

BRIEF COMMUNICATION

Validity and reliability of the Brazilian version of the Cognitive Reserve Assessment Scale in Health

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Objective: As the older population increases, it is important to identify factors that may reduce the risks of dementia in the general population. One such factor is the concept of cognitive reserve (CR). The present study analyzed the psychometric properties of the Cognitive Reserve Assessment Scale in Health (CRASH) in the Brazilian population. This scale was originally developed to measure CR in individuals with severe mental illness. We also investigated the relationship between the CRASH and clinical or sociodemographic variables.

Methods: This study was conducted with 398 individuals. We assessed sociodemographic variables and depression, anxiety, and stress symptoms (Depression, Anxiety and Stress Scale [DASS-21]) using a web-based survey. We constructed a confirmatory factor analysis (CFA) model in order to test the goodness of fit of the factor structure proposed in the original CRASH study.

Results: The McDonald's hierarchical ω for CRASH using CFA parameters was 0.61, and the Cronbach's alpha coefficient indicated good internal consistency when considering all items ($\alpha = 0.7$).

Conclusions: Our results suggest that CRASH can be used to assess CR in the general population in Brazil.

Keywords: cognitive reserve; cognition; validation study

Introduction

Cognitive reserve (CR) is the ability of the adult brain to maintain cognitive functioning in individuals undergoing brain pathology.¹ Longitudinal studies show that individuals with higher levels of CR have a reduced risk of dementia,² suggesting that neurobiological mechanisms may be involved in the trajectory of cognitive decline. However, using the CR concept is problematic due to its hypothetical nature and the lack of appropriate instruments for direct measurement.³ Schooling level and premorbid intelligence quotient (IQ) are the most commonly used variables to define CR.⁴ However, aspects

such as professional performance and engagement in intellectual, cultural, and physical activities and interpersonal relationships are also crucial for CR.⁵ Although some studies have evaluated CR in Brazilian samples,^{6,7} most of them only used IQ, education, or heterogeneous methods to assess CR.

In this context, the Cognitive Reserve Assessment Scale in Health (CRASH), originally developed to measure CR in individuals with severe mental illness, showed very satisfactory psychometric properties in its original publication.⁸ Therefore, this study aims to present a linguistic adaptation to Brazilian Portuguese of the CRASH, as well as its psychometric properties.

Methods

Sample

We recruited participants via an anonymous online questionnaire applied from June to September 2021. The questionnaire was built in the Google Forms platform and was disclosed on social networks, generating a snowball sample. Participants were excluded for having incomplete responses or non-Brazilian nationalities. Electronic informed consent was obtained from all participants following the Declaration of Helsinki, and the local ethics committee approved the study protocol.

Assessments

Clinical and sociodemographic assessment

Clinical and sociodemographic variables were assessed using a standardized protocol that included age, gender, household income, self-ascribed race, occupation, and marital status. The self-report assessment scale Depression, Anxiety and Stress Scale (DASS-21)⁹ measured the severity of stress, anxiety, and depression.

Cognitive reserve assessment

The CRASH is a self-report instrument that measures CR through four domains (education, occupation, and intellectual and leisure activities). The maximum total score of 90 is obtained using a formula in which all domains have the same weighting in the final score. Each domain's score is obtained by adding up the scores of every item (see the Portuguese version in Figure 1). For all scores, the higher the score, the greater the CR. The administration time is 10 minutes.⁸ This version of the CRASH was translated into Portuguese from the original Spanish version. Its linguistic adaptation is shown in Figure S1, available as online-only supplementary material.

Statistical analyses

The internal consistency of the transculturally adapted and translated Portuguese version of the CRASH was analyzed using Cronbach's alpha, and a value equal to or higher than 0.6-0.7 indicated good reliability. A sample size of 334 subjects was calculated to estimate Cronbach's alpha coefficient with the desired amplitude for a confidence interval of 0.1 and 10% of possible losses and refusals. The calculation considered a 95% confidence level and an expected Cronbach's alpha of 0.7. This calculation was performed using the online version of the Power and Sample Size for Health (PSS) tool.¹⁰

We used R (version 4.3.0) for confirmatory factor analysis (CFA) through the lavaan and lavaanPlot packages. The McDonald's hierarchical ω for the full CRASH instrument (based on the CFA model) was calculated using the psych R package.¹¹ We also investigated criterion-related validity through correlations between clinical symptoms (DASS-21) and the CRASH score. SPSS version 18 was used to analyze descriptive statistics and correlations.

Results

Demographic characteristics

We included 398 individuals aged 18-74 years. Of the total respondents, 291 (72.9%) were female, 363 (91%) were employed, 201 (50.4%) were married, and 56 (14%) had physical health problems. Other sample characteristics are shown in Table 1.

Validity and reliability assessment

Cronbach's alpha coefficient was equal to 0.7, indicating good internal consistency when considering all items.

We constructed a CFA model to test the goodness of fit of the factor structure proposed in the original CRASH study,⁸ consisting of four factors: sociability, leisure, occupation, and education. We used weighted least squares, mean- and variance-adjusted (WLSMV), for estimation since it is a robust estimator for categorical and ordered data and does not assume normally distributed data as input.¹² Regarding fit measures, we reported the following: χ^2 statistic and its p-value, comparative fit index (CFI), Tucker Lewis index (TLI), root-mean-square error of approximation (RMSEA), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), and standardized root mean square residual (SRMR). The McDonald's hierarchical ω for CRASH using CFA parameters was 0.61 (Tables S1 and S2, Figures S2 and S3, available as online-only supplementary material). Furthermore, CRASH was significantly correlated with DASS-21 depression ($r_s = -0.164$, $p < 0.001$). Participants with normal/mild symptoms of depression had higher CRASH scores than participants with moderate/severe symptoms ($t_{[397]} = 2.56$, $p = 0.011$). No other correlations were found between clinical variables (anxiety or stress) and CRASH.

Discussion

The present study demonstrated that the CRASH self-report scale is a valid method to assess CR in the general population in Brazil. The instrument demonstrated satisfactory psychometric properties and a four-factor structure (sociability, leisure, occupation, and education), similarly to the original study.⁸ The CRASH total score was slightly higher in the Brazilian sample compared to the Spanish control group (59.64 ± 11.09 vs. 52.10 ± 9.40 ,⁸ respectively). However, this discrepancy might be due to demographic differences between both samples.

Although self-reports may be biased, an individual's assessment of his or her own CR via an instrument specifically designed to address this construct is nonetheless important in both clinical practice and a research context. Also, an online questionnaire may be more flexible and reduce costs and social desirability bias,¹³ contributing to the pace and ease of research production. Moreover, studies that assess the reliability and validity of digital instruments are needed to reduce the source of bias when online surveys are growing. Here, we present the Brazilian Portuguese version of the CRASH as a valid

CRASH

Escala de Avaliação de Reserva Cognitiva em Saúde

Cognitive Reserve Assessment Scale in Health

Nome: _____ Data avaliação: ____ / ____ / ____

EDUCAÇÃO

Escolaridade	Escolaridade dos pais (progenitor com maior nível educacional)	Rendimento escolar infância e adolescência	Idiomas (capaz de manter uma conversa)
0. Ensino Fundamental (Incompleto 1 ^o -5 ^o) 1. Ensino Fundamental (Incompleto 6 ^o -9 ^o) 2. Ensino médio (Segundo grau) 3. Curso técnico (Ensino médio) 4. Curso superior (Terceiro grau) 5. Pós-graduação	0. Não escolarizados 1. Básica (Ensino fundamental) 2. Secundária (Ensino Médio) 3. Superior	0. Fracasso escolar (<5) 1. Baixo rendimento (5 a 5,9) 2. Rendimento suficiente (6 a 6,9) 3. Bom rendimento (7 a 8,4) 4. Excelente (8,5 a 10)	0. Idioma materno 1. Dois idiomas 2. Três idiomas 3. Mais de três idiomas

TOTAL EDUCAÇÃO (de 0 a 15)=

OCUPAÇÃO

Formação (no último ano)	Trabalho (maior tempo)
0. Sem ocupação 1. Formação não escolar (aprendeu com os pais) 2. Formação escolar (curso) 3. Formação técnico/profissionalizante 4. Nível superior	0. Sem trabalho 1. Não qualificado (aprendeu com os pais) 2. Com qualificação (curso profissionalizante – sem necessidade ensino médio) 3. Com qualificação (curso técnico – com necessidade de ensino médio) 4. Profissional (curso superior)

TOTAL OCUPAÇÃO (de 0 a 8)=

ATIVIDADES INTELECTUAIS E DE LAZER

	Atividade física		Atividade artística		Jogos intelectuais		Atividades culturais		TOTAL
	V	F	V	F	V	F	V	F	
Infância/Adolescência									
Vida adulta									
Situação atual									

Variedade (V) 0= Nenhuma; 1= 1 atividade; 2= 2 atividades; 3= 3 atividades ou mais

Frequência (F). 0=<1vez/semana; 1=1vez/sem; 2=2vezes/sem; 3=3vezes o +/sem. Frequência (F). 0=Nunca ou raramente; 1=Ocasional; 2=Bastante; 3=Muito

Atividade social

0. Isolamento social, nem mesmo relações superficiais	Infância/Adolescência
2. Relações sociais ocasionais ou com familiares	
4. Relações íntimas com poucos/as amigos/as (≤2), amizades casuais	
6. Muitos/as amigos/as (>5), relação próxima com alguns	Situação atual

TOTAL ATIVIDADES INTELECTUAIS E DE LAZER (de 0 a 90)=

TOTAL CRASH=
(Educação x 6 + Ocupação x 11,25 + Lazer)/3

Figure 1 Portuguese version of the Cognitive Reserve Assessment Scale in Health (CRASH).

and reliable digital instrument to help researchers and clinicians measure CR in the general population.

We found a negative correlation between CRASH and DASS-21 depression scores. This finding indicates that the CRASH scale may be sensitive to depression severity, which is in line with previous studies that have shown that higher CR scores were associated with lower depression scores in adults.^{14,15} Other clinical variables, such as anxiety and stress symptoms, were not correlated with the overall CRASH score. However, our participants were recruited from the general population and presented lower anxiety levels than the Spanish participants. The mean anxiety score was considered mild in our sample, and only 34.3% of respondents reported moderate to severe anxiety symptoms, which may explain this finding.

Our study has some limitations. First, this was a cross-sectional study conducted through an online questionnaire, thus only people with internet access could participate; this may limit the generalization of our findings. Second, we did not include clinical groups as in the original scale.⁸ Third, we did not use another instrument or domain to analyze convergent validity. Fourth, all outcomes were self-reported rather than evaluated by a clinician.

In summary, our findings showed that the Portuguese version of CRASH is a valid instrument to assess CR in the Brazilian population, with good internal consistency. CRASH appears to be a valuable tool for evaluation because it focuses on education, occupation, leisure, and social activities, unlike other studies that only indirectly measure CR by evaluating IQ or years of education.

Table 1 Sociodemographic data and mental health symptoms (n=399)

Characteristic	
Age (years), mean (SD)	35.97 (12.4)
Household income (BRL)	
> 4,484	291 (72.9)
1,212-4,484	95 (23.8)
< 1,212	13 (3.3)
Gender	
Women	291 (72.9)
Men	103 (25.8)
Transgender men	1 (0.3)
Queer/non-binary	2 (0.5)
Others	1 (0.3)
Unanswered	1 (0.3)
Self-ascribed race	
White	367 (92.0)
Black	11 (2.7)
Mixed/unanswered	21 (5.3)
Occupation	
Employed	363 (91.0)
Unemployed	14 (3.5)
Retired	22 (5.5)
Education	
Less than higher education	109 (27.3)
Higher education	290 (72.7)
Marital status	
Married	201 (50.4)
Unmarried	198 (49.6)
Physical health problems [†]	56 (14.0)
Neurological/psychiatric disorder [†]	79 (19.8)
Inpatient psychiatric treatment	12 (3.0)
Moderate/severe depression symptoms	143 (35.8)
Moderate/severe anxiety symptoms	137 (34.3)
Moderate/severe stress symptoms	143 (35.8)
DASS scores, mean (SD)	
Depression	11.7 (11.3)
Anxiety	8.7 (10.1)
Stress	16.0 (11.0)
Total	36.48 (29.4)

Data presented as n (%), unless otherwise specified.

BRL = Brazilian reais; DASS = Depression, Anxiety and Stress Scale.

[†] Asthma (n = 8), hypertension (n = 7), and other health problems (n = 41).

[‡] Depression (n = 15), anxiety disorder (n = 15), epilepsy (n = 3), and others/two or more disorders (n = 46).

As CR is a crucial construct to consider in measuring cognitive profiles, it would be interesting to add this scale to cognitive assessments to implement specific therapeutic strategies and personalized interventions focusing on the general population.

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Disclosure

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References

- Stern Y, Barulli D. Cognitive reserve. *Handb Clin Neurol*. 2019;167:181-90.
- Almeida-Meza P, Steptoe A, Cadar D. Markers of cognitive reserve and dementia incidence in the English longitudinal study of ageing Br J Psychiatry. 2021;218:243-51.
- Jones RN, Manly J, Glymour MM, Rentz DM, Jefferson AL, Stern Y. Conceptual and measurement challenges in research on cognitive reserve. *J Int Neuropsychol Soc*. 2011;17:593-601.
- Brinch CN, Galloway TA. Schooling in adolescence raises IQ scores. *Proc Natl Acad Sci U S A*. 2012;109:425-30.
- Stern Y. What is cognitive reserve? Theory and research application of the reserve concept. *J Int Neuropsychol Soc*. 2002;8:448-60.
- Cotrena C, Branco LD, Ponsoni A, Shansis FM, Fonseca RP. Cognitive reserve may outperform age, mood and psychiatric comorbidities as a predictor of executive functioning in bipolar disorder and healthy adults. *J Clin Exp Neuropsychol*. 2021;43:611-22.
- Farina M, Polidoro Lima M, Machado WL, Moret-Tatay C, Fernandes Lopes RM, Argimon II, et al. Components of an indirect cognitive reserve: a longitudinal assessment of community-dwelling older adults. *Neuropsychol Dev Cogn B Aging Neuropsychol Cogn*. 2021;28:907-20.
- Amoretti S, Cabrera B, Torrent C, Bonnin CDM, Mezquida G, Garriga M, et al. Cognitive Reserve Assessment Scale in Health (CRASH): its validity and reliability. *J Clin Med*. 2019;288:586.
- Vignola RC, Tucci AM. Adaptation and validation of the depression, anxiety and stress scale (DASS) to Brazilian Portuguese. *J Affect Disord*. 2014;155:104-9.
- Borges RB, Mancuso ACB, Camey SA, Leotti VB, Hirkata VN, Azambuja GS, et al. Power and sample size for health researchers: uma ferramenta para cálculo de tamanho amostral e poder do teste voltado a pesquisadores da área da saúde. *Clin Biomed Res*. 2020;40:247-53.

- 11 Revelle W. Psych: procedures for psychological, psychometric, and personality research. R package version 2.3.3. Evanston: Northwestern University; 2023.
- 12 Brown T. Confirmatory factor analysis for applied research. New York: Guildford; 2006.
- 13 Ball HL. Conducting online surveys. *J Hum Lact.* 2019;35:413-7.
- 14 Cancino M, Rehbein-Felmer L, Ortiz MS. [Cognitive reserve, depression and social support. Analysis of 206 older adults]. *Rev Med Chil.* 2018;146:315-22.
- 15 Zijlmans JL, Lamballais S, Vernooij MW, Ikram MA, Luik AI. Socio-demographic, lifestyle, physical, and psychosocial determinants of cognitive reserve. *J Alzheimers Dis.* 2022;85:701-13.