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Measurement properties of the Spanish version of assessment of survivor concerns in cancer patients

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One of the main concerns for cancer patients is the progression of the disease and their health. This study sought to examine the psychometric properties, validity evidence based on relations with other variables, and factorial invariance (by sex, age, and tumor site) of the Spanish version of the Assessment of Survival Concerns (ASC). The instrument was translated into Spanish following a back-to-back translation procedure to ensure linguistic and conceptual equivalence. Participants completed the questionnaire in a paper-and-pencil format as part of a prospective, multicenter study including 1,052 patients who also completed other related psychosocial measures. The findings support the reliability and validity of the ASC scores in assessing cancer-related concerns. The ASC is a brief, unidimensional measure with acceptable fit (RMSEA = 0.038, CFI = 0.998, TLI = 0.995, SRMR = 0.026). A strong invariance solution demonstrated acceptable fit across sex, age, and tumor site. The omega reliability estimate was ω = 0.83. Higher ASC scores were positively associated with greater symptoms of depression, anxiety, and psychological distress, as well as with higher physical symptom burden, indicating that patients experiencing more concern also reported worse psychological and functional outcomes. The Spanish version of the ASC provides reliable and valid scores for assessing cancer-related concerns in patients with metastatic cancer.

Keywords Invariance, Factor analysis, Preoccupation, Oncology, Psychological distress

In general, one of the main worries for cancer patients is the fear of cancer progression, which affects between 20% and 70% of patients[1,2]. Cancer concern is generally accepted as a multidimensional concept and can range from a normal adaptive response to a clinically relevant fear, especially when it involves intrusive, persistent thoughts about recurrence or progression, even without objective evidence[3]. Such concern is often accompanied by elevated anxiety and depression, reduced participation in daily activities, misinterpretation of bodily symptoms as signs of recurrence, social isolation, and excessive medical consultations, all significantly impacting quality of life[3,4].Empirical evidence shows that younger patients tend to report greater concern than older patients[5,6], while findings regarding other demographic factors, such as sex, are inconsistent[5,6], some studies suggest higher concern among women[2,7], whereas others find no sex differences[8,9]. These discrepancies may relate to sample composition, for example, when certain sex-specific cancer types predominate. Additionally, the relationship between cancer concern and clinical factors (e.g., tumor type, stage, treatment) remains inconclusive[5,6]. Some studies indicate lower concern in prostate cancer patients compared to other cancers[5], while others, such as Van der Val et al., found no differences by tumor site but higher concern in stage II patients[10].

Cancer concern can be influenced by various psychological factors. Previous research has revealed that uncertainty, depression, and anxiety correlate with greater cancer concern[5,11] and may have negative repercussions on quality of life[12]. Unlike other illnesses, cancer cells tend to grow and develop gradually and insidiously, provoking an intense sense of uncertainty about the disease and can lead to heightened concern and anxiety[13]. These emotional and psychological factors, in turn, can impact cancer patients' quality of life, thereby compromising their overall well-being and ability to lead a fulfilling and satisfactory life[5]. In addition, high levels of cancer concern have been associated with maladaptive coping strategies, reduced adherence to follow-up care, and increased health care utilization[5,6]. Therefore, assessing and addressing cancer concern is crucial in routine

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clinical practice, as it can inform personalized psycho-oncological interventions and improve survivorship care planning.

In the international medical literature, a wide variety of instruments exist that assess cancer concern[2,5]. One of the most widely used among them is the Assessment of Survivor Concerns (ASC), developed by Gotay and Pagano[4], and validated in English-[12], Turkish-[14], and Chinese-speaking[15] populations. The ASC is a brief, 6-item scale specifically designed to quantify concern about cancer and health[16]. Scores obtained on this scale have demonstrated acceptable internal consistency, ranging from α = 0.78 to 0.93, and test-retest intraclass correlation coefficients around 0.70, supporting its stability over time[12,14,15]. Its construct validity was confirmed using confirmatory factor analysis (CFA) with both short- and long-term survivors, showing good model fit and equivalent structure across groups[16]. Additionally, CFA in the Chinese version also indicated appropriate model fitness[16]. Convergent and discriminant validity have been supported through correlations with anxiety, depression, and quality of life measures, as well as comparisons with the Positive and Negative Affect Schedule (PANAS) and CES-D[4,5,12,16]. In terms of factor structure, the ASC has shown both a two-factor structure (cancer worry and health worry) in its original version and a unidimensional structure in Turkish and Chinese adaptations, reflecting its cross-cultural flexibility[14,15]. Moreover, studies in diverse samples—including thyroid, gynecological, breast, genitourinary, melanoma, and thoracic cancer patients—have confirmed its adequate psychometric performance[4,12,14,15]. The ASC has also been carefully adapted for use in different cultural contexts, ensuring conceptual equivalence across languages and populations[14,15]. Furthermore, its focus on survivor-specific concerns distinguishes it from other general distress or fear of recurrence scales, offering a more precise approach to understanding cancer-related worry[16], The Chinese version, for example, showed excellent internal consistency (α = 0.91), strong composite reliability, and satisfactory average variance extracted, further supporting its construct validity in different cultural and clinical contexts[15]. These findings suggest that the ASC is a robust, flexible instrument with solid psychometric evidence, making it a valuable tool for both clinical and research purposes in survivorship care.

Despite evidence supporting the utility of the ASC in different populations[4,12,14,15], to our knowledge, there are no studies analyzing the psychometric properties of the instrument in a broad Spanish population of cancer patients and probing measurement invariance according to age, sex, or tumor type. Measurement invariance ensures that instruments measure the same construct regardless of demographic characteristics or clinical factors, such as tumor type. Based on these considerations, the objectives of this study are (i) to assess the factorial structure of the Spanish version of the ASC in a heterogeneous sample of cancer patients, (ii) to examine the measurement invariance of ASC scores in subgroups defined by sex, age, and tumor location, (iii) to verify the appropriateness and accuracy of the measure, both marginally and conditionally, and (iv) to evaluate the construct validity of ASC scores with anxiety, depression, and quality of life. In line with the *Standards for Educational and Psychological Testing*[17] and the argument-based approach to validation[18,19] this study conceptualizes validity as an ongoing process of gathering evidence to support the interpretation and use of ASC scores in Spanish cancer patients.

Methods

Participants

This study included a total of 1,052 patients, of whom 583 (55%) were male and 469 (45%) were female. The average age of the participants was 65.8 years (standard deviation = 11.1). Most were married or in a relationship (68%) and had a high school level of education (52%), while 69% were retired or unemployed. In terms of clinical characteristics, the most common cancer types were thoracic (30%), digestive (41%), and breast (12%). The predominant histology was adenocarcinoma (64%) and most cases were stage IV (80%). The most prevalent treatment was chemotherapy (52%), see Table 1.

Instruments

Participants' sociodemographic information was gathered through a self-report questionnaire that included age, sex, marital status, educational level, and employment status. Clinical information, including tumor site, histology, stage, and treatment type, was obtained from patients' medical records by oncologists.

Assessment of Survivor Concerns (ASC) is a 6-item instrument used to inquire into cancer-related worry[16]. The scale comprises three questions related to cancer worry, covering concerns about diagnostic tests, developing other types of tumors, and cancer progression. And three questions about health worry, encompassing fear of death, personal health, and children's health[16]. Items are rated on a 4-point Likert scale, ranging from 1 ("Not at all") to 4 ("Very much"). Possible scores range from 6 to 24; higher scores indicate greater worry. The internal reliability, previously assessed by Gotay and Pagano[16], was 0.93 for the cancer worry subscale and 0.63 for health worry (with an alpha of 0.93 if the question about children's health is removed). According to the original authors, 19% did not answer this question, suggesting the possibility of its removal in future studies[16].

ASC Adaptation Process First, a bibliographic review was conducted to determine if a Spanish version of the ASC questionnaire already existed. Following this, one of the authors of the questionnaire (C. Gotay) was contacted to request permission for the translation, adaptation, and validation of the ASC in the Spanish context. The adaptation process sought to maintain linguistic coherence between the Spanish version and the original version (ASC) to minimize variations in item interpretation. We followed the cross-cultural adaptation guidelines outlined by Hambleton, Merenda, and Spielberger[20] for self-reported measures. Initially, two proficient bilingual translators, with extensive knowledge of English and Spanish, independently translated the original questionnaire from English to Spanish. These translators collaborated to reach a consensus on translations of words, phrases, and elements, combining their work with reference to the original questionnaire as well as their individual translations. To ensure cultural suitability and content validity, four unaffiliated medical professionals and psychologists carried out the evaluations, assessing comprehensibility, translation equivalence, and content

Demographic characteristics	*N*	%
Age (Mean ± Standard Deviation)	65.8 ± 11.1	
Sex		
Male	583	55
Female	469	45
Marital status		
Married or partnered	711	68
Not partnered	341	32
Education		
≤ Primary	505	48
>High School	547	52
Employed		
Yes	434	41
No (retired or unemployed)	618	69
Clinical characteristics		
Tumor site		
Thoracic	318	30
Digestive	426	41
Breast	126	12
Others	182	17
Stage (n, %)		
Locally advanced	214	20
IV	838	80
Histology		
Adenocarcinoma	675	64
Others	377	36
Systemic treatment		
Chemotherapy	550	52
Others	127	12
Others without CTx,	375	36

Table 1. Patient baseline demographic characteristics ($n = 1052$).

validity. Subsequently, two additional bilingual translators, who were unfamiliar with the original English version, back translated the revised Spanish version into English. The study directors then compared and synthesized the back-translation with the original questionnaire to produce the final version.

Brief Symptom Inventory (BSI-18) consists of 18 symptoms used to assess distress on a five-point scale ranging from "not at all" (0) to "extremely" (4)[21]. This instrument provides three categories of symptoms (somatization, depression, and anxiety) and generates an overall score known as the Global Severity Index (GSI). Internal consistency reliability estimates ranged from 0.75 to 0.88 in the Spanish sample with cancer[22].

European Organization for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC QLQ-C30) is widely used in Europe to examine quality of life and has proven its validity[23]. Responses on this questionnaire are rated on a scale from 1 (not at all) to 4 (very much), with the exception of the global quality of life scale, for which responses range from 1 (very poor) to 7 (excellent). All scores on the scales are linearly transformed to a range of 0 to 100. As for the functioning scales and global quality of life scale, higher scores represent a higher degree of functioning or quality of life, while for the symptom scales, a higher score indicates a greater symptom burden. Internal consistency reliability estimates ranged from 0.86 to 0.94 in the Spanish cancer sample[24].

Procedure

Fifteen hospitals in Spain participated in a prospective and observational study between February 2020 to September 2023. The study is part of a research program focused on cancer patients and funded by the bioethics section of the Spanish Society of Medical Oncology (SEOM). Approval to conduct the study was obtained from the Ethics Committees of each institution and the Spanish Agency of Medicines and Medical Devices (AEMPS; identification code: ES14042015). Participants were consecutively recruited from the oncology departments of the participating hospitals. All questionnaires were administered in a paper-and-pencil format during medical appointments, under the supervision of trained research assistants. Participants were eligible if they were 18 years of age or older, had a histologically confirmed diagnosis of advanced cancer, and were ineligible for surgery or other curative treatments. All participants provided informed consent prior to participation. Individuals with severe mental disorders that could interfere with questionnaire completion—such as psychotic disorders, bipolar disorder, or cognitive impairment—were excluded. Detailed instructions for completing the questionnaires were

provided. Data collection procedures were uniform across all hospitals and patient-related information was obtained from the respective treatment institutions. Participation was voluntary, anonymous, and had no impact on their medical care. Of the initial group of 1,166 recruited individuals, 1,052 met the inclusion criteria. A total of 114 were excluded: 61 did not meet the inclusion criteria; 41 met exclusion criteria, and 12 provided incomplete data.

Sample size justification

Specifically, we use a new algorithm known as SENECA[25] that allows to estimate the sample size required to compute factor analyses (exploratory and confirmatory) for a previously specified level of precision in terms of Root Mean Square of Residuals (RMSR). In our analysis, we defined a precision level of RMSR of 0.04 (i.e., the averaged differences between the observed correlations and the estimated from the model correlations was equal or lower than 0.04). The sample size suggested by SENECA was 300. In the present study, we included a large sample of 1,052 patients, which far exceeds this recommendation. This substantial sample size not only supports the psychometric analyses but also allowed us to perform subgroup analyses (e.g., by gender, age, and tumor site) to examine measurement invariance reliably.

Data analyses

The total sample was randomly divided into two equivalent subsamples using the Solomon procedure[26]. In the first subsample, an Exploratory Factor Analysis (EFA) was conducted using FACTOR software[27] to examine the dimensional structure and identify potential correlated residuals. In the second subsample, a Confirmatory Factor Analysis (CFA) was performed with Mplus to replicate the factor structure identified in the EFA. The CFA model was then applied to the total sample to assess measurement invariance across sex, age, and tumor site.

Given the conditions of the study, item scores were treated as ordered-categorical variables, and all structural analyses at the item level were (a) based on polychoric inter-item correlations and (b) fitted using robust estimation methods as implemented in FACTOR and Mplus. In the EFA, correlated residuals were explored using MORGANA factor analysis extraction[28]. These residual correlations (or "doublets") were also assessed using the EREC index[29], with values ranging from 0 to 1; substantial values above the cut-off criterion suggest that a pair of items shares specific variance beyond what can be explained by the common factors.

Model fit and appropriateness were evaluated using four indices that examined different facets of fit: comparative fit (CFI and TLI), absolute fit (RMSEA), and residual-based fit (SRMR). Reference values of CFI and TLI ≥ 0.95, RMSEA ≤ 0.06, and SRMR ≤ 0.08 indicate good model fit[30]. Descriptive analyses were conducted for ASC, exploring means, standard deviations, and distributions of the item scores.

Data adequacy was assessed using the Kaiser–Meyer–Olkin (KMO) test and Normed-MSA indices. Normed-MSA values below 0.50 indicated potential item removal[31]. Optimal Parallel Analysis[32] established the recommended number of factors. Essential unidimensionality was evaluated using Unidimensional Congruence (UniCo), Explained Common Variance (ECV), and Mean of Item Residual Absolute Loadings (MIREAL) indices[33]; values exceeding 0.95, ECV >0.85, and MIREAL < 0.30 identified essential unidimensionality.

After confirming the dimensional structure with EFA, the CFA was carried out on the second subsample to assess factor structure replicability. The common CFA solution was then applied to the total sample for comprehensive analysis. Subsequently, measurement invariance analyses were conducted to examine the stability of the factor structure across different groups.

The CFA solution was tested for measurement invariance in groups defined by sex (two groups), age (two groups), and tumor site (four groups). To evaluate invariance, a sequence of nested models was estimated: a configural model (same factor structure across groups with freely estimated parameters), a metric invariance model (constraining factor loadings to be equal across groups), and a scalar invariance model (constraining both loadings and thresholds). Model comparisons were conducted using changes in CFI and RMSEA, with ΔCFI $\leq$ 0.01 and ΔRMSEA $\leq$ 0.015 indicating acceptable invariance, following Cheung and Rensvold[34]. Establishing scalar invariance allows meaningful interpretation of latent mean differences across groups.

Finally, scoring properties were examined to evaluate the performance of different score types and their practical implications. The ASC, a narrow-bandwidth measure, addresses potential issues such as redundancies and inflated item discriminations[35]. Redundancies were resolved to ensure accurate reliability estimates. Scoring aspects—including the behavior of "optimal" scores (i.e., Expected A Posteriori [EAP] scores derived from the factor model to maximize measurement precision) and the effectiveness of simple sum scores—were investigated[36]. Reliability estimates, test information curves, McDonald's omega, the fidelity coefficient, and regression plots were used to evaluate psychometric accuracy and associations of ASC scores with external variables.

Results

Descriptive statistics

Descriptive statistics of the ASC can be found in Table 2. Item scores ranged from 2.58 to 3.41. ASC item score distributions were unimodal and asymmetrical, thereby indicating that most of the values were concentrated at the highest end of the response scale. All the corrected item-total correlations surpassed 0.570, except for item 6. This estimate, however, is still supposed to provide a non-negligible amount of information to measure the construct.

Exploratory factor analysis of the first Solomon subsample

The inter-item polychoric correlation matrix had good properties (KMO = 0.834; 95% confidence interval, 0.784 – 0.858). Normed-MSA for items ranged from 0.76 to 0.92. These outcomes indicated that the correlation matrix is well suited and that all 6 items contribute effectively to the common variance. Parallel analyses revealed that

Items	M	SD	Skews	Item-total correlations
1. I worry about futures diagnostic tests.	2.87	1.07	-0.52	0.634
2. I worry about another type of cancer.	2.70	1.14	-0.28	0.660
3. I worry about my cancer coming back.	2.86	1.14	-0.47	0.722
4. I worry about dying.	2.58	1.18	-0.08	0.570
5. I worry about my health.	3.41	0.85	-1.29	0.576
6. I worry about my children's health.	3.20	1.16	-1.06	0.249
ASC total	17.62	4.66	-0.44	

Table 2. ASC characteristics.

Doublets	Residual Correlations	95% confidence interval
2 & 3	0.516	0.387 – 0.645
5 & 6	0.290	0.151 – 0.423

Table 3. Pairs of items with freely estimated residuals.

Item	Loading value	95% Confidence interval
1	0.811	0.770 – 0.848
2	0.782	0.739 – 0.821
3	0.851	0.811 – 0.890
4	0.749	0.700 – 0.792
5	0.724	0.671 – 0.774
6	0.313	0.239 – 0.392

Table 4. Factor loading for total sample.

a single dimension accounted for 43.27% of the common variance and suggested a single factor to be extracted. Moreover, the essential unidimensionality index values were UNICO = 0.927, ECV = 0.876, and MIREAL = 0.239. The only item that had a low contribution to the unidimensionality was item 6. These outcomes also point toward a single dimension underlying the 6 item scores as the most plausible for the dataset. The unidimensional factor analysis solution yielded acceptable goodness-of-fit levels: RMSEA = 0.038, CFI = 0.998, GFI > 0.999, and SRMR = 0.029. The bootstrap 95% confidence intervals of factor loading overlapped for five items, while the corresponding confidence interval for item 6 (the one with the lowest loading value) suggested that this item had a significantly lowest loading value than the other five. Overall, the conclusion of the EFA was that the one-factor solution was the most acceptable for the ASC items. Furthermore, the results indicated that five (out of the six) items had comparable loading. Finally, doublets that were freely estimated by MORGANA factor analysis are shown in Table 3. The EREC index values for these two doublets indicated that their presence was unlikely to be due to random fluctuations.

As the literature reports that the intended ASC structure is bidimensional (the three first items related to one factor, and the three other items related to a second factor), we also extracted two factors in order to examine into this possibility. When two factors were extracted, five items loaded together (factor loading between 0.61 and 0.85), and the sixth item defined a separate factor (with a loading of 0.85). The inter-factor correlation value was 0.36. Moreover, only a single substantial doublet was now observed between items 2 and 3 (value of 0.49). The examination of this two-factor solution led us to reject it as an appropriate factor structure for the Spanish population.

Confirmatory factor analysis on the second Solomon subsample and on the total sample

The fit of the CFA unidimensional solution with two specified doublets (2 & 3 and 5 & 6) in the second subsample was quite reasonable and, given that both EFA and CFA specifications lead to the same solution in both subsamples, the CFA solution above was fitted finally to the total sample. Again, the fit was adequate: CFI = 0.994, TLI = 0.992, RMSEA = 0.050, and SRMR = 0.027. Table 4 presents loading estimates. As discussed above, the factor loadings, which were high (except for item 6), suggesting acceptable measurement accuracy even with this small set of items. In addition, the residual correlation estimates for the two specified doublets were 0.499 and 0.313, for pairs 2 & 3 and 5 & 6, respectively.

Measurement invariance

To assess measurement invariance, a sequence of nested models was tested in groups defined by sex (two groups), age (two groups), and tumor site (four groups). Specifically, we examined a configural model (same factor structure across groups with freely estimated parameters), a metric model (constraining factor loadings

to be equal across groups), and a scalar (strong) invariance model (constraining both loadings and thresholds). Because robust mean-and-variance corrected estimation procedures were used, traditional chi-squared difference tests were not applicable. Therefore, model comparisons were conducted using changes in CFI and RMSEA, with $\Delta CFI \leq 0.01$ and $\Delta RMSEA \leq 0.015$ indicating acceptable invariance, following Cheung & Rensvold[34].

The strongly invariant solutions had an excellent fit in all the multiple group analyses considered here. Furthermore, in relative and parsimony terms, they showed as good or even slightly better relative fit indices (RMSEA and CFI) than less restricted models, which is consistent with the strenght of the factor structure. Based on these results, the scalar (strong) invariance solution was selected and is reported in Table 5, which includes the fit indices for all models tested and the estimated latent means.

Group differences

To interpret mean differences, we note that (for identification purposes) the means are always fixed to zero in the first group and freely estimated in the rest. These solutions, although more restricted and parsimonious, showed acceptable fit and were preferred over less constrained alternatives based on parsimony and invariance criteria. The results indicate that women tend to have higher scores than men (mean difference = 0.179, $p < .01$), and younger individuals score higher than their older counterparts (mean difference= -0.279, $p < .001$). However, no significant mean differences were observed based on tumor site.

ASC score properties and accuracy

The optimal scores referred to above, and based on the structural solution in Table 4, were the EAP score estimates (see[37]. When they were used, their marginal reliability estimate was 0.84, which is acceptable for such a short test. More importantly however, is how reliably the EAP scores measure over the trait range (i.e., the information curve). This point was graphically assessed in Fig. 1, in which conditional reliability is plotted as a function of the trait level.

Figure 1 illustrates that the peak of the curve is attained at about one half a standard deviation below the mean, indicating that the EAP scores measure better at the middle-low trait levels. Moreover, the scores are seen to provide reasonable accuracy for the range of values that contains most of the respondents (between two standard deviations below the mean and almost two standard deviations above). Finally, the reliability clearly falls dramatically at the upper end of the continuum.

We turn now to the behavior of the simple sum scores. The omega reliability estimate (which is the appropriate estimate for these scores) was $\omega = 0.83$, only slightly below the marginal reliability of the "optimal" EAP scores. Furthermore, the relation between the sum scores and the EAP scores was essentially linear throughout the trait range (a result that can be predicted from Fig. 1). Finally, both sets of scores correlated 0.97 and the fidelity coefficient was 0.91. To sum up, the simple ASC sum scores can be properly used as proxies for the optimal (but more computationally demanding) EAP scores[36].

Validity evidence based on relations with other variables

The core, invariant CFA solution described above was used as a basis for a structural equation model including seven external variables to assess validity evidence based on relations with other variables. Model-data fit was quite good: RMSEA = 0.033, and CFI = 0.987. Table 6 provides the estimates for this validity model. These estimates are standardized weights and can be interpreted as disattenuated validity coefficients, in which ASC estimates are corrected for measurement error. The ASC factor revealed positive associations with psychological factors such as depression, anxiety, and global psychological distress (GSI), as well as functional scale, symptomatology, and quality of life.

Discussion

This pioneering study, based on a large sample of 1,052 metastatic cancer patients, is the first to validate the ASC in the Spanish population, providing robust evidence of the reliability and validity of its scores. These results are consistent with the framework proposed in the Standards for Educational and Psychological Testing[17] and contribute to a validity argument supporting the interpretation of ASC scores in this population[18,19]. The sample of advanced cancer patients in this study exhibited significant levels of cancer concern, as reflected in responses

Group	Model	χ^2 (df)	CFI	RMSEA (90% CI)
Sex	Configural	–	0.996	0.036 (0.01;0.06)
	Metric	–	0.996	0.036 (0.01;0.06)
	Scalar	51.95(30)	0.993	0.037 (0.02;0.05)
Age group	Configural	–	0.992	0.040 (0.02;0.05)
	Metric	–	0.991	0.042 (0.02;0.06)
	Scalar	56.89(30)	0.991	0.041 (0.02;0.05)
Tumor site	Configural	–	–	–
	Metric	–	0.994	0.035 (0.00;0.06)
	Scalar	92.77(76)	0.993	0.029 (0.00;0.048)

Table 5. Fit indices for measurement invariance models across groups. Note. For tumor site, the configural model did not converge.

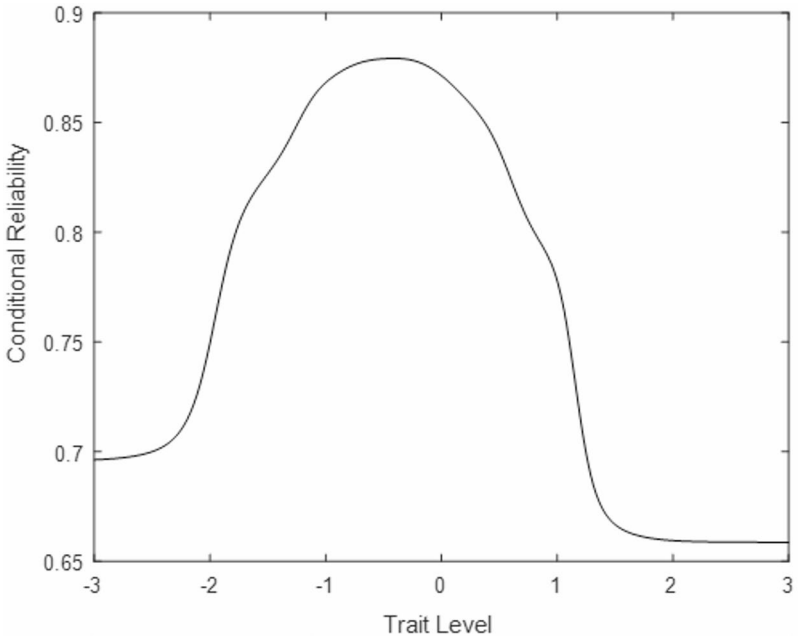

Fig. 1. Conditional reliability estimates as a function of trait level.

Variables	Estimate	*p* value
ASC score	0.245	< 0.001
Depression	0.472	< 0.001
Anxiety	0.547	< 0.001
Psychological distress	0.501	< 0.001
Functional Scale	− 0.350	< 0.001
Symptomatology	0.227	< 0.001
Quality of life	− 0.248	< 0.001

Table 6. Structural validity estimates for the ASC factor.

predominantly located at the upper end of the scale. This finding is consistent with previous studies that have noted that between 22% and 87% of cancer patients experience moderate to high levels of cancer concern[38,39], and it is one of the factors the silently dominates patients' lives[40].

Factor analysis (EFA and CFA) revealed that the six items of the ASC scale positively contribute to common variance, supporting a unidimensional model with one factor explaining 43% of the variance. Similar results were found in a sample of Turkish cancer patients, in which a unidimensional structure of the scale was also identified[14]. In our study, unlike the originally proposed bidimensional structure and despite a lower contribution of item 6, the single-factor solution exhibited acceptable levels of fit. The strong connection between most items and the overall measure supports the validity of the scale for assessing cancer-related concern. Nevertheless, the original authors consider the possibility of removing item 6, not due to its low contribution to the concept, but because 19% of participants tend not to respond to the question related to concern about their children's health[16]. In general, the factor loadings obtained in this study were relatively high compared to typical values in personality measures (usually around 0.40 to 0.70). These higher loadings support the strength, replicability, and stability of the ASC structure and suggest strong associations between items and the underlying construct. From a clinical perspective, the ASC can be a useful screening tool to identify cancer patients experiencing elevated worry levels that may require psychological support. Its brevity and ease of administration make it suitable for routine oncology settings, facilitating early detection of distress and personalized psycho-oncological interventions.

The invariance analysis demonstrated that the scale consistently measures the same construct across different demographic groups. These results support the applicability of the ASC scale in metastatic cancer patients, providing reliable and valid scores to assess concern related to the disease in this specific clinical population. Nevertheless, in terms of average assessment, women scored higher than men, and younger participants scored higher than their older counterparts. No significant differences were observed based on tumor location. These findings align with previous research indicating sex and age to be predictors of cancer concern. Women report higher rates of concern than men[2,7], and younger individuals tend to have higher scores compared to older patients[4,39]. Tumor location was not associated with significant differences in the intensity of concern[10].

Regarding the scale's accuracy, the comparison between EAP scores and simple sum scores indicates that the latter are a valid and practical alternative, which can be useful in clinical settings where efficiency is paramount. Concerning the precision of the scale scores, these vary across the range of concern levels, with scores measuring moderate to low levels of concern being more reliable and less precise than higher concern levels. This may be because patients with clinical levels of cancer concern are more likely to have psychiatric comorbidity[41]. The presence of comorbidity can contribute to increased variability in patients' responses on the cancer concern scale, complicating score interpretation.

The association of the ASC with psychological and functional dimensions aligns with findings from previous studies, supporting the robustness of the scale's construct[5,11]. In general, higher levels of concern are linked to increased depression and anxiety[5,12], as well as greater psychological distress and a decline in quality of life[5]. Our study confirms that patients with higher concern levels exhibit more symptoms of depression, anxiety, psychological distress, and physical symptoms. Given the emotional burden associated with concern. It is essential to prioritize the identification of patients with clinical levels of concern and to implement standardized assessments that enable accurate measurement of this concept, facilitating the distinction between normal and elevated or clinical levels.

For future research, the ASC provides a robust measure for longitudinal studies exploring how cancer-related concern evolves over the disease trajectory and how it interacts with treatment outcomes and quality of life.

This study has various **strengths and limitations**. Among its strengths, it highlights the comprehensive analysis of the psychometric properties of the ASC scale in a large sample of individuals with various types of cancer. The ability to randomly split the sample for exploratory and confirmatory analyses adds robustness to the findings. However, a potential limitation lies in the cross-sectional design of the study, which prevents establishing causal interpretations or identifying possible mediating effects. Additional longitudinal assessments of the ASC are needed to validate its performance in different clinical populations. Another limitation is that most participants were in stage IV, whereas previous studies have shown higher levels of concern in earlier stages of the disease, particularly among stage II patients. This may partly explain the response distribution observed in our sample. In addition, the study did not include a test–retest reliability assessment, which would be useful to confirm the temporal stability of ASC scores. Lastly, participant self-selection must be addressed, as the voluntary nature of participation could introduce biases that should be considered when interpreting the results.

Conclusion

In conclusion, the adaptation of the ASC to Spanish proves reliable and valid score-based evidence in metastatic cancer patients. Its brevity, with a mere six items, makes it a practical tool in clinical settings, minimizing the burden for participants, which is crucial when assessing concerns in patients with serious illnesses. Since cancer concern can have a significant impact on the emotional well-being and quality of life of these patients, the ASC emerges as a valuable instrument to identify specific areas of intervention and support in the clinical setting.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding authors on reasonable request.

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Author contributions

C.C.: Conceptualization, Formal analysis, Investigation, Methodology, Writing-original draft, Writing-review and editing, and Funding acquisition. U.L.-S.: Conceptualization, Data curation, Investigation, Methodology, Supervision, Writing-original draft, Writing-review and editing. P.J.F.: Conceptualization, Data curation, Investigation, Methodology, Supervision, Writing-original draft, Writing-review and editing. M.J.C.: Writing-review and editing. M.O.-A.: Writing-review and editing. P.J.-F.: Conceptualization, Data curation, Project administration, Investigation, Writing-review and editing, and Funding acquisition. All authors reviewed the manuscript.

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Declarations

Competing interests
The authors declare no competing interests.

Ethics approval and consent to participate
This study was approved by the Research Ethics Committee of the Principality of Asturias, serving as the reference committee, and was accepted by the ethics committees of the other participating centers. It was classified as observational and approved by the Spanish Agency of Medicines and Medical Devices (AEMPS) (identification code: L34LM-MM2GH-Y925U-RJDHQ). The acceptance date of the 15 centers and clinical research ethics committees was (1) Hospital Universitario de Canarias, Tenerife (20 June 2020); (2) Hospital Universitario La Paz, Madrid (4 March 2020); (3) Hospital Universitario Central de Asturias, Oviedo (17 May 2019)—reference committee; (4) Complejo Hospitalario Universitario de Ourense, Orense (7 January 2020); (5) Hospital Universitario Infanta Leonor, Madrid (15 May 2020); (6) Consorcio Hospital General Universitario de Valencia, Valencia (4 September 2020); (7) Hospital General Virgen de la Luz, Cuenca (10 March 2020); (8) Hospital Provincial de Castellón, Castellón (23 July 2020); (9) Hospital General Universitario de Elche, Elche (20 March 2020); (10) Hospital Universitario Clínico San Carlos, Madrid (19 January 2020); (11) Hospital San Pedro de Alcántara, Cáceres (26 June 2020); (12) Hospital Universitario Morales Meseguer, Murcia (8 July 2020); (13) Hospital Quironsalud Sagrado Corazón, Sevilla (13 February 2020); (14) Hospital General Universitario Santa Lucia, Cartagena (14 October 2020); (15) Hospital General Universitario de Ciudad Real, Ciudad Real (18 November 2020). This study was performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments. This study was an observational, non-interventionist trial. Signed informed consent was obtained from all patients.

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