



Factor structure and measurement invariance by gender of the GHQ12 scale among parents of children with cancer

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Abstract

Introduction: Although widely used, the General Health Questionnaire-12 (GHQ-12) has a model structure that remains open to debate. Initially conceived as unidimensional in earlier studies; however, numerous other research studies have proposed a multidimensional of GHQ-12.

Objectives: To assess the factor structure, internal reliability and invariance measure of a Moroccan GHQ-12 in a population of parents of children treated for cancer.

Patients and Methods: A total of 232 participants performed the Moroccan GHQ-12. The data obtained were subjected to exploratory factor analysis (EFA) to determine the potential factor structure of the scale of GHQ-12. Confirmatory factor analysis (CFA) models from previous studies are conducted for model fitting.

Results: The three-factor model was selected for its characteristics to best capture psychological distress ($\chi^2/dF=2.29$, CFI=0.92, RMSEA=0.074) obtained by EFA. The reliability and construct validity of this model were satisfactory. The CFAs supported the configurational, scalar and metric invariances of this model.

Conclusion: The study validated the use of the scale of GHQ-12 in the assessment of psychological distress in parents of children with cancer, while proposing a three-factor model adapted to the Moroccan context which would enable targeted preventive interventions to be put in place.



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Introduction

The psychological distress of parents whose children have cancer is an area of major concern, as these parents face an extremely stressful and traumatic situation. The growing attention of researchers to the mental health occurring in parents of children treated for cancer has led to an increased demand for valid and reliable research instruments to accurately assess their psychological distress (1-3). Such assessments are essential if we are to plan, implement and evaluate appropriate interventions aimed at improving the mental health of this group. The diagnostic and statistical manual of mental disorders is the most commonly used clinical tool for identifying symptoms of mental illness (4-6). However, it is not designed to assess minor psychiatric symptoms such as depression, anxiety and psychological distress (7). In response to this necessity, Sterling (8) developed the General Health Questionnaire

(GHQ), one of the most widely used tools for assessing general health, including mental health, in a variety of settings. The complete GHQ included 60 items (Q-60), but shortened versions were developed, such as Q-30, Q-28, Q-20 and Q-12. Of these adaptations, Q-12 is the most widely used (8). Its popularity over longer versions is mainly due to its brevity, self-administration and ability to produce reliable, robust results. The GHQ-12 was chosen by the World Organization of Health for the diagnosis of psychological diseases in primary care, due to its superior reliability compared with other similar screening tools (9). Numerous studies have demonstrated that the GHQ-12 present good psychometric characteristics in diverse populations across several countries. Although mostly used, GHQ-12 factor structure remains open to debate. Initially conceived as unidimensional, earlier studies, such as that conducted by Hankins et al,

Key point

The psychological distress of parents treated for cancer is an area of major concern. The GHQ-12 scale is a tool used for assessing this disorder. Exploratory and confirmatory factor analysis showed a reliable and valid construction of three-factor model. This study suggest that this tool could be useful in the early detection of distress symptoms in Moroccan parents, enabling targeted preventive interventions to be put in place.

supported the idea of a one-factor structure for the GHQ-12, asserting that the questionnaire measures a single global dimension of psychological distress (10). However, much other research has suggested that the GHQ-12 could be multidimensional (11–13) with both two- and three-factor models tested and conducted. Previously, Graetz has proposed three-factor model which have been validated by confirmatory analyses and has received high empirical support (14). These three-factors comprise: anxiety, loss of self-confidence and social dysfunction. At the same time, other studies have also identified three dimensions in the GHQ-12, but have assigned different names to the factors than those proposed by Graetz (14). For example, the Daradkeh exploratory factor analysis (EFA) revealed three dimensions: general dysphoria, lack of pleasure and social dysfunction (15). Likewise, del Pilar Sánchez-López and Dresch found that the three-factor are successful adaptation, stress and self-esteem too (16). Meanwhile, Martin and Newell, identified three factors, which he named self-esteem, stress and successful coping (17). However, the two-factor model has also been supported by studies based on EFA. The two-factor model, reproduced in different contexts, proposes the following alternatives: social dysfunction and dysphoria, social dysfunction and anxiety/depression, psychological distress and social dysfunction (18). Comparative studies by Kalliath et al in New Zealand (19) explored the factor structure of GHQ-12 in different countries and showed that, the structure of GHQ-12 can vary according to cultural context, sometimes confirming the unidimensional model in some countries (e.g. Western countries) and two- or three-dimensional models in others (20). It is therefore essential to carry out a thorough evaluation of the psychometric properties before using them on a large scale in a specific population, which could guide healthcare professionals in the design of adapted mental disorder prevention programs, specifically aimed at parents of children with cancer, who are likely to experience or already faced with psychological distress (21). In Morocco, no information is available on the factor structure of GHQ-12 scale among parents of children with cancer.

Objectives

Our study designed to assess factor structure and reliability of different-factor models of Moroccan GHQ-12 scale, with reference to the factor structures of previous research and to verify the reliability of this scale in the Moroccan

clinical context, particularly in the field of pediatric oncology, by analyzing internal consistency.

Patients and Methods**Participants**

A cross-sectional study was conducted on parents of children undergoing treatment for cancer admitted to the Rabat children's hospital, national reference center for the treatment of pediatric cancers in Morocco. Parents excluded from the study were those with a current or past psychiatric disorders, or those who refused participating in the study. Inclusion criteria included parents of children under 16 years treated for a confirmed cancer diagnosis during the last twelve weeks prior to the data collection period. Sample size was determined by the Schwartz formula, based on a prevalence rate of 50%, a precision of 0.05 and a confidence interval of 95%. Data were collected between June and September 2023, using a self-assessment questionnaire covering socio-demographic data and GHQ-12.

General Health Questionnaire

GHQ-12 is a widely used instrument in primary care for assessing psychological distress (8). The scale asks respondents whether they have recently experienced a particular symptom or behavior. Each item is scored on a four-point scale (less than usual, not more than usual, rather more than usual or much more than usual), giving a total score of 12 or 36, depending on the scoring method chosen. The most common scoring methods are bimodal [0-0-1-1] and Likert [0-1-2-3]. The Likert is a useful method for assessing the severity of symptoms on a continuum (22). The Likert scoring system is used. High score reflects severe degree of psychological distress (22).

Statistical analysis

Mean and standard deviation were calculated to characterize the sample. An EFA was performed, to determine whether the collected data would reproduce previously reported one-, two- or three-factor solutions. Beforehand, the value of Kaiser-Meyer-Olkin (≥ 0.5) and p-value of Bartlett's sphericity (< 0.001) were calculated (23). To evaluate various models of GHQ-12 latent structure, a series of confirmatory factor analyses (CFAs) were performed using structural equation modeling, based on robust maximum likelihood estimation. The models examined were compared to the results of previous studies into the factor structures of GHQ-12, and more specifically on three competing models that have been supported and validated by many other researchers. Model 1 corresponds to the original single-factor structure proposed by Andrich et al (24), with all 12 items considered for only one factor and measuring a single construct (psychiatric morbidity). Model 2 proposed by Andrich and van Schoubroeck was modeled as a two-dimensional measure comprising 12 items, six positive [items : 1, 3, 4, 7, 8, 12] and six negative [

items: 2, 5, 6, 9, 10, 11] (25). Model 3 is a model proposed by Graetz correlated with three factors including loss of confidence (2 items), social dysfunction and anhedonia (6 items), depression and anxiety (4 items) (14). Model 4 is the result of EFA, with GHQ-12 modeled as a three-latent-factor (anxiety, distress and social dysfunction). For assessing the fit of each model, some fit indices were used, including chi-square (χ^2) and its relationship to the number of degrees of freedom (χ^2/df), goodness-of-fit index (GFI), comparative fit index (CFI), and root-mean-square error approximation (RMSEA). A χ^2/df between 1 and 5 (26), CFI and GFI exceeded 0.90 (27) and RMSEA less than 0.08 (28) indicate an acceptable fit of the data collected to the model examined. The Akaike information criterion (AIC) was conducted to compare plausible alternative models; better fit is related to lower value of AIC. Convergent validity was tested by assessing the factor load of items and the average variance extracted (AVE) for each factor. The factor load of each element in this study and the AVE must not exceed 0.50 (29). Discriminant validity was tested following the method proposed by Jobst et al (30). To ensure adequate discriminant validity, the AVE square root should be superior to the inter-factor correlations. Internal reliability of the adopted model and factors was assessed using MacDonal's omega coefficient (ω) with a criterion value of >0.70 . The test-retest reliability between scale administrations was conducted on 60 parents during one week and evaluated using the coefficient of intra-class correlation ($ICC \geq 0.70$). Metric invariance (MI) of the adopted model, as a function of gender, was assessed using multi-group CFA (MGCFA). Three invariance tests that progress according to a hierarchical approach (31) were performed in this study; (a) configural invariance; latent constructs number and specific item loaded are assumed to be equivalent between groups, (b)

metric invariance and item-factor loadings are assumed to be equal between groups, (c) scalar invariance and item intercepts are assumed to be equal between groups. Higher model level was accepted with CFA value decreasing by 0.010, also a decrease in RMSEA by 0.015 and in SRMR by 0.030 on MI or by 0.150 on scalar invariance (32). Data was analyzed using SPSS and AMOS version 25.0, with significant threshold of 0.05.

Results

The statistics for the 12 items of GHQ-12 questionnaire are presented in Table 1. A mean score of 22.07 ± 6.83 (above the threshold of 12) was recorded. The items 5, 7 and 9 have recorded high scores (mean over 2.30) were items 5. This indicates that participants frequently experience high levels of tension, difficulty enjoying daily activities and feelings of depression. The factor loadings show the contribution of the item to the psychological distress factor. Values range from 0.352 to 0.702, indicating that some items, such as item 1 and 7, are more strongly related to the overall distress measure than others.

The GHQ-12 structure assessment was conducted using principal component analysis with rotation of varimax. The data collected met the Kaiser-Meyer-Olkin criteria for the sampling adequacy of 0.878. Bartlett's sphericity test shows acceptable fit ($\chi^2 = 871.6$; $P = 0.0001$). AFE produced a solution of three-factor, termed as follow; emotional distress (1, 5, 7, 9, and 12), anxiety (2, 6, 11) and social dysfunction (3, 4, 8, 11) and accounted for 57.8% of total item variance (Figure 1).

The CFA results are summarized in Table 2. Model adequacy was assessed using various adequacy indices. The analyses revealed that one-factor model was not acceptable. M2 and M3 were acceptable. However, the model 4 (three-dimensional developed in our study) offers

Table 1. Some descriptive statistics and loading for GHQ-12 items

Item	Code	Mean	Standard Deviation	Loading
1. Able to concentrate	GHQ12-1	2.26	0.890	0.702
2. Loss of sleep over worry	GHQ12-2	1.94	1.013	0.657
3. Playing a useful part	GHQ12-3	0.17	0.655	0.352
4. Capable of making decisions	GHQ12-4	1.19	1.243	0.655
5. Felt constantly under strain	GHQ12-5	2.68	0.591	0.655
6. Couldn't overcome difficulties	GHQ12-6	2.24	0.863	0.571
7. Enjoy activities by day-to-day	GHQ12-7	2.58	0.619	0.697
8. Able to face problems	GHQ12-8	0.95	1.196	0.590
9. Feeling unhappy and depressed	GHQ12-9	2.52	0.708	0.680
10. Losing confidence	GHQ12-10	1.61	1.165	0.681
11. Thinking of self as worthless	GHQ12-11	1.62	1.304	0.575
12. Feeling reasonably happy	GHQ12-12	2.32	0.606	0.644
Mean overall score		22.07	06.83	
Internal Consistency (ω)	0.84			

GHQ12: General Questionnaire of Health-12.

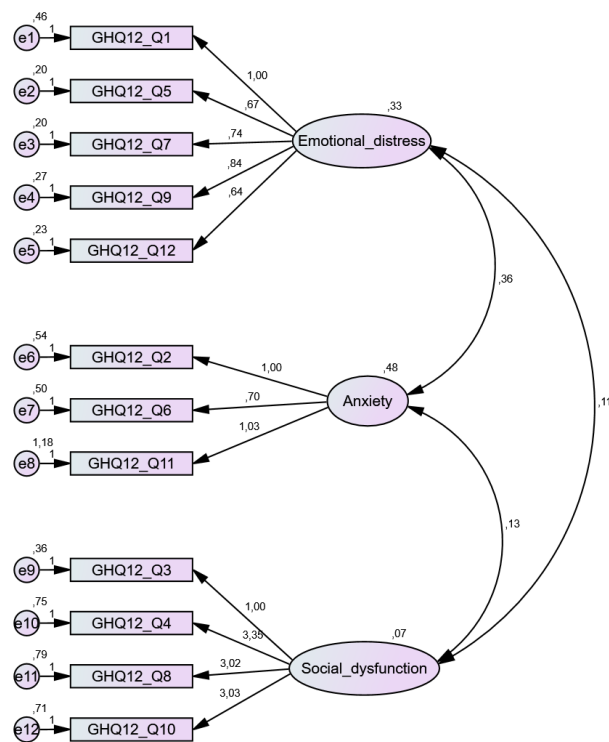


Figure 1. Path diagram of three-factor GHQ-12 model, with good fit indices ($\chi^2/df=2.29$, CFI=0.920, RMSEA=0.074, SRMR=0.056).

the best fit among the M1 and M2 models, demonstrating a very satisfactory fit with χ^2/df of 2.29, CFI of 0.92; GFI of 0.92; RMSEA of 0.074 and AIC of 171.22.

The GHQ12 total score was correlated with subscales of emotional distress, anxiety and social dysfunction. The *P* values of all correlations were below 0.01. The convergent validity was also moderately satisfactory, with factor loadings of 0.53 to 0.71 and statistically significant (Table 3).

The AVE of the three factors exceeded 0.5, indicating a convergent validity (Table 4). For the internal consistency, the MacDonal’s omega coefficient (ω) values for the model were satisfactory (0.84), while its subscales (0.61 to

0.78) were rather modest. Test and retest correlations were strong (above 0.80) (Table 4). These findings suggest that this scale has satisfactory reliability over time.

Discriminant validity: The diagonal represents the square root of the AVE for each factor, which should be higher than the values of correlations with the other factors. Thus, the square roots of the AVE for factors 1 (0.66), 2 (0.605) and 3 (0.633) are greater than their respective correlations, particularly between factors 1 and 2 (0.49) and factors 1 and 3 (0.57). These results indicate satisfactory discriminant validity for these factors (Table 5).

Table 6 presents the fit indices of CFAs testing the invariance by gender of the selected GHQ-12 three-factor model. The three-factor model fits the data well for each gender group separately. Indeed, the χ^2/df ratio, CFI and RMSEA indicate a good fit for both the male and female groups. Next, the invariance test is performed hierarchically. The configural model indicates that all groups have the same basic structure. The fit indices are good (CFI=0.945, RMSEA=0.043) indicating a similar model structure for men and women.

The metric model tests whether factor loadings are the same between groups. The change in fit indices ($\Delta CFI = -0.003$, $\Delta SMRMR = 0.000$ and $\Delta RMSEA = 0.003$) are minimal, indicating that metric invariance is confirmed.

Finally, the scalar model tests whether item intercepts are the same between groups. Change in the fit indices ($\Delta CFI = 0.004$, $\Delta SMRMR = 0.000$, $\Delta RMSEA = -0.001$) is also minimal, confirming scalar invariance, which implies that gender differences reflect true differences on latent constructs and not measurement bias.

Discussion

Given the absence of a GHQ-12 scale with a defined factor structure adapted to the Moroccan clinical context, our study tries to verify the factor structure of this scale using a CFAs approach with four different models in parents

Table 2. Fit quality indices for GHQ-12 tested model

Model	χ^2	df	χ^2/df	CFI	GFI	RMSEA	SRMR	AIC
M1	170.944	54	3.166	0.858	0.881	0.097	0.068	218.944
M2	121.928	53	2.301	0.916	0.922	0.075	0.057	171.928
M3	132.00	45	2.93	0.89	0.84	0.091	0.065	234.47
M4	117.227	51	2.29	0.920	0.924	0.074	0.056	171.227

Table 3. GHQ-12 and extracted factors correlations

	Score total GHQ	Emotional distress	Anxiety	Social dysfunction
Score total GHQ	-			
Emotional distress	0.867**	-		
Anxiety	0.800**	0.623**	-	
Social dysfunction	0.812**	0.570**	0.476**	-

** Significant at level 0.01.

Table 4. Moroccan GHQ-12 validity

		Standardized coefficient	Unstandardized coefficient	Coefficient omega d(ω)	ICC	AVE
F1 Emotional distress	GHQ12_Q1	0.65	1.000	0.781	0.87	0.51
	GHQ12_Q5	0.659	0.673			
	GHQ12_Q7	0.695	0.744			
	GHQ12_Q9	0.683	0.836			
	GHQ12_Q12	0.612	0.640			
F2 Anxiety	GHQ12_Q2	0.688	1.000	0.609	0.80	0.49
	GHQ12_Q6	0.67	0.703			
	GHQ12_Q11	0.695	1.033			
F3 Social dysfunction	GHQ12_Q3	0.621	1.000	0.716	0.91	0.5
	GHQ12_Q4	0.716	3.353			
	GHQ12_Q8	0.675	3.020			
	GHQ12_Q10	0.691	3.034			

of children treated for cancer. One model corresponded to original unidimensional model; two models based on the literature with details on the CFAs of this scale and a fourth model obtained from the EFA.

To the authors' knowledge, this is the first study that examined the factor structure of GHQ-12 in Moroccan clinical context, using psychometric properties of CFAs in a population of parents of children with cancer.

Overall, our results confirm the construct validity, internal consistency and gender invariance of the GHQ-12 (male versus female). The questionnaire has therefore proven its applicability to parents of children with cancer.

The EFA extracted from the GHQ-12 three common factors with eigenvalues >1.0, and found that they accounted for 57.6% of total item variance, which was greater compared to variance observed in Spanish population (54.2%) (16), Chinese professionals (56.7%) (33), which the value recommended and the recommended

is 50.0% (34).

CFAs results indicate that the three-factor model obtained by AFE offered superior fit compared to other models with satisfactory fit indices, such as χ^2/df , CFI, GFI, and RMSEA. This finding is in line with previous studies conducted in several cultural contexts, including the study by Liang et al (35), who found that three-factor model provided a better capture of the underlying dimensions of psychological distress. In their analysis of the GHQ-12 in a Malaysian population, Ibrahim and colleagues confirmed that the three-factor model better represented the cognitive, emotional and social aspects of stress, corroborating our findings (36). Similarly, CFA of a study conducted by Lee and Kim (37) among early childhood teachers found that Graetz's three-factor model, comprising depression and anxiety 4 items-factor [2, 5, 6, 9], social dysfunction 6 items-factor [1, 3, 4, 7, 8, 12] and loss of confidence 2 items-factor [10, 11], present a good fit. However, our results show a first factor, with 6 items [1, 5, 7, 9, 12] corresponds to the "Emotional distress" dimension and accounts for 39.4% of the variance, 3 items-factor [2, 6, 11] corresponds to the "Anxiety" dimension and accounts for 11.1% of the variance and common factor 3 gathered items [3, 4, 8, 10] reflecting the "Social dysfunction" dimension and accounts for 7.25%. The three-factor model obtained in our study differs from

Table 5. Fornell-Larcker criterion

	Emotional distress	Anxiety	Social dysfunction
Emotional distress	0.66	-	-
Anxiety	0.49	0.605	-
Social dysfunction	0.57	0.686	0.633

Table 6. Fit indices for the three-factor GHQ-12 model according to gender, invariance and CFAs

		χ^2 (df)	χ^2/df	CFI	ΔCFI	SRMR	$\Delta SRMR$	RMSEA (90% CI)	$\Delta RMSEA$
Gender	Male	37.854 (51)	0.742	1.000	-	0.0948	-	0.000 (0.000–0.050)	-
	Female	106.947 (51)	2.097	0.924	-	0.0574	-	0.073 (0.054–0.093)	-
CFA	Invariance nested model								
	Configural (unconstrained model)	145.571 (102)	1.427	0.945	-	0.0584	-	0.043 (0.026–0.058)	-
	Metric (equal factor loadings)	152.193 (111)	1.371	0.948	-0.003	0.0584	0.000	0.040 (0.022–0.055)	0.003
	Scalar (equal item intercepts)	161.6376 (117)	1.382	0.944	0.004	0.0584	0.000	0.041 (0.024–0.055)	-0.001

those previously mentioned, which could be explained by cultural and contextual variations that seem to influence the structure of factors in the assessment of psychological distress (12,33). In addition to the factorial aspects, the factorial model established in this study showed good reliability. Indeed, the overall results of the omega and intra-class coefficient were satisfactory. These results are consistent with a large number of psychometric studies of GHQ-12 conducted in different populations (11,15,38).

In terms of convergent and discriminant validity, our results show satisfactory validity, with saturation coefficients and extracted mean value greater than or equal to 0.5. These results are in line with those of Lee and Kim (37), who also found similar levels of convergent validity in their study of GHQ-12 in Korea. However, some studies, such as that by Gao et al (39), reported significant overlap between GHQ-12 factors, suggesting a more unitary structure in certain populations (39).

Finally, analysis of the invariance of three-factor model between the gender shows that GHQ-12 is invariant, enabling valid comparisons between men and women. This result is in line with study by Aloba et al, which confirmed similar GHQ-12 invariance in different populations (40). However, other studies have emphasized the importance of taking cultural differences and sample specificities into account when assessing invariance (32).

Conclusion

This study validated the use of GHQ-12 in the assessment of psychological distress in parents of children with cancer, while proposing a model with three dimensions including emotional distress, anxiety and social dysfunction adapted to the Moroccan context. The results suggest that this tool could be useful in the early detection of distress symptoms in parents, enabling targeted preventive interventions to be put in place.

Limitations of the study

The results of the study should be interpreted with some limitations in mind. Firstly, the relatively modest size of sample could affect the generalization of the results to a global population. In addition, the study focused on a single cultural and regional context, which limits comparison with other international studies. Despite these limitations, the study provided consistent evidence for the reliability of Moroccan GHQ-12, and its implementation could play a crucial role in the context of cancer on children as a rapid and effective screening instrument for psychological distress in parents. This would make it easier to identify those individuals most exposed to develop future psychological distress, thus facilitating the implementation of appropriate preventive measures. Future studies, carried out on larger and more diversified samples, are needed to deepen the practical evaluation of the factors identified by GHQ-12 scale.

Authors' contribution

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Methodology: Asmaa Marrakchi, Miloud Chakit.

Project administration: Aboubaker El Hessni & Abdelhalem Mesfioui.

Resources: Aboubaker El Hessni.

Software: Asmaa Marrakchi.

Supervision: Aboubaker El Hessni & Abdelhalem Mesfioui.

Validation: Aboubaker El Hessni & Abdelhalem Mesfioui.

Visualization: Miloud Chakit, Majdouline Obtel.

Writing—original draft: Asmaa Marrakchi.

Writing—review & editing: Asmaa Marrakchi, Miloud Chakit.

Conflicts of interest

The authors declare that they have no interest in conflict

Ethical issues

The surveys conducted in this study were carried out in accordance with the principles set out in the Declaration of Helsinki. The study protocol was approved by the Biomedical Research Ethics Committee of the University Mohammed V, Rabat (Ref #01/23). All parents/guardians of the participants have provided a written informed consent. All data collected were treated confidentially. Ethical issues (plagiarism, data fabrication, double publication) have been completely observed by the authors.

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