Psychometric proprieties analyses of psychological vulnerability scale for secondary school students

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Background: The concept of psychological vulnerability is associated with the individual's maladaptive cognitive beliefs, such as self-criticism, perfectionism, and the need for external validation and approval, reducing the individual's ability to cope with negative life experiences. This study aimed to explore psychometric proprieties of the Psychological Vulnerability Scale in secondary school students.

Methods: A psychometric study was conducted with a non-probabilistic sample of 1,875 secondary school students (55.5% female) aged 15 to over 18 years. Participants completed a self-report questionnaire that included demographic information, the Psychological Vulnerability Scale, and a Positive Mental Health questionnaire.

Results: Analysis revealed acceptable skewness values (between −0.557 and 0.6385) and kurtosis (ranging from −1.29 to −0.704). Confirmatory factor analysis (CFA) indicated excellent global fit indices, confirming the original structure. Invariance testing between genders demonstrated that the Psychological Vulnerability Scale was consistent for boys and girls (configural invariance) and that each item contributed similarly to the construct (metric invariance). The Psychological Vulnerability Scale showed good internal consistency, with an ordinal Cronbach's alfa above 0.70. Reliability estimates, including inter-item reliability or MacDonald's Omega, indicated mean item-inter correlations falling within the recommended range of 0.15−0.50.

Conclusion: The Psychological Vulnerability Scale is a reliable tool that allows health professionals to assess the psychological vulnerability of individuals in both clinical (e.g., hospitals, health centers) and non-clinical (e.g., schools, universities) contexts throughout the life cycle (e.g., young people, adults, and older adults).

1 Introduction

The Psychological Vulnerability Scale (PVS) was developed by Sinclair and Wallston (1999) in the United States to identify predictors of vulnerability in adult populations with chronic illnesses. This instrument captures maladaptive cognitive dimensions or cognitions that enhance maladjusted reactions to stress, such as self-criticism, perfectionism, and the need for external validation and approval (Sinclair and Wallston, 1999; Sinclair and Wallston, 2010). According to Beck and Haigh (2014), psychological vulnerability encompasses dimensions associated with negative thinking perceived by individuals about life events, negative self-perceptions, negative perceptions of others, and rigid cognitive functioning. The original version of the instrument developed by Sinclair and Wallston (1999) for adults with rheumatoid arthritis has demonstrated reliable and valid psychometric properties in both clinical and research contexts. The PVS has been translated and adapted for different contexts, including community and hospital contexts in the United States of America (Sinclair and Wallston, 2010), Scotland (Selbie et al., 2004) and Spain (Rueda et al., 2007). More recently, the PVS has been adapted for academic contexts to assess the psychological vulnerability of higher education students (Akin, 2014; Satice et al., 2014; Satici, 2016; Satici et al., 2015; Nogueira et al., 2017). Regarding the Portuguese context, the PVS was translated and culturally adapted by Nogueira et al. (2017). The authors conducted a study with 267 higher education students, confirming the PVS as a reliable instrument with adequate internal consistency and excellent stability over time. Cronbach's alpha remained stable and adjusted to the original version. The construct validity of the Portuguese version of the PVS supported the original one-dimensional structure of six items, in line with previous literature (Sinclair and Wallston, 2010; Rueda et al., 2007; Satice et al., 2014; Akın et al., 2015; Selbie et al., 2004).

The validation of the PVS adapted to the Portuguese context has been widely used in research involving higher education students. During the COVID-19 pandemic, a study assessed the impact on the mental health of higher education students, focusing on their psychological vulnerability (Sequeira et al., 2022). The pandemic has affected the global population across their lifespans, especially young people in secondary education. Motivated by the significant mental health implications of the pandemic, specifically regarding the psychological vulnerability of secondary school students, this study aimed to explore the psychometric proprieties of the Psychological Vulnerability Scale for this demographic.

2 Methods

2.1 Procedures

This project is part of a multicenter study on mental health literacy among secondary school students. Students from the 10, 11, and 12th grades were recruited from two schools, one in the north of Portugal (Barcelos municipality) and the other in the autonomous region of Madeira. Before data collection, the research team provided detailed information by email to the schools' directors, explaining the study objectives, data collection procedures, and the organization of the research teams. After study approval, the research team met with the class directors to address any questions regarding the study's implementation and to obtain informed consent from students and their guardians. Also, before collecting the data, the research team ensured data collection harmonization and conducted instrument training. The study followed all ethical assumptions for human research. Before data collection in the classroom, students were provided with details about the nature and objectives of the study, anonymity and confidentiality, the duration of the questionnaire, and their right to withdraw from the study at any time. Written consent was obtained from students and their guardians. Data collection occurred between October 2022 and March 2023.

2.2 Measures

A Sociodemographic Questionnaire was completed by the participants including questions about age, gender, school year, and residence.

The Psychological Vulnerability Scale was employed to gather information about psychological vulnerability. The PVS is a six-item scale ranging from 1-does not describe me at all to 5-describes me very well. Possible total scores range from 6 to 30, with higher scores indicating greater psychological vulnerability (Nogueira et al., 2017; Nogueira and Sequeira, 2024).

In addition, the Positive Mental Health Questionnaire (PMH) containing 39 questions on the way we think, feel, and act, was applied. The questions were grouped into six dimensions: personal satisfaction, pro-social attitude, self-control, autonomy, problem-solving and personal fulfillment, and interpersonal relationship skills. A previous study demonstrated that this questionnaire presented very good internal consistency for the global construct, with Cronbach's alpha values for the dimensions ranging from 0.51 to 0.84, indicating good to very good reliability (Sequeira et al., 2014).

2.3 Data analysis

Data analysis was performed using IBM SPSS Statistics software (v.29, SPSS Inc., Chicago, IL) and JASP (v.0.18.3.0). Results were considered significant for $p < 0.05$. Participants with more than 10% missing data were excluded from the analysis. There were no missing values. A few moderate univariate outliers were identified by calculating the Mahalonobis distance (Tabachnick and Fidell, 2019) but were retained in the sample.

First, the psychometric sensitivity was assessed by examining measures of central tendency and distribution shape for the sample. Items with skewness above 3 and kurtosis above 7 (in absolute values) were rated as problematic (Kline, 2016).

Confirmatory factor analysis (CFA) was conducted to determine if the covariance structure of the model (Nogueira et al., 2017) matched the covariance structure of the data (Cheung and Rensvold, 2002). The global quality of factorial adjustment was assessed using several indices, such as chi-square ($\chi2$), $\chi2$ to degree of freedom ratio ($\chi2/df$), comparative fit index (CFI), Tucker-Lewis index (TLI), and the root mean square error of approximation (RMSEA). Model fit was considered adequate for $\chi2/df$ values below 5, CFI and TLI of at least 0.90, and RMSEA below 0.08 (Brown, 2006).

TABLE 1 Descriptive and item analysis.

	M	SD	Mdn	Minimum	Maximum	Sk	Ku
Item 1	3.27	1.32	3	1	5	−0.368	−0.984
Item 2	2.90	1.25	3	1	5	−0.079	−0.967
Item 3	2.59	1.41	3	1	5	0.272	−1.29
Item 4	2.23	1.30	2	1	5	0.638	−0.890
Item 5	2.93	1.31	3	1	5	−0.005	−1.13
Item 6	3.44	1.29	4	1	5	−0.557	−0.704

The model was drawn (Mai et al., 2022).[1] Factorial validity of the Psychological Vulnerability Scale was confirmed by ensuring that all items had standardized factorial weights higher than 0.50 ($\lambda ij \geq 0.50$, $\lambda ij2 \geq 0.25$; Tabachnick and Fidell, 2019).

The measurement invariance of the PVS was tested through a sequence of restrictive models: testing for equal number of factors between male and female (configural invariance), ensuring equivalent factor loadings for each item (metric invariance), and restricting identical item intercepts (scalar invariance). Invariance was considered established when the added restrictions did not result in a significant deterioration of model fit. A non-significant χ^2 difference test result and a Comparative Fit Index (ΔCFI) change value equal to or less than 0.01 supported measurement invariance testing (Byrne, 2010). Following conservative criteria of Chen (2007), measurement invariance was further confirmed when changes in CFI were less than 0.01 and changes in RMSEA were less than 0.015. Additionally, changes in SMRS were required to be less than 0.030 for metric invariance or 0.015 for scalar invariance.

Pearson correlations were performed to examine the relationship between scores on the Psychological Vulnerability Scale and the Positive Mental Health Questionnaire. Values above 0.80 indicated a very strong correlation, values between 0.60 and 0.80 revealed a strong correlation, values between 0.40 and 0.60 indicated a moderate correlation, values between 0.20 and 0.40 indicated a weak correlation, and values below 0.20 were considered negligible (Schober et al., 2018).

To assess internal consistency, Cronbach's alpha, and McDonald's Omega coefficients were computed for the PVS. Coefficients above 0.70 were considered acceptable, indicating good internal consistency (Ventura-León and Caycho-Rodriguez, 2017). Inter-item reliability was measured by computing the mean inter-item correlation for the Psychological Vulnerability Scale dimensions, aiming for values falling within the recommended range of 0.15 to 0.50 (Briggs and Cheek, 1986). Corrected item-total correlations were also calculated, with a cut point equal to or higher than 0.20 (Tabachnick and Fidell, 2019).

3 Results

3.1 Participants

The study included 1,875 adolescents (55.5% female) who completed a questionnaire through the Google platform. The inclusion criteria included adolescents with 15 years or more in secondary

education. Age ranged from 15 years to over 18 years, with the majority being 17 years old (31.5%).

3.2 Descriptive and item analysis

Table 1 shows the descriptive statistics for items on the Psychological Vulnerability Scale. A five-point Likert-type scale was fully utilized in 100% of the items. Also, the average scores for items on the Psychological Vulnerability Scale ranged between 2.59 (SD = 1.41) for item 3 and 3.44 (SD = 1.29) for item 6, not distancing itself from the range of items median, as a central tendency, ranging from 2 to 4.

All items presented adequate sensitivity, assuming absolute skewness and kurtosis values within the accepted limits of normal distribution (Kline, 2016). Finally, acceptable items' skewness (ranging between −0.557 and 0.6385) and kurtosis (ranging between −1.29 and − 0.704) were identified.

3.3 Construct validity: confirmatory factor analysis, convergent and discriminant validity

CFA fit indices for the two proposed models are presented in Table 2. Two models were evaluated. Model 1 representing the instrument with a one-factor structure, gathering all 6 items in a single dimension, following the original model (Nogueira et al., 2017). Indicators of acceptable model fit were provided by chi-square statistic (χ^2 (9) = 132.970, $p < 0.001$, CFI = 0.956, TLI = 0.926, and RMSEA = 0.086, CI [0.073–0.099]). However, modification indices (considered as threshold 11) suggested a correlation between errors of items 3 and 4. The model modification indices were identified and the theoretical content shared between those items resulted in the improved solution of Model 2 (χ^2 (8) = 42.465, p < 0.001, CFI = 0.988, TLI = 0.977, and RMSEA = 0.048, CI [0.034–0.063]). The standardized factorial weights and individual item reliability for the model are presented in Figure 1.
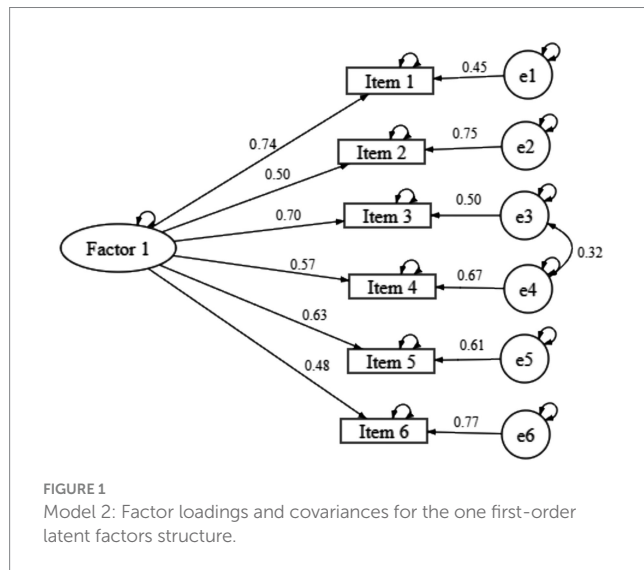
These results supported the one first-order latent structure (Model 2) for the original Psychological Vulnerability Scale (Nogueira et al., 2017). Furthermore, the quality of the Psychological Vulnerability Scale's local adjustment was supported by factorial validity ($\lambda ij \geq 0.50$, $\lambda ij2 \geq 0.25$), considering that five items standardized factorial weights were higher than 0.50 (Tabachnick and Fidell, 2019), except for item 6 ($\lambda ij2 = 0.23$), with low saturation level, indicating that the latent dimension explained less than 25% of the result of this item.

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1 https://semdiag.psychstat.org

TABLE 2 CFA models fit indices (*n* = 1872).

	$\chi 2$	df	$\chi 2/$ df	CFI	TLI	RMSEA
Model 1. One factor	132.970	9	14.8	0.956	9.926	0.926
Model 2. One factor with error correlation	42.465	8	5.31	0.988	0.977	0.048

RMSEA, Root Mean Square Error Approximation.

FIGURE 1
Model 2: Factor loadings and covariances for the one first-order latent factors structure.

3.4 Concurrent validity

The analysis of the correlations between the Psychological Vulnerability Scale and the Positive Mental Health Questionnaire (Table 3) indicated that psychological vulnerability was negatively correlated with the total score of positive mental health, personal satisfaction, pro-social attitude, autonomy, and interpersonal relationship skills. Conversely, positive correlations were found between psychological vulnerability and self-control, problem-solving, and personal fulfillment. All correlations were statistically significant and presented low to moderate magnitudes.

The Positive Mental Health Questionnaire (QSM+, Portuguese version) used in this study was translated and adapted to the Portuguese population by Sequeira et al. (2014). This version provided evidence for reliability, content validity, and criterion validity in samples of the Portuguese adult population. Thus, during the psychometric evaluation of the QSM+ in the Portuguese population, the factorial structure proposed by Lluch-Canut (2003); Lluch (2002); and Lluch (1999) underwent modifications, resulting in the final structure of the QSM+ (Portuguese version).

In the final structure of the QSM+, only the factors of personal satisfaction and self-control did not undergo modifications in the adaptation of the QSM+ to the Portuguese population. The version used in this study to define the positive mental health factors adheres to the QSM+ structure.

The items that constitute the QSM+ consist of statements reflecting ways of thinking, feeling, and acting that are common among individuals and relate to the six factors of positive mental health: personal satisfaction, pro-social attitude, self-control, autonomy, problem-solving, self-actualization, and interpersonal relationship skills (Sequeira et al., 2014; Lluch, 1999; Lluch-Canut, 2003).

3.5 Multi-group CFA for measurement invariance across gender groups

Table 4 summarizes the fit indices for tests of measurement invariance across genders. According to Chen (2007) criteria, the results evidenced configural, metric, and scalar invariance between boys and girls. Specifically, there was a non-significant χ^2 difference test result and ΔCFI <0.01, combined with ΔRMSEA <0.015 and SRMR <0.030 (for metric invariance) or < 0.015 (for scalar invariance).

3.6 Reliability of the psychological vulnerability scale: internal consistency evidence

The Psychological Vulnerability Scale demonstrated good internal consistency, with a Cronbach's alfa (α) of 0.78. Additional reliability estimates, including inter-item reliability and MacDonald's Omega (ω), were provided to facilitate future comparisons with other studies.

Table 5 shows the internal consistency, mean inter-item correlations, and corrected item-total correlation range of the Psychological Vulnerability Scale, confirming the scale's good internal consistency. Nevertheless, the mean inter-item correlations fell within the acceptable value range of 0.15–0.50 (Briggs and Cheek, 1986), and the corrected item-total also demonstrated good values above 0.20 (Tabachnick and Fidell, 2019).

4 Discussion

This study aimed to explore the psychometric proprieties of the PVS for secondary school students.

Regarding the descriptive analysis of the items on the PVS, as previously described in the results section, the PVS is a five-point Likert scale. A global analysis of the items revealed that the mean scores of the items on the PVS ranged between 2.59 (SD = 1.41) for item 3 and 3.44 (SD = 1.29) for item 6, not deviating from the median range of the items, with a central value varying from 2 to 4. Furthermore, all items showed adequate sensitivity, assuming absolute values of skewness and kurtosis within the accepted limits for normal distribution (Kline, 2016). Based on the analyzed data, acceptable skewness of the items (between −0.557 and 0.6385) and kurtosis (ranging from −1.29 to −0.704) were identified.

In the factor structure analysis, the procedures used the original model obtained from a previous study (Nogueira et al., 2017), confirming a one-factor structure through confirmatory factor analysis. The CFA results demonstrated very good global adjustment indices, confirming the previous structure. However, Item 6 "I often feel resentful when others take advantage of me" showed factor

TABLE 3 Person correlations testing for concurrent validity between the psychological vulnerability scale and the positive mental health questionnaire.

	1	2	3	4	5	6	7	8
1. Psychological Vulnerability	–							
2. Positive Mental health total score	−0.216**	–						
3. Personal satisfaction	−0.559**	0.539**	–					
4. Pro-Social Attitude	−0.092**	0.642**	0.144**	–				
5. Self-control	0.381**	0.423**	−0.243**	0.241**	–			
6. Autonomy	−0.559**	0.471**	0.609**	0.132**	−0.224**	–		
7. Problem-solving and personal fulfillment	0.301**	0.545**	−0.259**	0.458**	0.533**	−0.275**	–	
8. Interpersonal relationship skills	−0.124**	0.701**	0.347**	0.392**	0.201**	0.264**	0.258**	–

**$p < 0.01$.

TABLE 4 Results of psychological vulnerability scale invariance tests.

	χ^2(df)	CFI	TLI	RMSEA (90%CI)	SRMR	Model comp	$\Delta\chi^2$ Δ(df)	ΔCFI	ΔRMSEA	ΔSRMR
M1: Configural invariance	43.827 (16)	0.989	0.979	0.043 (0.028–0.059)	0.019					
M2: Metric invariance	53.118 (21)	0.987	0.981	0.040 (0.027–0.054)	0.028	M1	9.291[n.s.](5)	−0.002	−0.003	0.018
M3. Invariance Scalar	67.883 (26)	0.985	0.982	0.039 (0.027–0.052)	0.031	M2	14.765 [n.s.](5)	−0.002	−0.001	0.003

$N = 1873$; Males: $n = 833$; Females; $n = 1,040$; χ^2 = chi-square goodness-of-fit statistic; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; RMSEA, Root Mean Square Error Approximation; Δ, Differences between two indices.

TABLE 5 Internal consistency of the psychological vulnerability scale.

	Cronbach's Alfa	MacDonald's Omega	Mean inter-item correlation	Corrected item-total correlation range
Psychological vulnerability scale	0.78	0.79	0.375	0.722–0.777

loadings below the recommended values, similar to findings from the exploratory factor analysis in the previous study (Nogueira et al., 2017). Considering the item content and this study sample, this result could be explained by the aspects related to adolescence. According to Piaget, egocentrism is a prominent feature of adolescent cognitive development, manifesting in various ways. Adolescents often exhibit a strong self-focus and tend to believe in the uniqueness and transformative power of their thoughts. They may develop elaborate "theories" or "systems" about themselves and the world, often in a somewhat naive manner. Additionally, adolescents begin formulating life plans, adopting adult roles, and expressing a desire for societal change. However, this heightened self-focus can lead to a relative inability to differentiate between their perspectives and societal norms, a phenomenon Piaget referred to as cognitive egocentrism. In their efforts to shape their environment according to their desires, adolescents may struggle to differentiate their constructs from broader societal expectations they seek to influence through these constructs. This cognitive egocentrism is commonly observed in adolescent writings, particularly in diaries and intimate confessions, where beliefs in the originality and potency of their ideas and their capacity to

radically transform the world are often expressed. However, these expressions can sometimes be misinterpreted as signs of pathological messianism or megalomania (Galanaki, 2017).

Measurement invariance between genders was tested, and the results indicated that the basic organization of the PVS was supported for both boys and girls (configural invariance), with each item contributing similarly to the construct (metric invariance; Byrne, 2010; Chen, 2007). This suggests that the PVS can be employed to compare vulnerability scores across different demographic segments. By analyzing latent mean scores and conducting group comparisons, it is possible to assess actual variations in vulnerability levels rather than differences in item interpretation (Putnick and Bornstein, 2016).

Regarding the construct's reliability, the Psychological Vulnerability Scale demonstrated good internal consistency, with an ordinal Cronbach's alpha above 0.70 (Ventura-León and Caycho-Rodriguez, 2017; Nunnally, 1978) contributing to an overall sense of quality (Borsboom et al., 2004). Compared to a previous study (Nogueira et al., 2017), our data showed even higher reliability values. Other reliability estimates were presented, including inter-item

reliability or MacDonald's Omega, which were not previously estimated in the PVS previous study. MacDonald's Omega indicated good internal consistency for the total sample, with mean item-inter correlations falling within the recommended range of 0.15–0.50 (Briggs and Cheek, 1986). The corrected item-total correlation range also demonstrated favorable results, exceeding 0.20 (Tabachnick and Fidell, 2019).

5 Conclusion

The psychological vulnerability scale is a reliable instrument that enables health professionals to assess the psychological vulnerability of individuals in different clinical contexts (e.g., hospitals, health centers) and non-clinical contexts (e.g., schools, universities) throughout the life cycle (e.g., young people, adults, and older adults). Identifying psychological vulnerability allows for individualized, differentiated, and early interventions by health professionals. These study results also underscore the need for further research to refine the psychometric properties of the instrument. Future studies should include clinical and non-clinical samples to establish cut-off points, making the instrument more discriminative and sensitive. Improving the precision of the scale in assessing psychological vulnerability (e.g., low, medium, and high risk of psychological vulnerability) will facilitate more preventive and less remedial interventions, enabling anticipatory management of psychological vulnerability risk.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, after further request.

Ethics statement

The study was approved by the Ethics Committee of the Nursing School of Porto (reference number ADHOC_822/2020). Written consent was obtained from students and their guardians.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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