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The Genetic Psychosocial Risk Instrument (GPRI): A Validation Study for European Portuguese

O Instrumento de Avaliação do Risco Genético Psicossocial (GPRI): Estudo de Validação para Português Europeu

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ABSTRACT

Introduction: Screening instruments specifically developed to identify genetic testing applicants who may need professional psychosocial support are much needed. However, there are no screening instruments validated for the Portuguese language. This paper presents the translation, adaptation, and validation process of the Genetic Psychosocial Risk Instrument in a sample of 207 Portuguese applicants to genetic testing in the context of inherited cancer risk.

Material and Methods: Participants were mainly female (84.06%), with a mean age of 40.08 (SD = 12.89) and were recruited from the Portuguese Oncology Institute of Porto. Confirmatory factor analysis was conducted to confirm the Genetic Psychosocial Risk Instrument factorial structure. Convergent validity was assessed with the Impact of Events Scale, the Clinical Outcome Routine Evaluation – Outcome Measure, and the Hospital Anxiety and Depression Scale.

Results: A model composed by the factors 'Internal Impact of Genetic Testing', 'External Impact of Genetic Testing' and 'History of Mental Health Concerns' was confirmed. These factors showed good internal consistency, convergent and discriminant validity. The factor 'Personal Loss to Cancer' proposed in the Canadian and French versions did not converge. We propose excluding this factor from the European Portuguese version of the scale.

Conclusion: The European Portuguese version of the Genetic Psychosocial Risk Instrument is a reliable and valid instrument, although more research is needed to effectively use it in routine clinical oncogenetic departments.

Keywords: Genetic Counseling; Genetic Testing; Neoplastic Syndromes, Hereditary; Psycho-Oncology; Psychometrics; Translation; Validation Study

RESUMO

Introdução: A literatura tem apontado a necessidade de instrumentos de rastreio de risco psicossocial desenvolvidos especificamente para o contexto do teste genético. No entanto, de acordo com o nosso melhor conhecimento, não existe nenhum instrumento com estas características que esteja validado para a língua portuguesa. Este artigo apresenta o processo de tradução, adaptação e validação do Instrumento de Risco Psicossocial Genético numa amostra de 207 utentes convidados à realização de testes genéticos no contexto de risco de cancro hereditário.

Material e Métodos: Os participantes são maioritariamente do sexo feminino (84,06%), com média de idade de 40,08 (DP = 12,89) e foram recrutados no Instituto Português de Oncologia do Porto. Foi realizada uma análise fatorial confirmatória para estudar a estrutura fatorial do Instrumento de Risco Genético Psicossocial. A validade convergente foi avaliada com a Escala de Impacto de Eventos, a Escala da Avaliação de Rotina de Resultado Clínico - Medida de Resultado e a Escala de Ansiedade e Depressão Hospitalar.

Resultados: Confirmou-se um modelo composto pelos fatores 'Impacto Interno do Teste Genético', 'Impacto Externo do Teste Genético' e 'Histórico de Preocupações com a Saúde Mental'. Estes fatores apresentaram boa consistência interna, validade convergente e discriminante. O fator 'Perda Pessoal para o Cancro' proposto nas versões Canadiana e Francesa não convergiu. Propomos excluir este fator da versão portuguesa da escala.

Conclusão: A versão portuguesa do Instrumento de Risco Genético Psicossocial é um instrumento confiável e válido, embora seja necessária mais investigação para que seja integrado efetivamente na prática de rotina.

Palavras-chave: Aconselhamento Genético; Estudo de Validação; Psico-Oncologia; Psicometria; Síndromes Neoplásicas Hereditárias; Teste Genético; Tradução

INTRODUCTION

Hereditary cancer syndromes are adult-onset hereditary diseases caused by genetic pathogenic variants that increase the lifetime probability of developing cancer, compared with the general population.[1,2] These pathogenic variants are identified through genetic testing (GT), which can be offered to healthy individuals from families with suspected or confirmed hereditary cancer syndromes. Once identified as pathogenic variant carriers, individuals may work with geneticists and other healthcare professionals to implement personalized prevention programs (PPP) to prevent the onset of cancer. Nevertheless, effective PPP often involve considering invasive life-altering procedures, such as organ-removal surgeries (e.g., prophylactic bilateral mastectomy), which are associated with important

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psychosocial challenges.[3] Research has consistently shown that a subgroup of GT applicants may experience long-term psychological maladjustment.[4] Pathogenic variant carriers may feel increased distress, anxiety, cancer worry, anger, and guilt for possibly having transmitted the pathogenic variant to their children.[4-7] Moreover, siblings who are non-carriers may experience distress and feelings of survivor guilt towards family members who are pathogenic variant carriers.[8] Therefore, identification of applicants who may need additional psychosocial support in the process of adaptation to GT and its results is an important care step.

Several instruments have been used to screen for psychosocial issues in GT applicants (e.g., Impacts of Events Scale[9]; Multidimensional Impact of Cancer Risk Assessment Questionnaire),[10] but they are either too broad or do not consider GT-specific risk-factors.[11] To fill this gap, Esplen *et al* developed a measure specifically for routine assessment of psychosocial risk in GT applicants. In its original version, the Genetic Psychosocial Risk Instrument (GPRI) has shown good psychometric properties, clinical utility, and acceptability.[11]

Portuguese is the sixth most spoken language in the world, being the official language of over 250 million people.[12] However, to our knowledge there are no specific instruments to assess psychosocial risk in GT applicants being used in any Portuguese speaking countries. Therefore, a Portuguese version of the GPRI is much needed to assist Portuguese speaking geneticists and genetic counsellors in their routine practice. In this sense, our aim with this study was to present the European Portuguese version of the GPRI and to validate its factorial structure for the Portuguese population. We anticipated that the European Portuguese version of the GPRI would replicate the factorial structure of the original version and correlate significantly with measures of anxiety, depression, and distress. Additionally, based on prior research about genetic testing psychological adjustment,[4,13] we expected that cancer patients would have greater psychosocial risks than pre-symptomatic applicants, and that the number of children would be positively correlated with the psychosocial risk.

MATERIAL AND METHODS

Participants and procedure

Study participants were 207 patients from the Portuguese Oncology Institute of Porto (IPO-PORTO), aged 18 or over who opted to undergo genetic testing to assess the presence of the following hereditary cancer syndromes: hereditary breast and ovarian cancer (HBOC), hereditary non-polyposis colorectal cancer (HNPCC), hereditary gastric diffuse cancer (HGDC), and familial adenomatous polyposis (FAP). Both pre-symptomatic and participants diagnosed with cancer were included. Participants were excluded if they were not able to understand the context of GT and the implications of GT results or did not have sufficient literacy. This work is part of an ongoing project approved by the IPO-PORTO Ethics Committee (Doc. CES-IPOP 04_2017).

Data collection took place between September 2018 and March 2020. A medical geneticist invited applicants to participate during their first genetics consultation. Applicants who decided to participate were referred to a researcher, who presented the study in detail and asked for written informed consent. After giving consent, participants completed a battery of questionnaires composed by the Genetic Psychosocial Risk Instrument,[11] the Impact of Events Scale,[9] the Hospital Anxiety and Depression Scale[14,15] and the Clinical Outcome Routine Evaluation – Outcome Measure Scale.[16,17]

Scale translation

The translation of the scale was performed independently by two researchers with extensive experience in translating and adapting psychometric scales, one senior psycho-oncologist and one senior medical geneticist. An initial version was obtained by consensus, and a bilingual Portuguese researcher performed the back translation. The semantic content of some of the items was discussed with the author of the scale. The initial translated version was tested in a sample of five applicants (not included in the study) to assess the clarity of items and instructions. Applicants' uncertainties around the meaning of items were considered, and the wording of a few items was changed after careful consideration by the five researchers involved in the translation process, until a final version was accomplished.

Instruments

Genetic Psychosocial Risk Instrument (GPRI)

The GPRI[11] is a 20-item scale that measures the psychosocial risk of applicants undergoing genetic testing. Of these 20 items, 12 are to be answered according to a five-point Likert scale and eight items are Yes or No questions. The GPRI is composed by three factors: (1) perceived impact and personal adjustment to genetic testing; (2) history of mental health concerns and (3) personal history/family history/loss to cancer. The GPRI has shown high internal consistency (Cronbach's α = 0.81), convergent and discriminant validity. It was able to identify 84% of participants displaying post-GT results distress, as assessed by a battery of measures composed by the Hamilton's Anxiety Rating Scale,[18] the Hamilton's Depression Rating Scale,[19] the Brief Symptom Inventory,[20] and the Impact of Events Scale.[9] To date, the GPRI was validated for the Canadian population[11] and for the French population.[21] However, the French version of the GPRI (GPRI-F) has a slightly different factorial structure, despite exhibiting high reliability (Cronbach's α =

0.81) as well. Specifically, the GPRI-F is composed by four factors: (1) Anticipated or experienced impact of having a disease risk or genetic pathogenic variant; (2) Anticipated or likely external impact from having a disease risk or genetic pathogenic variant; (3) Personal history of or vulnerability to mental health issues or symptoms and (4) Personal or family history of the genetic disease being tested in the clinic.

Impact of Events Scale

The Impact of Events Scale (IES[9]) is a 15-item Likert scale used to measure distress triggered by a stressor or life event. The IES comprises two domains: (1) 'Intrusion', which relates to intrusive thoughts and feelings about the event or stressor and (2) 'Avoidance', which relates to patterns of avoidance in terms of thoughts, feelings, and behaviors. The IES has been frequently used with genetic populations and has shown good psychometric properties.

Hospital Anxiety and Depression Scale

The Hospital Anxiety and Depression Scale (HADS[14,15]) is a well-known instrument assessing symptoms of depression and anxiety. The HADS has shown good psychometric properties, both in the original[14] and the Portuguese version.[15]

Clinical Outcome Routine Evaluation-Outcome Measure

The CORE-OM[16,17] is a five-point Likert scale of global distress (GD), comprising 34 items and four dimensions: subjective well-being, commonly experienced problems or symptoms, social/life functioning, and risk to self and others. The CORE-OM has shown good psychometric properties both in its original version[16] as well as in the Portuguese version.[17]

Data analysis

All analyses were performed in R, using the Lavaan and semTools packages. First, we conducted descriptive statistics and calculated an inter-item correlation matrix, using tetrachoric, biserial, and Pearson's coefficients to account for both continuous and dichotomous variables. Then, we evaluated the GPRI factor structure, using confirmatory factor analysis (CFA) to test the original GPRI factor structure, proposed by Esplen *et al*.[11] This three-factor solution measures patients' (a) 'Personal/family history of/Loss to Cancer' (PLC; 3 items), (b) 'Perceived Impact of Genetic Testing' (PIGT, 12 items), and (c) 'History of Mental Health Concerns' (HMHC, five items). We then tested alternative factor structures and used nested model comparisons to achieve the best fitting model. We employed the weighted least squares mean and variance adjusted (WLSMV) estimator for testing the models, since the indicators of PLC and HMHC were defined as categorical. Indicators measuring PIGT ranged from 1 to 5 and were modeled as continuous.[22] The percentage of missing values was quite low (0.05%). Missing data were handled using pairwise deletion, which is considered the most efficient method in this situation.[23] Chi-square goodness-of-fit statistic, the root mean square error of approximation (RMSEA), the comparative fix index (CFI) and the standardized root mean square residual (SRMR) were used to assess model fit. Values lower than 0.06 for RMSEA, greater than 0.95 for CFI, and lower than 0.80 for SRMR indicate good model fit.[24]

After inspecting GPRI internal consistency (Cronbach's alpha), we investigated its convergent and discriminant validity by considering the direction and magnitude of associations with the following measures: Impact of Events Scale (IES); Hospital Anxiety and Depression Scale (HADS); and the CORE Outcome Measure (CORE-OM). We also analyzed the relations between the GPRI scores and distinct aspects of personal/family history (e.g., previous cancer diagnosis) and demographic features (e.g., number of children), using *t*-test for independent samples.

RESULTS

Appendix 1 (Appendix 1: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/16497/6690) displays the items' frequencies and descriptive statistics. The PLC items showed relatively high frequencies, with nearly 50% of participants indicating they have taken care of a very ill parent or close relative in the past (item 2) or lost a close family member to the disease for which they were being tested (item 3). Overall, participants reported moderate scores on the items tapping PIGT. These items were normally distributed, showing reduced levels of skewness (range -0.60 to 0.88) and kurtosis (range -1.07 to 0.30). A relatively low percentage of participants were seeing a counselor due to emotional concerns (item 18), and few of them reported emotional problems associated with suicidal thoughts (item 17).

The inter-item correlation matrix, including dichotomous and continuous variables, is also presented in Appendix 1 (Appendix 1: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/16497/6690). The average correlation among items from the same subscale was 0.12, 0.37, and 0.67 for PLC, PIGT, and HMHC, respectively. The correlation between items 14 ("I have had emotional problems in the past") and 17 ("I have had emotional problems that led me to have thoughts about suicide") from the HMHC subscale was close to 1.0, suggesting these items are highly redundant.

As originally proposed by Esplen *et al*,[11] the CFA model for the GPRI included three oblique factors: PLC, PIGT, and HMHC. No residual covariances were specified. This

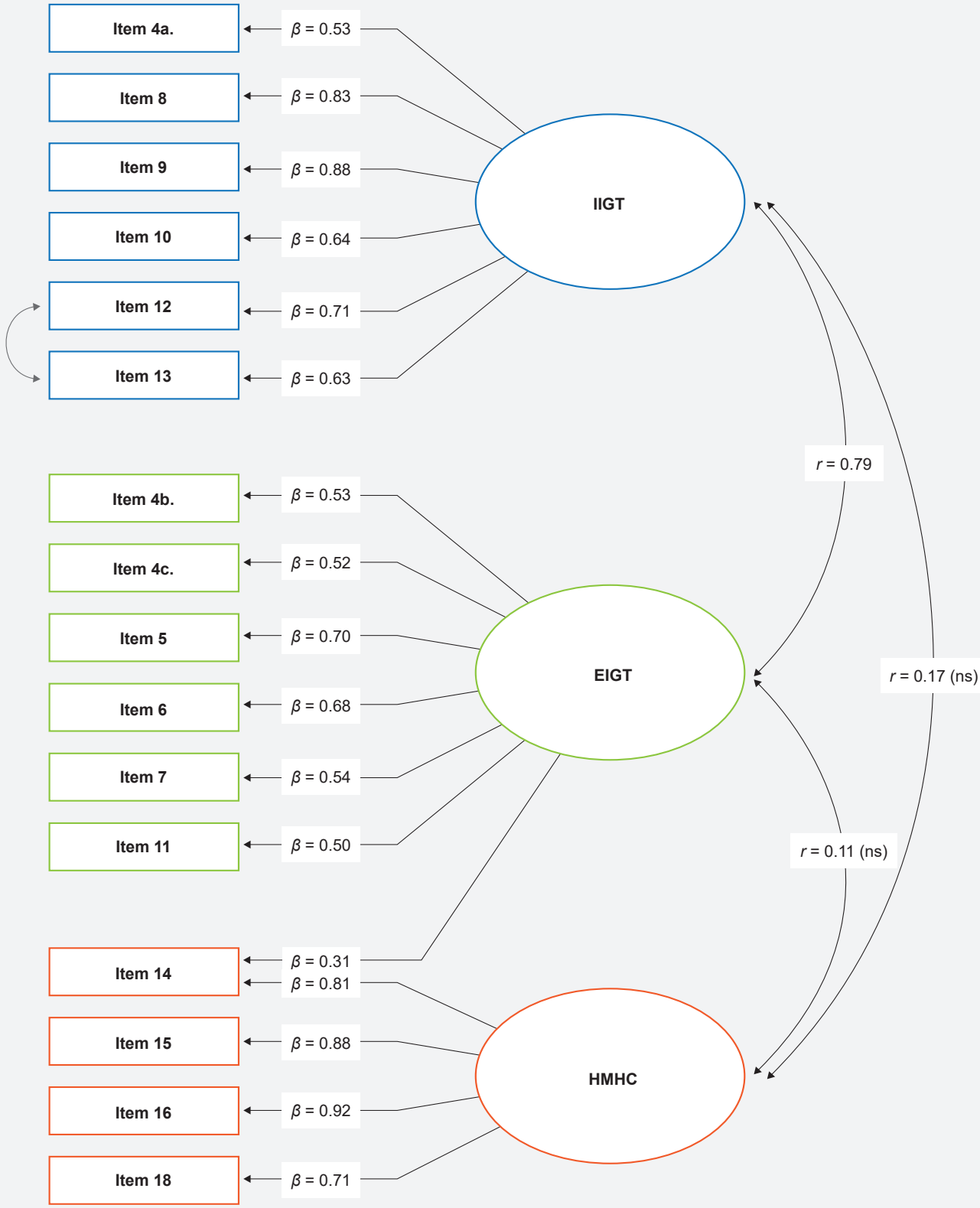

Figure 1 – Confirmatory factor analysis model examining the factor structure of the Genetic Psychosocial Risk Instrument.
IIGT: Internal Impact of Genetic Testing; EIGT: External Impact of Genetic Testing; HMHC: History of Mental Health Concerns.
All parameters are significant at $p < 0.01$ unless otherwise indicated; ns = non-significant.

baseline model (Model 1) did not converge, perhaps because of the existing collinearity between items 14 and 17. To tackle this issue, we decided to drop item 17 from the model, because the scores of this item showed very low variability. As Table 1 displays, the CFA model excluding item 17 (Model 2) showed less than adequate fit to the data, $\chi^2(149) = 226.26$, $p < 0.001$, RMSEA = 0.05 [90% CI (0.04; 0.06)], CFI = 0.89, SRMR = 0.09. We used the modification indices (MI) to identify potential sources of significant model improvement. Model fit improved by specifying residual covariances between items 12 ("I have generally felt sad in the past month") and 13 ("I have generally felt nervous and anxious in the past month") and between items 4c ("I will have difficulties in my family relationships") and 6 ("I am worried that my test result will impact on my relationship with my significant other (or future partner)"). In addition, we allowed a cross-loading of the item 14 ("I have had emotional problems in the past") to the factor measuring the perceived impact of genetic testing (PIGT). Results from the likelihood ratio test in Table 1 indicated that this model (Model 3) fitted the data significantly better than Model 2, $\Delta\chi^2(3) = 30.41$, $p < 0.001$. Despite Model 3's adequate fit, the estimation process resulted in some improper solution (also known as Heywood cases) involving the factor representing PLC, namely estimated negative factor variance and correlations between factors with absolute values > 1.0. Furthermore, all PLC factor loadings were non-significant.

We tested the alternative GPRI 4-factor solution proposed by Maheu *et al.*[21] In this CFA model (Model 4), we reproduced the original PLC and HMHC (except item 17) factors. The 12-item PIGT factor was decomposed into two six-item factors measuring the internal impact of genetic testing (IIGT) and external impact of genetic testing (EIGT). Based on the MI, the residual covariance between items 12 and 13 and the cross-loading of the item 14 to the PIGT were also specified. As shown in Table 1, Model 4 provided significantly better fit to the data than Model 3, $\Delta\chi^2(2) = 6.11$, $p = 0.047$. Nevertheless, like Model 3, the estimation of Model 4 resulted in inadmissible, improper solutions for some of the PLC's factor parameters.

Given the PLC non-significant factor loadings, and to avoid Heywood cases, we tested models 3 and 4 without the PLC factor. Model 5 specified two factors, PIGT (12 items) and HMHC (4 items), whereas Model 6 specified three factors, IIGT (6 items), EIGT (6 items), and HMHC (4 items). Both models provided good fit to the data (Table 1), thus eliminating the estimation issues previously described. We retained Model 6 because it fitted the data better than Model 5, $\Delta\chi^2(1) = 4.10$, $p = 0.043$. Fig. 1 presents the standardized coefficients for this Model 6 and Appendix 2 (Appendix 2: https://www.actamedicaportuguesa.com/revista/index.php/amp/article/view/16497/6691) presents estimates, standard errors, confidence intervals and correlation of errors.

As depicted in Fig. 1, all factor loadings were significant at $p < 0.01$. Except for the EIGT cross-loading on item 14, all the standardized factor loadings were higher than 0.50. This CFA model also estimated the error-free correlations between the factors representing IIGT, EIGT, and HMHC. As expected, results indicated a strong association between IIGT and EIGT ($r = 0.79$, $p < 0.001$).

Regarding internal consistency, we opted to use the Cronbach's alpha for the IIGT and EIGT subscales because these subscales' observed variables are continuous and The Kuder-Richardson Formula 20 (KR-20) for the HMHC subscale because the observed variables pertaining to this subscale are dichotomous. In this sense, the Cronbach's alpha for the IIGT and EIGT subscales was 0.75 and 0.85 respectively, and the KR-20 for the HMHC subscale was 0.76, which suggests overall good internal consistency. For establishing the GPRI convergent and discriminant validity, we examined the associations between the scores on these GPRI's subscales and the scores obtained by Impact of Events Scale (IES), the Hospital Anxiety and Depression Scale (HADS), and the CORE outcome measure (CORE-OM). These are well-established measures of psychological adjustment and distress in the face of disease. We also investigated GPRI ability to discriminate genetic psychosocial risk across patients with and without a known diagnosis of cancer and within different demographic subgroups. Results in Table 2 indicate the psychosocial risk to genetic testing measured by the IIGT, EIGT, and HMHC subscales was positively associated with higher levels of intrusion, avoidance, anxiety, depression, and psychological distress.

Table 1 – Goodness of fit statistics for the GPRI's CFA models and nested model comparisons

Model tested	χ^2(df)	**RMSEA** (90% CI)	**CFI**	**SRMR**	**Compared Model**	$\Delta\chi^2(\Delta df)$
Model 1	---	---	---	---	---	---
Model 2	226.26 (149)**	0.05 (0.04; 0.06)	0.89	0.09	---	---
Model 3	184.48 (146)*	0.04 (0.02; 0.05)	0.94	0.08	Model 2	30.41 (3)**
Model 4	176.08 (144)*	0.03 (0.01; 0.05)	0.95	0.07	Model 3	6.11 (2)*
Model 5	125.92 (100)*	0.04 (0.01; 0.05)	0.96	0.07	---	---
Model 6	118.88 (99)	0.03 (0.00; 0.05)	0.97	0.06	Model 5	4.10 (1)*

*: $p < 0.05$; **: $p < 0.01$

Table 2 – Pearson correlations and descriptive statistics

	1	2	3	4	5	6	7	8	9	10	11	12	13
Genetic Psychosocial Risk Instrument													
1. IIGT	---												
2. EIGT	0.60**	---											
3. HMHC	0.18*	0.17*	---										
Impact of Events Scale													
4. Intrusion	0.58**	0.49**	0.24**	---									
5. Avoidance	0.48**	0.40**	0.21**	0.66**	---								
6. IES total score	0.58**	0.48**	0.25**	0.89**	0.93**	---							
Anxiety and Depression Scale													
7. Anxiety	0.58**	0.37**	0.32*	0.62**	0.43**	0.57**	---						
8. Depression	0.55**	0.37**	0.24**	0.50**	0.40**	0.50**	0.75**	---					
Core Outcome Measure													
9. Distress	0.61**	0.36**	0.30**	0.62**	0.43**	0.58**	0.83**	0.78**	---				
Demographic variables													
10. Age	0.11	0.04	0.15*	0.03	0.06	0.05	0.07	0.11	0.07	---			
11. Education (Years)	-0.20**	-0.15*	-0.08	-0.16*	-0.04	-0.11	-0.13	-0.13	-0.006	-0.29**	---		
12. Income	-0.25**	-0.18*	-0.07	-0.19*	0.02	-0.08	-0.13	-0.04	-0.1	0.06	0.43**	---	
13. Number of children	0.16*	0.09	0.10	0.15	0.12	0.14	0.13	0.05	0.05	0.70**	-0.19*	0.06	---
M	2.86	2.36	0.30	8.73	12.38	21.10	6.00	3.71	0.85	40.08	11.88	2.43	1.24
SD	0.86	0.80	0.34	7.16	8.52	14.32	3.71	3.40	0.56	12.89	3.76	1.14	0.90
Range	1 - 5	1 - 5	0 - 1	0 - 31	0 - 36	0 - 61	0 - 17	0 - 17	0.0 - 2.97	18 - 69	4 - 19	1 - 5	0 - 4

PLC: Personal Loss to Cancer; PIGT: Perceived Impact of Genetic Testing; HMHC: History of Mental Health Concerns; M: mean; SD: standard deviation
*: $p < 0.05$; **: $p < 0.01$

The IIGT and EIGT scores were negatively correlated with participants' years of education and income. Patients' age and number of children were associated with increasing levels of IIGT and HMHC, respectively.

Finally, we conducted independent-sample *t*-tests to examine differences between women and men, and between those with and without a confirmed diagnosis of cancer on psychosocial risk to genetic testing. Results are presented in Table 3. The GPRI's subscales measuring IIGT and HMHC seem to discriminate male patients from female patients, as well as between patients with and without cancer diagnoses. Compared to men, women showed higher average rates of internal impact to genetic testing and a more evident history of mental health concerns. As expected, patients with a confirmed diagnosis of cancer displayed higher levels of IIGT and HMHC. Results indicated the scores from the EIGT subscale discriminate between women and men but not between patients with and without a cancer diagnosis. Male patients presented significant higher scores of EIGT than female patients.

DISCUSSION

Identifying individuals at risk for psychosocial issues is essential to promote psychological adjustment and quality of life in GT applicants. A screening instrument with this purpose should be clinically practical, reliable, and adapted to the population it intends to be used on. The results of this study confirm the reliability and validity of the Portuguese version of the GPRI with Portuguese GT applicants in the context of hereditary cancer.

We started by testing the original three factor model proposed by Esplen *et al*[11] and the alternative four factor model proposed in the French version, by Maheu *et al*.[21] However, our data could not fit either of these models adequately. The best fitting model for our data was composed by two factors proposed by Maheu *et al*[21]: (1) 'Internal Impact of Genetic Testing' (IIGT) and (2) 'External Impact of Genetic Testin'g (EIGT), plus one factor proposed by Esplen *et al*[11]: (3) 'History of Mental Health Concerns' (HMHC). It is worth noting that the initial factor 'Perceived Impact of Genetic Testing' (PIGT) proposed by Esplen *et al*[11] also provided a good fit for the data, but the subdivision of this factor in two (IIGT and EIGT) resulted in a better adjustment. One major difference between our results and prior versions concerned the factor 'Personal Loss To Cancer' (PLC). Our analysis found non-significant factor loadings for PLC, thus failing to

Table 3 – Descriptive statistics (mean and standard deviation) and mean comparison (*t*-test) for GPRI's subscales across female and male patients, with and without cancer diagnosis

	M (SD)	*t*	df	d
Internal Impact of Genetic Testing (IIGT)				
Female	2.93 (0.86)	2.85**	46.03	0.53
Male	2.48 (0.83)			
Without cancer diagnosis	2.71 (0.81)	-2.54*	173.95	0.38
With cancer diagnosis	3.05 (0.91)			
External Impact of Genetic Testing (EIGT)				
Female	2.28 (0.81)	2.94**	46.29	0.54
Male	2.45 (0.80)			
Without cancer diagnosis	30.25 (8.61)	-1.44	171.70	0.22
With cancer diagnosis	35.46 (8.67)			
History of Mental Health Concerns (HMHC)				
Female	0.33 (0.35)	3.78**	61.53	0.56
Male	0.14 (0.24)			
Without cancer diagnosis	0.21 (0.30)	-3.45**	172.84	0.51
With cancer diagnosis	0.38 (0.34)			

*: $p < 0.05$; **: $p < 0.01$

confirm the existence of this latent construct. Although having been a caregiver of a cancer patient or having experienced personal loss of a family member due to cancer might affect psychological adjustment to hereditary cancer risk,[26] our results do not confirm the existence of the PLC subscale in the European Portuguese version of the GPRI. More research is needed to understand why this occurs. However, it is plausible that it may be due to sociocultural differences between Portuguese, French and Canadian populations. Another difference between our model and prior versions that could be related with cultural differences relates with the option to drop item 17 ("I have emotional problems that led me to thoughts about suicide") due to the existing collinearity with item 14 ("I have had emotional problems in the past").

Construct validity of the three subscales (EIGT, IIGT and HMHC) composing the final model was supported by our study, showing very good indicators of internal consistency (Cronbach's α = 0.85, 0.75, for EIGT and IIGT, and KR-20 = 0.76 for HMHC), discriminant and convergent validity. As expected, and consistent with the Canadian[11] and French versions,[21] the GPRI correlated with measures of depression, anxiety and distress, suggesting that it can identify GT applicants in need of psychological support. The results also indicated that female patients and patients diagnosed with cancer present higher scores regarding the HMHC and the IIGT factors. This is in line with prior research, that found that, in general, female patients tend to report higher levels of cancer-worry,[25] anxiety[26] and depression[27] than male participants, and that cancer patients are more susceptible to feelings of anxiety and depression.[28] Moreover, we found that participants with children displayed higher levels of IIGT and HMHC, which is in agreement with the literature. Research with pathogenic variant carriers from hereditary cancer families has consistently shown that concerns about possibly transmitting the pathogenic variant to children and communicating with children about test results tend to be central themes.[8,29,30] As the provision of genetic testing in Portuguese hospitals and clinics increases, clinicians will need a practical, reliable, and brief way to screen patients who may be at risk of maladjustment to GT and GT results. Global measures of distress or screening instruments may be less apt to identify specific genetic-testing contextual issues that could be addressed with tailored interventions.

Our results suggest confidence in the use of the GPRI by Portuguese genetic counsellors and medical genetics experts working in oncology departments. The validated tool may be used in routine practice to rapidly identify applicants who may be at risk of psychological adjustment issues and promptly refer them to psychological support services. Nevertheless, to integrate the Portuguese Version of the GPRI effectively in routine practice as a screening instrument, further research should be conducted to establish cut-off scores.

Limitations

Two important limitations should be noted. Our sample had a low proportion of male participants and only included applicants undergoing GT for hereditary cancer syndromes. A second limitation is related with the fact that we could not

replicate the factorial structure of both the original version and the French version. This may hamper the applicability of the instrument in research settings because it may be significantly more difficult to compare outcomes across studies conducted in different countries and cultures. In this sense, given these results, we suggest that a cross validation study with diverse countries should be carried out.

CONCLUSION

The Portuguese version of the GPRI is a reliable and valid screening measure of the psychological adjustment in the context of genetic cancer testing. Our results suggest that GPRI-P is composed by 16 items and three dimensions referring to 'History of Mental Health Concerns', 'Internal Impact of Genetic Testing' and 'External Impact of Genetic Testing'.

AUTHOR CONTRIBUTIONS

PG: Data acquisition, drafting and approval of the final version of the manuscript.

TF: Data analysis, drafting and approval of the final version of the manuscript.

PMM, CMDS: Design and conception of the study. Critical review and approval of the final version of the manuscript.

ES: Data acquisition. Critical review and approval of the final version of the manuscript.

JS: Critical review and approval of the final version of the manuscript.

MJE: Critical review and approval of the final version of the manuscript.

PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the Helsinki Declaration of the World Medical Association updated in 2013.

DATA CONFIDENTIALITY

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

COMPETING INTERESTS

The authors have declared that no competing interests exist.

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