribution of a given construct and, therefore, might work better to discriminate individuals at the upper end of the construct distribution rather than the lower end (i.e., can discriminate people with higher levels of stress rather than lower).

Measurement equivalence

Measurement equivalence testing allows us to understand if the mean score differences of a given test/questionnaire across different groups are due to true differences in the mean levels of the latent construct. In other words, it provides information on whether score differences are sole given by changes in the latent construct and not by exogenous sources of variation.

ME was carried out for groups of sex, age (18 to 25 years; 26 to 39 years; 40+ years), study level (bachelor; residency or specialization; masters, PhD or post-doc), family income (BRL 0 to 2,004; BRL 2,005 to 8,640; BRL 8,641+) and area of study (exact sciences or technology; health sciences; social sciences, education or arts). It was tested using the whole data set. Missing data was handled with pairwise deletion, since for this part of the analysis some sociodemographic

variables had missing values (missing n for gender = 4, for study level = 3, for area of study = 12, for age = 3).

It was tested by using multigroup confirmatory factor analysis (MG-CFA) using the Wu and Estabrook approach (2016)[36]. It consists of applying a sequence of constraints and global model fit indices are compared between each constrained model. The first step is to establish configural equivalence by constraining the model factor structure to be the same across groups. The second step is to establish threshold equivalence by further constraining item thresholds to be the same across groups. The third step is to establish metric equivalence by further constraining item factor loadings to be the same across groups (i.e., an increase of one unit on the scale has the same meaning across the compared groups). The fourth step is to constrain latent intercepts to be equal to establish scalar equivalence (i.e., respondents from different groups with the same value on the latent factor would have the same score on the observed indicators). Reaching scalar equivalence means that questionnaire's scores are comparable between groups. Thus, we tested if the HESI-Br models in each group are structurally similar (configural equivalence), if items are informing symptoms at equivalent level (threshold equivalence), if they are equally correlated with the latent factors (metric equivalence) and latent means are equivalent (scalar equivalence). $\Delta CFI < 0.01$ and $\Delta RMSEA < 0.015$ or $\Delta SRMR < 0.010$ between nested models with increasing levels of constraints indicate equivalence.[37–39]

Convergent/discriminant validity

CFA models, including the HESI-Br and DASS (second order model), were used to test whether the two scales assess the same underlying latent construct (convergent) or if they inform on two correlated, but separate constructs (discriminant validity). We fitted a second-order model, where the HESI-Br (5 factors) and DASS-21 (3 factors) loaded in higher-order factor (i.e., testing convergence by modelling the correlation between HESI-Br and DASS-21 as originating from the same source/latent factor) and a two-correlated factor model in which DASS-21 was modelled as a second-order model ('internalizing symptoms') and HESI-Br factors were allowed to correlate with DASS-21 higher-order factor (i.e., testing discriminant validity by modelling HESI-Br and DASS-21 as independent constructs, while allowing them to correlate). Fit indices (RMSEA, CFI, TLI and SRMR) were compared between models. A $\chi 2$ test was performed to test the difference between models.

Measurement equivalence was carried using the measEq.syntax function in the lavaan package in R.[40] CFA and convergent/discriminant validity analysis were carried out using the

"lavaan" package in R.[40] Item response theory analysis was carried out using the "mirt" package in R.[41] R version 4.1.0 was used for all analyses (The R Foundation for Statistical Computing 2021).

Results

Exploratory factor analysis

Bartlett test p-value was = 0, indicating that correlations between items were sufficiently large. The KMO value was =.85, indicating the sample size was good. All KMO values for individual items were also acceptable (>.72). Parallel analysis suggested eight factors. Table 2 shows the factor loadings after rotation. Five factors had at least three items with factor loadings >.3 without any cross-loadings. Thus, we retained 15 items and five factors for the CFA. After examining item content of each factor and inspired by the original instrument, we named factor 1 as career dissatisfaction, factor 2 as faculty shortcomings, factor 3 as excessive workload, factor 4 as financial concerns and factor 6 as a toxic learning environment.

Table 2. HESI-Br 8-factor EFA results (n = 511)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
Proportion explained	0.16	0.16	0.17	0.13	0.10	0.12	0.09	0.07
Q17	0.84	.	.	.	.	.	.	.
Q10	0.73	.	.	.	.	.	.	.
Q26	0.42	0.32	.	.	.	.	.	.
Q6	0.36	.	.	.	.	.	.	.
Q19	0.34	.	.	.	.	.	.	.
Q1	.	.	.	.	.	.	.	.
Q22	.	.	.	.	.	.	.	.
Q8	.	0.80	.	.	.	.	.	.
Q33	.	0.60	.	.	.	.	.	.
Q2	.	0.51	.	.	.	.	.	.
Q27	.	0.43	.	.	.	.	.	.
Q13	.	.	.	.	.	.	.	.
Q31	.	.	0.68	.	.	.	.	.
Q30	.	.	0.55	.	.	.	.	.
Q29	.	.	0.50	.	.	.	.	.
Q32	.	.	0.43	.	.	.	.	.
Q16	.	.	0.38	.	.	.	.	.
Q25	.	.	.	.	.	.	.	.
Q21	.	.	.	.	.	.	.	.
Q12	.	.	.	0.74	.	.	.	.
Q23	.	.	.	0.61	.	.	.	.
Q28	.	.	.	0.57	.	.	.	.
Q20	.	.	.	.	0.61	.	.	.
Q14	.	.	.	.	0.55	.	.	.

Q9	.	.	.	.	.	0.52	.	.
Q11	.	.	.	.	.	0.52	.	.
Q15	.	.	.	.	.	0.39	.	.
Q7	0.37	.	.	.	.	0.37	.	.
Q18	.	.	.	.	.	.	.	.
Q4	.	.	.	.	.	.	0.67	.
Q5	.	0.34	.	.	.	.	0.39	.
Q3	.	.	.	.	.	.	.	.
Q24	.	.	.	.	.	.	.	0.89
Correlations	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
Factor 1	1.00							
Factor 2	0.32	1.00						
Factor 3	0.15	0.36	1.00					
Factor 4	0.14	0.15	0.42	1.00				
Factor 5	0.09	-0.01	0.22	0.24	1.00			
Factor 6	0.24	0.31	0.44	0.34	0.12	1.00		
Factor 7	0.13	0.25	0.27	0.20	0.15	0.21	1.00	
Factor 8	0.08	0.11	0.22	0.31	0.05	0.22	0.08	1.00

Note: Factor loadings <0.3 are not shown. EFA: Exploratory factor analysis. HESI-Br: Brazilian Portuguese version of the Higher Education Stress Inventory

Confirmatory factor analysis

The analysis confirmed the HESI-Br structure with five factors and 15 items (RMSEA = 0.056, 90% CI = 0.047 – 0.066; CFI = 0.97; TLI = 0.967; SRMR = 0.064). The second-order "Educational Stress" model presented worse fit indices (RMSEA = 0.069, 90% CI = 0.060 – 0.077; CFI = 0.960; TLI = 0.950; SRMR = 0.077) in comparison (p-value < 0.001) with the 5-correlated factor model, suggesting multidimensionality. All five factors presented acceptable internal reliabilities, with Cronbach's α ≥.72 and McDonald's ω ≥.64. CFA results are depicted in Table 3. The analysis of covariance suggests low to moderate correlation between factors (coefficients range 0.13 to 0.66).

Table 3. HESI-Br 5-factor model CFA results, item difficulty and item discrimination parameters (n = 510)

Factor	Item	Factor loadings (λ)	Item difficulty (parameter β, in z-score)			Item discrimination (Parameter α)
			Totally disagree (1) → Somewhat disagree (2)	Somewhat disagree (2) → Somewhat agree (3)	Somewhat agree (3) → Totally agree (4)	
"Career dissatisfaction" (α = 0.73; ω = 0.75)	10. Not satisfied with choice of career	0.864	0.030	1.118	1.831	3.486
	17. Not proud of profession	0.852	0.142	1.384	2.013	3.271
	6. Personal development not stimulated through studies	0.565	0.339	3.577	5.902	0.672
"Faculty shortcomings" (α = 0.77; ω = 0.74)	8. Lack of encouragement from teachers	0.849	-0.675	0.620	1.692	3.052
	2. Lack of respectful treatment from teachers	0.839	0.385	1.521	2.444	2.349
	33. Lack of feedback from teachers	0.523	-1.558	0.431	2.135	1.235
"Excessive workload" (α = 0.74; ω = 0.70)	29. Too much student-controlled group-activities, resulting in unclear curriculum	0.753	-1.405	0.293	2.396	1.184
	30. Literature too difficult and extensive	0.709	-1.092	-0.019	1.399	2.221
	31. Pace of studies too high	0.664	-1.455	-0.266	1.172	1.918
"Financial concerns" (α = 0.71; ω = 0.64)	12. Worries over financing during education	0.796	-0.953	-0.346	0.730	1.665
	23. Worries about housing	0.666	-0.283	0.272	1.303	1.584
	28. Worries over future economy (debts from studies)	0.552	0.319	0.815	1.857	1.361
"Toxic learning environment" (α = 0.73; ω = 0.68)	15. No acceptance towards weakness and personal shortcomings	0.768	-0.847	0.252	1.420	1.703
	11. Cold and impersonal attitudes enhanced by education	0.693	-0.734	0.602	2.259	1.716
	9. Competitive attitudes among students	0.601	-1.284	-0.209	1.262	1.465

Note: CFA, Confirmatory factor analysis; α, Cronbach's α; ω, McDonald's ω; HESI-Br, Brazilian Portuguese version of the Higher Education Stress Inventory.

Item response theory analysis

IIC demonstrates that the 'career dissatisfaction' factor predominantly captures the information of those subjects in the higher end of the stress spectrum (Fig. 1). Similarly, most items in the 'faculty shortcomings', 'excessive workload', 'financial concerns' and 'toxic learning environment' factors capture the information of those subjects in the whole spectrum (i.e., -2 to 2 SD of the latent construct), which indicate that they might be good for screening educational-related stress. Table 3 describe item difficulty and discrimination for all HESI-Br items. As an example, a person with +0.602 SD of the "toxic learning environment" academic stress construct, presents a probability of 50% to answer "Somewhat disagree" to "Somewhat agree" in the "Cold and impersonal attitudes enhanced by education" item. These proprieties are demonstrated in the ICC curves, which reveals that most response categories in HESI-Br items are informative for increasing levels of stress (Supplementary Figure 4).

Measurement equivalence

Measurement equivalence analysis resulted in ΔCFI < 0.01 and ΔRMSEA < 0.015 or ΔSRMR < 0.010 between nested models with increasing levels of constraints. Results are provided in Table 4. It suggests that HESI-Br is equivalent across sex, age groups, study level, family income and area of study and, therefore, mean education-related stress levels between these groups can be compared.

Table 4. HESI-Br measurement equivalence testing

Sample in each group (n)	Constrain	RMSEA	CFI	SRMR	Model comparison	Δ RMSEA	Δ CFI	Δ SRMR	Decision
Sex: Male = 235 Female = 783	Configural	0.051	0.980	0.060					
	Threshold	0.049	0.981	0.060	Configural	0.002	0.001	0.000	Invariant
	Metric	0.048	0.980	0.061	Threshold	0.001	0.001	0.001	Invariant
	Scalar	0.048	0.979	0.061	Metric	0.000	0.001	0.000	Invariant
Age groups: 18y - 25y = 532 26y- 39y = 360 40+y = 126	Configural	0.044	0.985	0.062					
	Threshold	0.040	0.986	0.062	Configural	0.004	0.001	0.000	Invariant
	Metric	0.039	0.986	0.063	Threshold	0.001	0.000	0.001	Invariant
	Scalar	0.040	0.984	0.063	Metric	0.001	0.002	0.000	Invariant
Study level: Bachelor = 619	Configural	0.047	0.983	0.064					
	Threshold	0.043	0.984	0.064	Configural	0.004	0.001	0.000	Invariant

Residency, specialization = 132 Masters, PhD, post-doc = 267	Metric	0.042	0.984	0.065	Threshold	0.001	0.000	0.001	Invariant
	Scalar	0.047	0.978	0.066	Metric	0.005	0.006	0.001	Invariant
Family income: Low = 223 Middle = 502 High = 292	Configural	0.047	0.983	0.065					
	Threshold	0.043	0.985	0.065	Configural	0.004	0.002	0.000	Invariant
	Metric	0.042	0.984	0.066	Threshold	0.001	0.001	0.001	Invariant
	Scalar	0.040	0.984	0.066	Metric	0.002	0.000	0.000	Invariant
Area of study: Exact, tech = 250 Health = 379 Social, education, arts = 380	Configural	0.050	0.982	0.066					
	Threshold	0.047	0.982	0.066	Configural	0.003	0.000	0.000	Invariant
	Metric	0.047	0.980	0.067	Threshold	0.000	0.002	0.001	Invariant
	Scalar	0.047	0.979	0.067	Metric	0.000	0.001	0.000	Invariant

Note: Decision is based on ΔCFI < 0.01 and ΔRMSEA < 0.015 or ΔSRMR < 0.010, which indicate model equivalence. χ2, Chi square test; df, degree of freedom; RMSEA, Root Mean Square Error of Approximation; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; SRMR, Standardized Root Mean-square Residual; Δ, differences between fit indices. y = years, HESI-Br, Brazilian Portuguese version of the Higher Education Stress Inventory

Convergent/discriminant validity analysis with DASS

HESI-Br shows discriminant validity in relation with DASS-21. The second-order factor model presented significantly poorer fit indices (RMSEA = 0.069, 90% CI = 0.067 – 0.071; CFI = 0.983; TLI = 0.982; SRMR = 0.074) in comparison with the model on which DASS-21 and HESI-Br were modelled as two different, but correlated constructs (RMSEA = 0.040, 90% CI = 0.037 – 0.042; CFI = 0.994; TLI = 0.994; SRMR = 0.047). Covariances between HESI-Br factors and the general DASS-21 ‘distress’ factor were low to moderate (coefficients range: 0.19 – 0.42) and are shown in Supplementary Table 2.

Discussion

The present study aimed to translate and adapt the HESI to Brazilian Portuguese and evaluate its structure, internal reliability, convergent/discriminant validity, and measurement equivalence. The results indicate that a model with five-correlated factors (career dissatisfaction, toxic environment, faculty shortcomings, excessive workload, and financial concerns) within 15 items is the most suitable structure of the HESI-Br. The five factors presented low to acceptable reliability indices. Highest indices were revealed for ‘career dissatisfaction’, ‘faculty shortcomings’ and ‘excessive workload’, meaning that for those factors sum scores tend to point to the same cohesive construct.

Compared to the seven-factor model with 24 items from the original HESI,[7] the psychometric analysis of the HESI-Br identified a structure with fewer factors and items. However, the identified factors were similar to five of the seven factors described in the original scale (namely, financial concerns, workload, faculty shortcomings, low commitment, and non-supportive climate). The HESI has already been adapted for the Korean and Arabic languages, being validated in medical and nursing students, respectively. Regarding psychometric properties, the K-HESI (Korean version) found a 22-item seven-factor model.[8] On the other hand, the Arabic-HESI study resulted in a 16-item two-factor model.[15] It is important to highlight those differences might have emerged due to methodological factors. For example, items with cross-loadings were eliminated for Korean HESI and HESI-Br, but not for Arabic HESI. Beyond this hypothesis, the instrument may have different structures between these countries because HESI may be non-equivalent, given that educational systems and cultural aspects could be significantly different. Thus, future studies should determine the cross-cultural invariance of HESI.

The IRT analysis showed that, overall, the instrument captures information about stress on students in the mean levels of the latent academic stressors. However, some items are better to discriminate those with high levels of stress and do not work to detect those with mild levels of academic stress, such as item 10, 17, 6, 2 and 28. This indicate that while the “Career dissatisfaction” construct (composed by items 10, 17 and 6) suits for detection of academic stress in those with high levels of academic-related stress, the other four constructs are better to be used for screening purposes.

Furthermore, HESI-Br may be useful to compare mean levels of stress among students with different characteristics. Hence, to our knowledge, this is the first study to ascertain measurement equivalence for multiple sample characteristics for the HESI. HESI-Br showed measurement equivalence in all tested levels (sex, age, education level, area of study and family income) and, therefore, comparisons among these groups are likely to measure true psychological stress mean differences. It should be noted, however, that as other versions of the HESI have found different structures, the scale is potentially non-equivalent across countries, as mentioned above.

In the present study, DASS-21 scores correlated higher to the ‘financial concerns’ factor than to other HESI-Br factors. Indeed, prevalent economic problems, lack of investment in education, and great inequalities between public and private universities may influence educational stress among students in Brazil. This effect has been captured in a previous meta-analysis, showing that lower family income was associated with higher stress in Brazilian medical students.[5] Beyond correlation, we analyzed if both DASS-21 and HESI-Br scales measured the same latent construct (a general distress factor), but the model fit was inferior to the model in which DASS-21 and HESI-Br are estimated as correlated but structurally different constructs. This suggests academic stress has

different characteristics from the distress symptoms that are measured in DASS-21. This is somewhat expected, as the HESI is intended to measure issues related to stress reported in interviews with students [7] but does not capture symptoms of specific disorders.

Some of the HESI-Br factors presented higher correlation with DASS score than others. As seen in Supplementary Table 2, toxic learning environment and high workload were more correlated with higher general distress than career dissatisfaction and faculty shortcomings. In the original HESI, however, the 'low commitment' factor, which is similar to the HESI-Br 'career dissatisfaction' factor, showed the highest odds ratio for depressive symptoms measured by the Major Depression Inventory (MDI). Although depression as measured by the MDI in the original HESI study might not translate perfectly when comparing to DASS scores, depressive symptoms are components of the DASS-21,[7] so it is reasonable to assume some comparability. This comparison highlights potential non-equivalence in student stress between culturally and socioeconomically different countries such as Brazil and Sweden. In Brazil, stress in higher education might be affected by low aspirations tied to an uncertain prospect regarding one's career, which can influence in the way that a given student understands items regarding that construct and, therefore, endorse items in a different way. In other words, in high-income countries, lower expectations about one's career might be more indicative of general distress, whereas in low and middle-income countries, these expectations might already be low, so a high perception of workload and the perception of a toxic learning environment might be more useful to identify students under significant levels of general distress.

Strengths and limitations

This study has a few strengths: (a) a large sample (1021 students), (b) with students from diverse levels in higher education (undergraduate, graduate, postgraduate) and (c) fields of study. HESI-Br was invariant on several aspects and can be used in various student populations.

This study has at least four important limitations. First, it was a non-probabilistic sample, selected for convenience from an internet-based survey. However, most of the participants were female, self-declared white, and had high or middle income, which partially reflects the characteristics of the university student's population. Second, it is noteworthy that the last phase of validation was developed within a broad research project, structured with the objective of monitoring the mental health of the Brazilian population during the current pandemic. During the Covid-19 pandemic in Brazil, the educational stress among students tends to be even greater, due to education-related stressors, such as distance learning and uncertainties regarding the quality of academic education [42] as well as stressful external events to the student environment, such as

financial losses and social isolation.[43] Future studies should investigate the psychometric properties of the scale when stressors related to the COVID-19 pandemic are not present. Third, the present study does not allow to examine why the structure was different from the other versions. Fourth, the 'financial concerns' factor is limited in terms of reliability, but still composes the best structure for scale.

Conclusion

The HESI-Br scale contains 15 items within 5 factors, namely career dissatisfaction, faculty shortcomings, high workload, financial concerns, and toxic learning environment. The results suggest measurement equivalence by sex, age, educational levels, fields of study and family income, which indicates comparability of HESI-Br between groups with different sociodemographic characteristics. Furthermore, IRT analysis suggests the instrument is a potential tool for screening Brazilian university students and can also discriminate those with moderate-to-high levels of stress. Further investigations of the HESI-Br should investigate whether it is comparable in different countries and cultures, with different educational systems. Nonetheless, HESI-Br is a valid tool for screening and assessment of relevant stressors related to the higher education in Brazil.

References

1. Lai AY, Lee L, Wang MP, Feng Y, Lai TT, Ho L, et al. Mental Health Impacts of the COVID-19 Pandemic on International University Students, Related Stressors, and Coping Strategies. Front Psychiatry. 2020;11:584240.

2. Moutinho ILD, Lucchetti ALG, Ezequiel OS, Lucchetti G. Mental health and quality of life of Brazilian medical students: Incidence, prevalence, and associated factors within two years of follow-up. Psychiatry Res. 2019;274:306–12.

3. Dyrbye LN, Thomas MR, Eacker A, Harper W, Massie FS, Power DV, et al. Race, ethnicity, and medical student well-being in the United States. Arch. Intern. Med. 2007;167:2103–9.

4. Chaabane S, Chaabna K, Bhagat S, Abraham A, Doraiswamy S, Mamtani R, et al. Perceived stress, stressors, and coping strategies among nursing students in the Middle East and North Africa: an overview of systematic reviews. Syst Rev. 2021;10:136.

5. Pacheco JPG, Giacomin HT, Tam WW, Ribeiro TB, Arab C, Bezerra IM, et al. Mental health problems among medical students in Brazil: A systematic review and meta-analysis. Rev Bras Psiquiatr. 2017;39:369–78.

6. Crane MF, Searle BJ, Kangas M, Nwiran Y. How resilience is strengthened by exposure to stressors: the systematic self-reflection model of resilience strengthening. Anxiety, Stress Coping. 2018;32:1–17.

7. Dahlin M, Joneborg N, Runeson B. Stress and depression among medical students: A cross-sectional study. Med Educ. 2005;39:594–604.

8. Shim EJ, Jeon HJ, Kim H, Lee KM, Jung D, Noh HL, et al. Measuring stress in medical education: validation of the Korean version of the higher education stress inventory with medical students. BMC Med Educ. 2016;16:1–8.

9. Ribeiro ÍS, Pereira R, Freire IV, de Oliveira BG, Casotti CA, Boery EN. Stress and Quality of Life Among University Students: A Systematic Literature Review. Heal Prof Educ. 2018;4:70–7.

10. Kokou-Kpolou CK, Jumageldinov A, Park S, Nieuviarts N, Noorishad P-G, Cénat JM. Prevalence of Depressive Symptoms and Associated Psychosocial Risk Factors among French University Students: the Moderating and Mediating Effects of Resilience. Psychiatr Q. 2021;92:443–57.

11. Turner J, Bartlett D, Andiappan M, Cabot L. Students' perceived stress and perception of barriers to effective study: impact on academic performance in examinations. Br Dent J. 2015;219:453–8.

12. Halboub E, Alhajj MN, AlKhairat AM, Sahaqi A-AM, Quadri MFA. Perceived Stress among Undergraduate Dental Students in Relation to Gender, Clinical Training and Academic Performance. Acta Stomatol Croat. 2018;52:37–45.

13. Tempski P, Bellodi PL, Paro HBMS, Enns SC, Martins, Milton A Schraiber LB. What do medical students think about their quality of life? A qualitative study. BMC Med Educ. 2012;12:106.

14. Vitaliano PP, Russo J, Carr JE, Heerwagen JH. Medical school pressures and their relationship to anxiety. J Nerv Ment Dis. 1984;172:730–6.

15. Masha'al D, Hayajneh AA, Tawalbeh LI. Psychometric evaluation of the Arabic version of the higher education inventory scale for nursing students. BMC Psychiatry. 2021;21:1–13.

16. Kamulegeya LH, Kitonsa PJ, Okolimong E, Kaudha G, Maria S, Nakimuli-Mpungu E. Prevalence and associated factors of alcohol use patterns among university students in Uganda. Pan Afr Med J. 2020;37:339.

17. Dahlin M, Fjell J, Runeson B. Factors at medical school and work related to exhaustion among physicians in their first postgraduate year. Nord J Psychiatry. 2010;64:402–8.

18. Khan MN, Akhtar P, Ijaz S, Waqas A. Prevalence of Depressive Symptoms Among University Students in Pakistan: A Systematic Review and Meta-Analysis. Front. public Heal. 2020;8:603357.

19. Akhtar P, Ma L, Waqas A, Naveed S, Li Y, Rahman A, et al. Prevalence of depression among university students in low and middle income countries (LMICs): a systematic review and meta-analysis. J Affect Disord. 2020;274:911–9.

20. Gao L, Xie Y, Jia C, Wang W. Prevalence of depression among Chinese university students: a systematic review and meta-analysis. Sci Rep. 2020;10:15897

21. Tam W, Lo K, Pacheco J. Prevalence of depressive symptoms among medical students: overview of systematic reviews. Med Educ. 2019;53:345–54.

22. Barros A da SX. Expansion of higher education in Brazil: limits and possibilities. Educ e Soc. 2015;36:361–90.

23. Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (INEP). Censo da Educação Superior 2019 - Divulgação dos resultados [Internet]. 2020. Available from: https://download.inep.gov.br/educacao_superior/censo_superior/documentos/2020/Apresentacao_Censo_da_Educacao_Superior_2019.pdf

24. Bastos JL, Barros AJD, Celeste RK, Paradies Y, Faerstein E. Age, class and race discrimination: their interactions and associations with mental health among Brazilian university students. Cad Saude Publica. 2014;30:175–86.

25. Naser AY, Dahmash EZ, Al-Rousan R, Alwafi H, Alrawashdeh HM, Ghoul I, et al. Mental health status of the general population, healthcare professionals, and university students during 2019 coronavirus disease outbreak in Jordan: A cross-sectional study. Brain Behav. 2020;10:e01730.

26. Calegaro VC, Negretto BL, Weber LP, Kerber N, Zoratto G, Rodrigues L, et al. Monitoring the evolution of posttraumatic symptomatology, depression and anxiety during the COVID-19 pandemic in Brazilians (COVIDPsiq). Protoc Exch [Internet]. 2020; Available from: https://doi.org/10.21203/rs.3.pex-945/v2

27. Lovibond PF, Lovibond SH. The structure of negative emotional states: comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. Behav Res Ther. 1995;33:335–43.

28. Vignola RCB, Tucci AM. Adaptation and validation of the depression, anxiety and stress scale (DASS) to Brazilian Portuguese. J Affect Disord. 2014;155:104–9.

29. Zanon C, Brenner RE, Baptista MN, Vogel DL, Rubin M, Al-Darmaki FR, et al. Examining the Dimensionality, Reliability, and Invariance of the Depression, Anxiety, and Stress Scale–21 (DASS-21) Across Eight Countries. Assessment. 2020;28:1531-44.

30. Wild D, Grove A, Martin M, Eremenco S, McElroy S, Verjee-Lorenz A, et al. Principles of good practice for the translation and cultural adaptation process for patient-reported outcomes (PRO) measures: Report of the ISPOR Task Force for Translation and Cultural Adaptation. Value Heal. 2005;8:94–104.

31. Kaiser HF. An index of factorial simplicity. Psychometrika. 1974;39:31–6.

32. Bartlett MS. The effect of standardization on a Chi-square approximation in factor analysis. Biometrika. 1951;38:337–44.

33. Hu LT., Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct Equ Model. 1999;6:1–55.

34. Cronbach LJ. Coefficient alpha and the internal structure of tests. Psychometrika. 1951;16:297–334.

35. McDonald RP. Test Theory: A Unified Treatment. 1st ed. Mahwah, NJ: Lawrence Erlbaum; 1999.

36. Wu H, Estabrook R. Identification of Confirmatory Factor Analysis Models of Different Levels of Invariance for Ordered Categorical Outcomes. Psychometrika. 2016;81:1014–45.

37. Chen FF. Sensitivity of Goodness of Fit Indexes to Lack of Measurement Invariance. Struct Equ Model A Multidiscip J. 2007;14:464–504.

38. Meredith W. Measurement invariance, factor analysis and factorial invariance. Psychometrika.

1993;58:525–43.

39. Svetina D, Rutkowski L, Rutkowski D. Multiple-Group Invariance with Categorical Outcomes Using Updated Guidelines: An Illustration Using Mplus and the lavaan/semTools Packages. Struct Equ Model A Multidiscip J. 2020;27:111–30.

40. Rosseel Y. lavaan: An R Package for Structural Equation Modeling. J Stat Softw. 2011;48.

41. Chalmers RP. Mirt: A multidimensional item response theory package for the R environment. J Stat Softw. 2012;48.

42. Araújo FJ de O, de Lima LSA, Cidade PIM, Nobre CB, Neto MLR. Impact Of Sars-Cov-2 And Its Reverberation In Global Higher Education And Mental Health. Psychiatry Res. 2020;288:112977.

43. Wathelet M, Duhem S, Vaiva G, Baubet T, Habran E, Veerapa E, et al. Factors Associated with Mental Health Disorders among University Students in France Confined during the COVID-19 Pandemic. JAMA Netw Open. 2020;3:1–13.

Online-only supplementary material

Inventário de Estresse na Educação Superior (IEES)
Versão traduzida para o Português (Brasil)
Higher Education Stress Inventory (HESI)

Abaixo você encontrará diversas afirmações sobre sua relação e experiência pessoal com o ambiente acadêmico. Por favor, para cada uma delas, indique o seu grau de concordância.
Os termos 'estudo' e 'estudos' se referem a todas as suas atividades acadêmicas e carga de trabalho.

Inventário de Estresse na Educação Superior (IEES) – IEES – tabela de pontuação		Discordo totalmente	Discordo parcialmente	Concordo parcialmente	Concordo totalmente
1	Os estudos controlam a minha vida e tenho pouco tempo para outras atividades.	1	2	3	4
2	Eu sinto que meus professores me tratam com respeito.	4	3	2	1
3	Eu me preocupo de que não vou adquirir todos os conhecimentos necessários para minha futura profissão.	1	2	3	4
4	Os estudos criaram isolamento e desconhecimento entre os estudantes.	1	2	3	4
5	Os professores frequentemente falham em esclarecer o objetivo dos estudos.	1	2	3	4
6	Os estudos estimulam meu desenvolvimento pessoal.	4	3	2	1
7	O papel profissional apresentado em minha formação entra em conflito com minhas visões pessoais.	1	2	3	4
8	Os professores dão incentivo e atenção pessoal.	4	3	2	1
9	Existe uma atitude competitiva entre os estudantes.	1	2	3	4
10	Eu estou satisfeito(a) com a escolha da minha carreira.	4	3	2	1
11	Eu sinto que os estudos tiveram um papel na criação de uma atitude fria e impessoal entre os estudantes.	1	2	3	4
12	Como estudante, minha situação financeira é uma preocupação.	1	2	3	4
13	Meus colegas estudantes me dão apoio.	4	3	2	1
14	Eu me preocupo com longas jornadas de trabalho e com as responsabilidades da minha futura carreira.	1	2	3	4
15	Meu treinamento é caracterizado por uma atmosfera em que fraquezas e imperfeições pessoais não são aceitas.	1	2	3	4
16	Como estudante, é frequentemente esperado que eu participe de	1	2	3	4

	situações em que meu papel e função não são claros.				
17	Estou orgulhoso(a) de minha profissão futura.	4	3	2	1
18	Sinto que sou tratado(a) de forma pior por causa de meu gênero.	4	3	2	1
19	Eu posso exercer influência sobre o meu currículo (incluindo atividades optativas e extracurriculares).	1	2	3	4
20	O *insight* (percepção) que tenho tido da minha futura profissão tem me causado preocupação sobre uma carga de trabalho estressante.	1	2	3	4
21	Existe demasiado foco no aprendizado passivo dos fatos e muito pouco em busca ativa de conhecimento e tempo para reflexão.	1	2	3	4
22	Expectativas da minha família influenciaram demais a escolha de minha carreira.	1	2	3	4
23	Eu estou preocupado(a) com questões relacionadas a moradia (habitação, local para morar).	1	2	3	4
24	Eu sinto que sou tratado(a) de forma pior por causa da minha origem étnica.	1	2	3	4
25	Conheço vários futuros colegas que parecem abatidos ou insatisfeitos em sua profissão.	1	2	3	4
26	Eu sinto que minha formação está me preparando bem para minha futura profissão.	4	3	2	1
27	As atividades do centro/diretório acadêmico promovem um senso de comunidade e contribuem para um melhor ambiente de trabalho para os estudantes.	4	3	2	1
28	Estou preocupado(a) com minhas economias futuras e minha habilidade em pagar o financiamento estudantil.	1	2	3	4
29	A educação é altamente caracterizada por atividades em grupo. Consequentemente, os objetivos são pouco claros e responsabilidade demais é colocada no estudante.	1	2	3	4
30	A literatura é demasiadamente difícil e extensa.	1	2	3	4
31	O ritmo de estudos é acelerado demais.	1	2	3	4
32	A formação demanda que eu participe de situações que eu acho antiéticas.	1	2	3	4
33	Os professores frequentemente dão retorno sobre o conhecimento e habilidades dos estudantes.	4	3	2	1

Estudo original: Dahlin M, Joneborg N, Runeson B. Stress and depression among medical students: a cross-sectional study. Medical Education 2005;39(6):594-604.

Table S1. Response frequency (%) of HESI items (n = 1,021)

	Totally disagree	Somewhat disagree	Somewhat agree	Totally agree
Q1	0.21	0.23	0.40	0.16
Q2*	0.02	0.07	0.28	0.63
Q3	0.12	0.12	0.36	0.39
Q4	0.21	0.28	0.36	0.15
Q5	0.27	0.34	0.31	0.08
Q6*	0.02	0.06	0.34	0.57
Q7	0.51	0.27	0.18	0.04
Q8*	0.06	0.22	0.46	0.27
Q9	0.22	0.24	0.33	0.21
Q10*	0.04	0.10	0.34	0.53
Q11	0.31	0.34	0.29	0.06
Q12	0.25	0.17	0.29	0.29
Q13*	0.10	0.15	0.49	0.26
Q14	0.11	0.13	0.34	0.41
Q15	0.29	0.28	0.27	0.16
Q16	0.23	0.27	0.39	0.11
Q17*	0.03	0.07	0.33	0.57
Q18	0.53	0.20	0.19	0.08
Q19*	0.06	0.11	0.39	0.44
Q20	0.18	0.22	0.37	0.23
Q21	0.16	0.28	0.41	0.16
Q22	0.49	0.22	0.20	0.09
Q23	0.44	0.16	0.24	0.17
Q24	0.89	0.05	0.05	0.01
Q25	0.19	0.22	0.38	0.20
Q26*	0.05	0.19	0.52	0.23
Q27*	0.24	0.23	0.40	0.14
Q28	0.58	0.13	0.18	0.11
Q29	0.22	0.37	0.33	0.08
Q30	0.18	0.31	0.37	0.14
Q31	0.15	0.27	0.38	0.20
Q32	0.64	0.22	0.11	0.02
Q33*	0.12	0.28	0.42	0.18

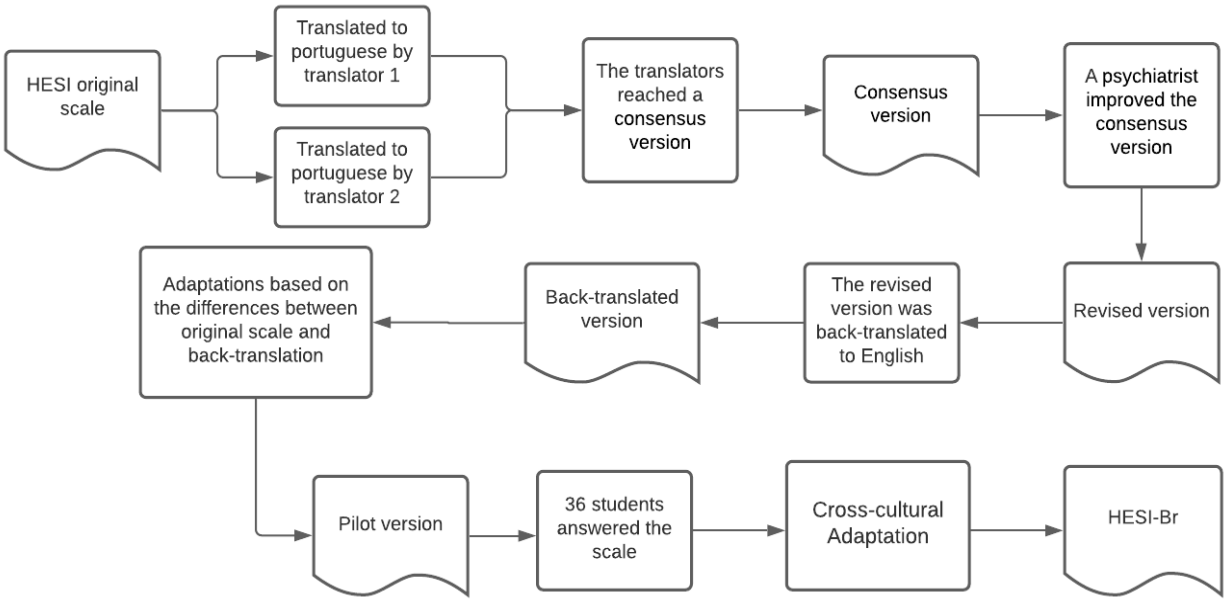
Note: *Reverse-coded. HESI, Higher Education Stress Inventory.

Table S2. Correlation of DASS-21 general distress factor and 5 HESI-Br factors

Factor	Career dissatisfaction	Faculty shortcomings	High workload	Financial concerns	Toxic learning environment
Career dissatisfaction	1.00				
Faculty shortcomings	0.461	1.00			
High workload	0.195	0.384	1.00		
Financial concerns	0.209	0.217	0.459	1.00	
Toxic learning environment	0.357	0.524	0.631	0.473	1.00
Distress	0.296	0.193	0.368	0.424	0.389

Note: DASS-21 general distress factor is the higher-order factor representing the correlation between depression, anxiety, and stress first-order factors. DASS-21, Depression, Anxiety and Stress Scale.

Figure S1. Translation and cross-cultural adaptation flowchart of the HESI-Br



Legend: A perfect rectangle represents a process. A rectangle with a curved side represents a document.

Figure S2. Data analysis flowchart

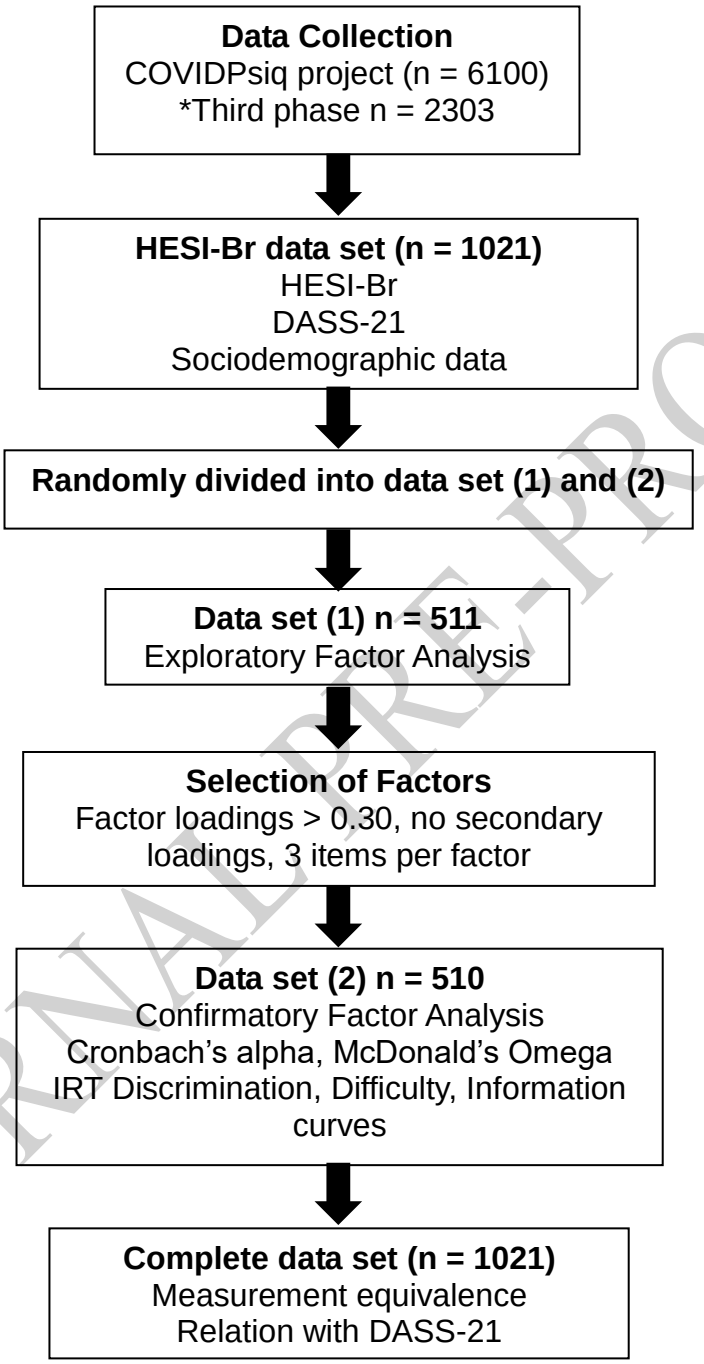


Figure S3. Scree plot of parallel analysis using weighted least squares for the HESI-Br

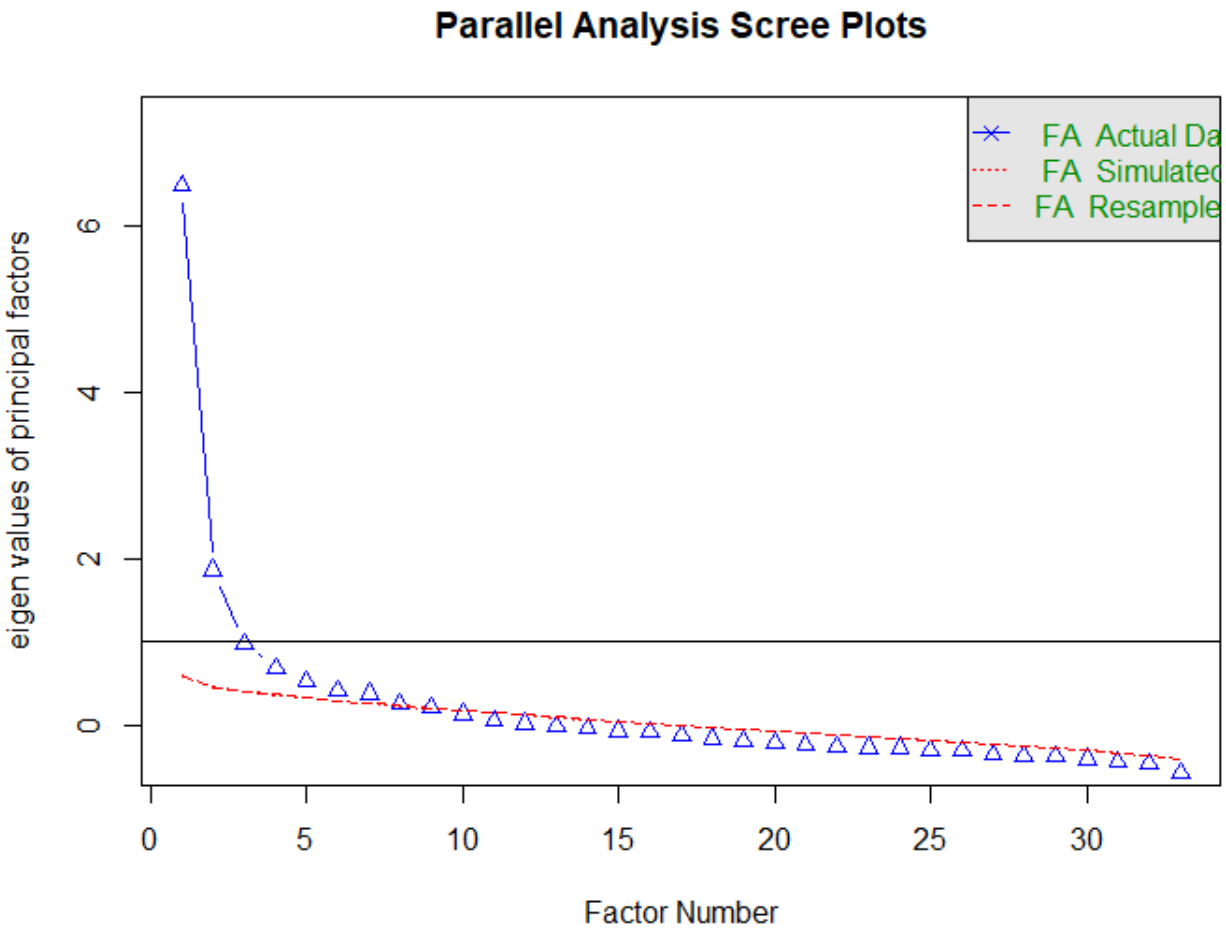
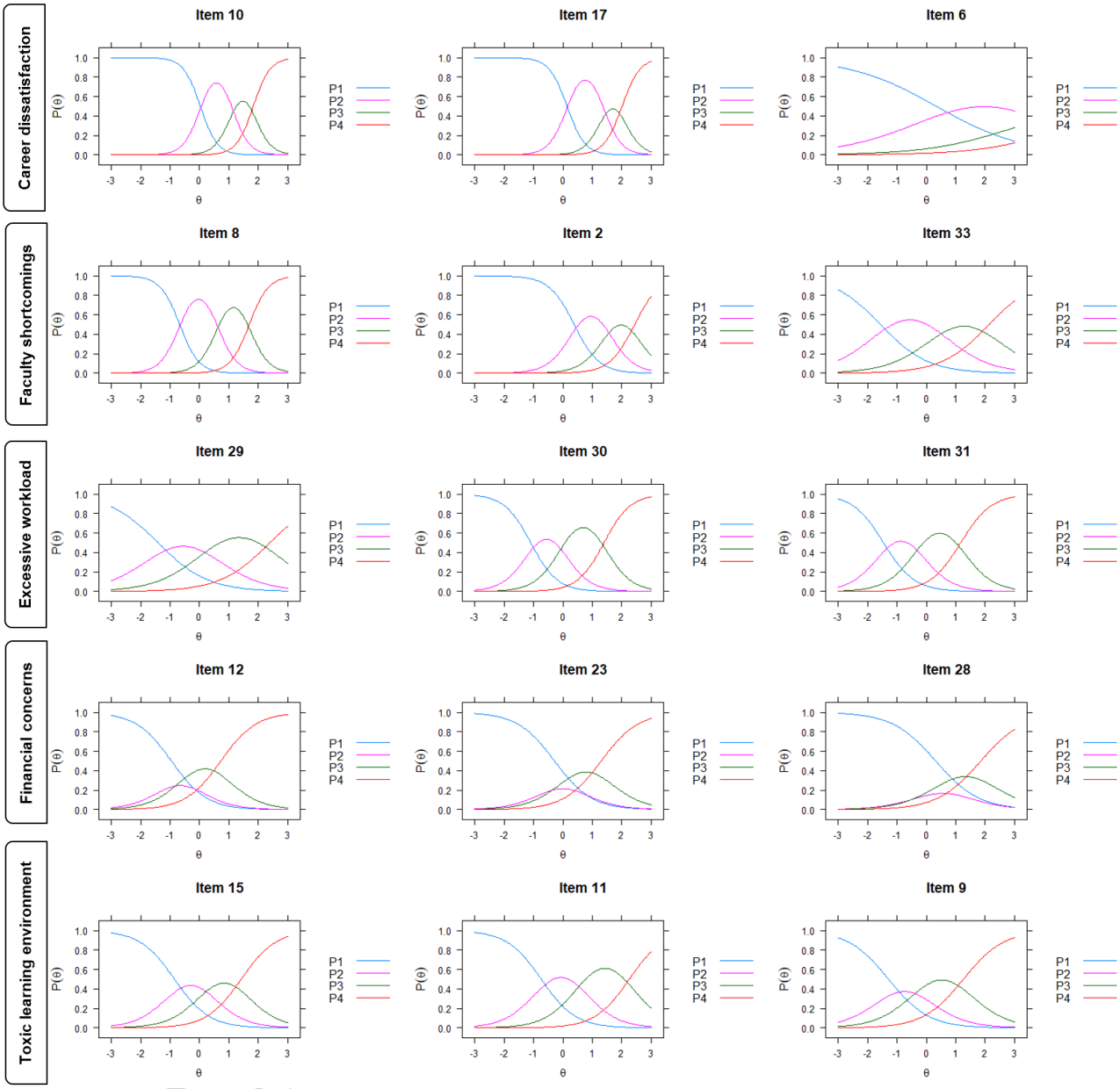


Figure S4. Item characteristic curves for the HESI-Br.



Legend: P(θ) corresponds to answer probability and θ corresponds to the standardized latent construct.