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Cross-cultural adaptation, reliability and validity of the Greek version of the Fremantle Back Awareness Questionnaire (FreBAQ-GR) in people with chronic non-specific low back pain

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Abstract

Background: Disturbed back-specific body perception is a recognised feature of chronic low back pain (CLBP). The Fremantle Back Awareness Questionnaire (FreBAQ) assesses this construct, but no Greek version was available.

Objective: To cross-culturally adapt the FreBAQ into Greek (FreBAQ-GR) and evaluate its measurement properties.

Methods: Forward–backward translation, expert review and pilot testing preceded validation in 100 adults with chronic non-specific LBP (52 women; 25–70 years) attending a physiotherapy practice. Structural validity was examined with principal axis factoring, Velicer's minimum average partial (MAP) test and parallel analysis; construct validity with Spearman correlations against pain intensity, disability (RMDQ), anxiety/depression (HADS, DASS-21), kinesiophobia (TSK) and catastrophising (PCS); internal consistency with Cronbach's α; and 5-day test–retest reliability (n = 33) with $ICC_{2,1}$, SEM and $MDC_{95\%}$.

Results: Content validity indices were 1.0. Both MAP and parallel analysis supported one factor, on which all nine items loaded (0.32–0.77; 41.4% common variance). Items 7, 9 and 2 had low communalities; a six-item version explained 51.1%. The FreBAQ-GR correlated with TSK (ρ = 0.58), HADS-Anxiety (0.50), DASS-21 subscales (0.33–0.48), PCS (0.35) and RMDQ (0.30), negatively with symptom duration (−0.27), and not with pain intensity, HADS-Depression or age. Cronbach's α was 0.85 (9-item) and 0.86 (6-item). The $ICC_{2,1}$ was 0.96 (95% CI 0.91–0.98), SEM 1.5 and $MDC_{95\%}$ 4.2 points. No floor or ceiling effects were found.

Conclusions: The FreBAQ-GR is reliable and valid for Greek-speaking people with CLBP. The nine-item total score is recommended for comparability with other versions; the six-item form requires confirmatory testing.

Highlights

- The FreBAQ was cross-culturally adapted into Greek with full content validity
- One factor was supported by Velicer's MAP test and parallel analysis
- Internal consistency was good (α = 0.85) and test–retest reliability excellent
- Back awareness correlated most with kinesiophobia, anxiety and stress
- The 9-item total score is advised; a 6-item form needs confirmatory testing

1. Introduction

Low back pain (LBP) is the leading cause of years lived with disability worldwide; between 1990 and 2019 its global incidence and associated disability-adjusted life years increased by approximately 50% and 47%, respectively, reaching an estimated 223.5 million incident cases in 2019 (Wang et al. 2022). A

considerable proportion of people with an acute episode go on to develop chronic LBP (CLBP), irrespective of the initial cause of symptoms (Balagué et al. 2012). Persistence of LBP is shaped by interacting biological, psychological and social factors (Nieminen et al. 2021; Liew et al. 2023). Alongside higher baseline pain intensity, depression, stress and pain catastrophising, lower primary somatosensory and corticomotor excitability in the acute phase explained an additional 15% of the variance in pain intensity six months later (Jenkins et al. 2023), and disturbed body perception in late pregnancy predicted persistent postpartum lumbopelvic pain (Goossens et al. 2021).

Sensorimotor dysfunction in persistent pain spans altered sensory feedback, multisensory cortical processing, sensorimotor integration and body representation, and is thought to contribute to the maintenance of pain (Tsay et al. 2015; Vittersø et al. 2022). In CLBP, these changes include altered trunk muscle structure and control (Hodges and Danneels 2019), reorganisation of somatosensory and motor cortical areas (Kregel et al. 2015; Goossens et al. 2019) and distorted perception of the size, shape, position and ownership of the back (Moseley 2008; Wand et al. 2016). Such perceptual disturbances are now incorporated into contemporary models of CLBP, such as the fit-for-purpose model, which conceptualises persistent back pain as a problem of how information about the back is sampled, weighted and interpreted (Wand et al. 2023). Interventions that target back perception, such as visual feedback, sensory discrimination training and graded sensorimotor retraining, have reduced pain in experimental and clinical studies (Wand et al. 2012, 2013; Nishigami et al. 2019; Bagg et al. 2022). Body-awareness approaches are also used within bodywork and movement therapies for people with persistent pain (Lundwall et al. 2019).

Despite this, back-specific body perception is rarely assessed in routine clinical practice. Self-report is the most feasible way to capture how the back feels to the person, and the Fremantle Back Awareness Questionnaire (FreBAQ) was developed for this purpose (Wand et al. 2014, 2016). The FreBAQ has since been adapted into Dutch, Japanese, German, Turkish, Persian, Hindi, Chinese, Spanish, Italian, Polish, French and Brazilian Portuguese (Janssens et al. 2017; Ehrenbrusthoff et al. 2018b; Nishigami et al. 2018; Erol et al. 2019; Mahmoudzadeh et al. 2020; Rao et al. 2021; Schäfer et al. 2021; Hu et al. 2022; García-Dopico et al. 2023a; Monticone et al. 2024; Budzisz et al. 2025; Homs et al. 2025; Claudio et al. 2026). A recent systematic review using the Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) recommended the FreBAQ over other body-perception questionnaires for people with CLBP, but rated the evidence for its structural validity as insufficient and for its measurement error as indeterminate, and called for further studies (Paredes Sanchez et al. 2025). No Greek version of the FreBAQ, or of any other back-specific body-perception questionnaire, is currently available.

Therefore, the aims of this study were (i) to translate and cross-culturally adapt the FreBAQ into Greek (FreBAQ-GR) and (ii) to evaluate its structural validity, construct validity, internal consistency, test–retest reliability and measurement error in Greek-speaking people with chronic non-specific LBP.

2. Materials and methods

2.1. Study design and ethics

This was a two-phase cross-sectional measurement study with a repeated-measures component for test–retest reliability. In the first phase the FreBAQ was translated and cross-culturally adapted into Greek; in the second phase its measurement properties were evaluated. The study is reported in line with the COSMIN reporting guideline for studies on measurement properties of patient-reported outcome measures (Gagnier et al. 2021). The protocol was approved by the Research Ethics Committee of the University of West Attica, Athens, Greece (approval no. 56006/17.06.2022) and the study was conducted according to the Declaration of Helsinki. All participants received a written information sheet and provided written informed consent before inclusion. Data were pseudonymised and handled according to the EU General Data Protection Regulation (2016/679).

2.2. Participants

Adults aged 20–70 years with non-specific LBP of more than three months' duration, who were able to read and understand Greek, were consecutively recruited from patients referred by their treating physician to a private physiotherapy practice in Athens, Greece, between September 2022 and January 2023. Exclusion criteria, determined by the referring clinicians, were: (1) previous spinal surgery; (2) nerve root pain; (3) evidence of specific spinal pathology (malignancy, infection, fracture or inflammatory disease); (4) other serious orthopaedic, medical or psychiatric conditions; (5) significant spinal deformity; (6) current pregnancy or less than six months post-partum; and (7) uncorrected visual impairment (Wand et al. 2012, 2014). All data were collected before the start of physiotherapy treatment. Sex was recorded as reported by participants.

A sample of at least 100 participants was targeted, as this satisfies both the 10-participants-per-item rule and the minimum of 100 recommended for factor analysis and for very good methodological quality of studies on structural validity and internal consistency (Sousa and Rojjanasrirat 2011; Mokkink et al. 2018; de Winter et al. 2009).

2.3. Cross-cultural adaptation

Permission was obtained from the developer of the FreBAQ (Prof. B.M. Wand). The adaptation followed established guidelines (Beaton et al. 2000; Sousa and Rojjanasrirat 2011). Two bilingual translators whose native language was Greek, one a health professional and one without a clinical background, independently produced forward translations, which were synthesised into a preliminary Greek version after resolution of minor discrepancies. Two bilingual translators - one native-English speaker and one non-native speaker with a strong command of English (comprising one health professional and one non-health professional) – who were blinded to the original questionnaire, independently back-translated the preliminary version into English. A six-member expert committee comprising a methodologist (the principal investigator), a health professional and all translators reviewed all versions for semantic, idiomatic, experiential and conceptual equivalence and agreed by consensus on the pre-final version.

The pre-final FreBAQ-GR was pilot-tested in 10 people with chronic non-specific LBP. Each pilot participant and each committee member rated the instructions and items of the questionnaire on a dichotomous scale (clear/unclear); when an element was rated as unclear, the respondent was asked to suggest how it should be rephrased for clarity. Any part of the questionnaire (instructions, items or response format) rated as unclear by at least 20% of the sample had to be re-evaluated (Sousa and Rojjanasrirat 2011). The committee members then evaluated each item for relevance to back-specific body perception (content-related validity) on a 4-point scale (1 = not relevant; 2 = unable to assess relevance; 3 = relevant but needs minor alteration; 4 = very relevant and succinct); items rated 1 or 2 required revision. The item-level content validity index (I-CVI) and the scale-level index using the averaging method (S-CVI/Ave) were then calculated (Yusoff 2019). Values of 1.00 for both the I-CVI and the S-CVI/Ave were set as the minimum acceptable, a stricter criterion than the I-CVI ≥ 0.83 and S-CVI/Ave ≥ 0.90 recommended for panels of six experts (Yusoff 2019), and any item not achieving them was to be revised and re-evaluated.

2.4. Procedures

Participants completed, in paper format and in the presence of one of two physiotherapy students (EI, VP), a demographic form (age, sex, height, body mass and symptom duration) and the questionnaires described below. To assess test–retest reliability, a convenience subsample of 33 participants completed the FreBAQ-GR a second time five days later, at the same time of day and under the same conditions, with no physiotherapy session or other new intervention in between.

2.5. Measures

2.5.1. Fremantle Back Awareness Questionnaire

The FreBAQ consists of nine items describing how the back may feel to people with LBP (Wand et al. 2014). Items 1–3 address neglect-like symptoms (derived from work on complex regional pain syndrome; Galer and Jensen 1999), items 4 and 5 proprioceptive acuity, and items 6–9 perceived size and shape of the back. Each item is rated on a 5-point scale from 0 (never feels like that) to 4 (always, or most of the time, feels like that), giving a total score of 0–36, with higher scores indicating greater disturbance of back awareness. The original version showed adequate internal consistency and a unidimensional structure on Rasch analysis, although item 8 showed misfit and items 4–6 were suggested as a possible second dimension (Wand et al. 2014, 2016).

2.5.2. Pain intensity

Average pain intensity over the previous week was rated on an 11-point numeric rating scale (NRS) from 0 (no pain) to 10 (worst imaginable pain). The NRS is a valid and reliable measure of pain intensity in people with LBP (Hawker et al. 2011; Chiarotto et al. 2019).

2.5.3. Roland-Morris Disability Questionnaire

The Roland-Morris Disability Questionnaire (RMDQ) contains 24 yes/no statements about activity limitations attributed to LBP on the day of completion, giving a score of 0–24, with higher scores indicating greater disability (Roland and Morris 1983). The validated Greek version was used (Boscainos et al. 2003).

2.5.4. Hospital Anxiety and Depression Scale

The Hospital Anxiety and Depression Scale (HADS) contains 14 items scored 0–3, forming anxiety (HADS-A) and depression (HADS-D) subscales of seven items each (range 0–21) and a total score (0–42) (Zigmond and Snaith 1983). Mean Cronbach's α values of 0.83 (HADS-A) and 0.82 (HADS-D) have been reported (Bjelland et al. 2002). The Greek version has been validated in a general hospital sample (Michopoulos et al. 2008).

2.5.5. Depression, Anxiety and Stress Scale-21

The Depression, Anxiety and Stress Scale-21 (DASS-21) contains three 7-item subscales (depression, anxiety and stress) rated 0–3 for the previous week. Following the standard procedure, subscale sums were multiplied by two to align them with the full 42-item version, giving subscale scores of 0–42 and a total score of 0–126 (Lovibond and Lovibond 1995). The Greek DASS-21 has shown acceptable validity and internal consistency in general-population and psychiatric samples (Lyrakos et al. 2011; Pezirkianidis et al. 2018).

2.5.6. Tampa Scale of Kinesiophobia

The 17-item Tampa Scale of Kinesiophobia (TSK) assesses fear of movement and (re)injury; items are rated from 1 (strongly disagree) to 4 (strongly agree), and four items are reverse-scored, giving a total of 17–68 (Miller et al. 1991). A systematic review in people with musculoskeletal pain found sufficient evidence for its reliability and construct validity, but inconsistent evidence for its structural validity (Dupuis et al. 2023). The Greek version has shown good reliability and validity in people with CLBP (Georgoudis et al. 2022).

2.5.7. Pain Catastrophizing Scale

The Pain Catastrophizing Scale (PCS) contains 13 items on rumination, magnification and helplessness in relation to pain, each rated 0–4, giving a total score of 0–52 (Sullivan et al. 1995). Its internal consistency and validity are well supported (Wheeler et al. 2019), and the Greek version has been validated in a clinical population (Christakou 2021).

2.6. Statistical analysis

Analyses were performed in IBM SPSS Statistics 29.0.2.0 (IBM Corp., Armonk, NY, USA). Velicer's minimum average partial (MAP) test and parallel analysis were run with the SPSS syntax of O'Connor (2000). McDonald's ω and the Bland–Altman statistics were calculated in [SPSS 29 / Python 3 (SciPy) – authors to confirm]. The normality of continuous variables was examined with the Kolmogorov–Smirnov test. Because most variables, including the FreBAQ-GR, deviated from normality, descriptive statistics

are presented as mean (standard deviation, SD), range and median (interquartile range, IQR), and non-parametric correlations were used. The significance level was set at α = 0.05 (two-tailed).

Score distribution. Response frequencies were calculated for each item. Floor and ceiling effects were considered present if more than 15% of participants obtained the lowest (0) or highest (36) possible total score (Terwee et al. 2007).

Structural validity. Sampling adequacy was examined with the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity. Exploratory factor analysis (EFA) was performed with principal axis factoring (PAF), which does not require multivariate normality (Costello and Osborne 2005; Field 2018). The number of factors to retain was determined a priori with Velicer's MAP test (Velicer 1976) and Horn's parallel analysis (Horn 1965), the latter based on the 95th percentile of eigenvalues from 1,000 random data sets of equal size (O'Connor 2000); oblique (direct oblimin) rotation was planned if more than one factor was retained. Items with communalities below 0.40 were considered for removal (Beavers et al. 2013), one at a time starting with the lowest, with the solution re-estimated after each removal. A solution was considered sound if all factor loadings were at least 0.32, no item cross-loaded at 0.32 or more, and the factor explained at least 50% of the common variance (Tabachnick and Fidell 2019).

Construct validity (hypothesis testing). Spearman's rank correlation coefficients (ρ) were calculated between the FreBAQ-GR total scores and age, body mass index (BMI), symptom duration, pain intensity, RMDQ, HADS, DASS-21, TSK and PCS scores. Based on previous adaptations (Wand et al. 2014, 2016; Nishigami et al. 2018; García-Dopico et al. 2023a; Paredes Sanchez et al. 2025), positive correlations of weak-to-moderate magnitude were expected with disability, kinesiophobia, pain catastrophising, anxiety, depression and stress, and weak or no correlations with age, BMI, symptom duration and pain intensity. Correlations were interpreted as negligible (< 0.10), weak (0.10–0.39), moderate (0.40–0.69), strong (0.70–0.89) or very strong (≥ 0.90) (Schober et al. 2018). Differences between women and men were examined with the Mann–Whitney U test.

Internal consistency. Cronbach's α (acceptable ≥ 0.70) (Terwee et al. 2007) and McDonald's ω (Dunn et al. 2014) were calculated, together with corrected item–total correlations and α if item deleted (Zijlmans et al. 2019).

Test–retest reliability and measurement error. Relative reliability was estimated with the two-way random-effects, absolute-agreement, single-measurement intraclass correlation coefficient ($ICC_{2,1}$) and its 95% confidence interval (CI), interpreted as poor (< 0.50), moderate (0.50–0.75), good (0.75–0.90) or excellent (> 0.90) (Koo and Li 2016). Absolute reliability was quantified by the standard error of measurement (SEM), calculated as the square root of the mean square error term of the analysis of variance, and the minimal detectable change at the 95% confidence level ($MDC_{95\%} = 1.96 \times \sqrt{2} \times SEM$) (Weir 2005). Both were also expressed as a percentage of the grand mean and of the scale range. Systematic differences between test and retest were examined with the Wilcoxon signed-rank test and Bland–Altman 95% limits of agreement (Bland and Altman 1986).

3. Results

3.1. Cross-cultural adaptation and content validity

No major difficulties arose during translation. The terms 'swollen' (item 7) and 'shrunk' (item 8) required discussion to be rendered clearly and precisely in Greek and were resolved by consensus; the colloquial term 'μέση' (literally 'waist') was added alongside the anatomical term 'οσφύς' in the instructions, as this is how Greek-speaking patients commonly refer to the low back. In the pilot test, all instructions, response options and items were rated as clear by both patients and committee members, so no further changes were required. All items were rated as very relevant to back-specific body perception by all committee members (I-CVI = 1.0 for every item; S-CVI/Ave = 1.0). The final FreBAQ-GR is provided in Appendix A.

3.2. Participants and score distribution

The 100 participants (52 women) had a median symptom duration of 6 months (range 3–84) (Table 1). Their pain intensity, disability, psychological and FreBAQ-GR scores are presented in Table 2. Women and men did not differ in FreBAQ-GR scores (median 12.5 vs 16.0; $p = 0.35$).

Table 1
Characteristics of the participants (n = 100).

Sex, women/men, n	**Mean (SD)**	**Range**	**Median (IQR)**
	52/48		
Age (years)	51.2 (12.8)	25–70	52.0 (15.8)
Height (cm)	171.0 (9.6)	153–190	170.0 (15.0)
Body mass (kg)	80.5 (16.0)	50–120	80.0 (19.8)
Body mass index (kg/m^2)	27.4 (4.5)	19.5–37.9	27.3 (7.0)
Symptom duration (months)	16.8 (18.6)	3–84	6.0 (19.0)

SD, standard deviation; IQR, interquartile range.

Table 2
Scores on the FreBAQ-GR and the other questionnaires (n = 100).

Questionnaire (possible range)	Mean (SD)	Range	Median (IQR)
FreBAQ-GR, 9-item (0–36)	13.4 (7.7)	0–25	15.0 (13.0)
FreBAQ-GR, 6-item (0–24)	8.6 (5.8)	0–19	8.0 (10.0)
Pain intensity, NRS (0–10)	5.6 (1.9)	1–10	5.0 (2.0)
RMDQ (0–24)	10.8 (4.7)	0–24	11.0 (6.0)
HADS-Anxiety (0–21)	7.5 (3.8)	1–20	7.0 (4.8)
HADS-Depression (0–21)	6.6 (3.9)	0–18	6.0 (5.0)
HADS total (0–42)	14.1 (6.7)	3–31	13.0 (8.8)
DASS-21 Depression (0–42)	7.3 (8.2)	0–42	4.0 (9.5)
DASS-21 Anxiety (0–42)	8.0 (8.5)	0–36	4.0 (11.5)
DASS-21 Stress (0–42)	13.7 (8.5)	0–40	13.0 (13.5)
DASS-21 total (0–126)	29.0 (23.0)	0–108	24.0 (27.5)
TSK (17–68)	43.0 (8.2)	25–62	43.0 (12.8)
PCS (0–52)	23.6 (11.7)	1–52	22.0 (19.0)

FreBAQ-GR, Greek Fremantle Back Awareness Questionnaire (6-item version: items 1, 3, 4, 5, 6 and 8); NRS, numeric rating scale (average pain over the previous week); RMDQ, Roland-Morris Disability Questionnaire; HADS, Hospital Anxiety and Depression Scale; DASS-21, Depression, Anxiety and Stress Scale-21 (subscale scores multiplied by two); TSK, Tampa Scale of Kinesiophobia (17-item); PCS, Pain Catastrophizing Scale; SD, standard deviation; IQR, interquartile range.

The FreBAQ-GR total score ranged from 0 to 25 (mean 13.4, SD 7.7) with a slight negative skew (− 0.31). Six participants (6%) scored 0 and none obtained the maximum score; therefore, no floor or ceiling effects were present. Depending on the item, 53–79% of participants endorsed the described perception at least rarely (Table 3). Item 9 ('lopsided') and item 2 ('focus all my attention') were the most frequently endorsed and item 7 ('enlarged/swollen') the least. Item 8 ('shrunk') showed a bimodal distribution, with 47% of participants responding 'never' and 31% 'often' or 'always'.

Table 3
Response frequencies and item scores of the FreBAQ-GR (n = 100).

Item	Never	Rarely	Occasionally	Often	Always	Mean (SD)	Median (IQR)
1. My back feels as though it is not part of the rest of my body	28	22	19	27	4	1.6 (1.3)	1.5 (3.0)
2. I need to focus all my attention on my back to make it move the way I want it to	21	13	29	26	11	1.9 (1.3)	2.0 (2.0)
3. I feel as if my back sometimes moves involuntarily, without my control	40	15	23	18	4	1.3 (1.3)	1.0 (2.0)
4. When performing everyday tasks, I don't know how much my back is moving	26	16	34	19	5	1.6 (1.2)	2.0 (2.0)
5. When performing everyday tasks, I am not sure exactly what position my back is in	28	20	27	23	2	1.5 (1.2)	2.0 (2.8)
6. I can't perceive the exact outline of my back	35	20	22	21	2	1.4 (1.2)	1.0 (2.0)
7. My back feels like it is enlarged (swollen)	45	33	11	10	1	0.9 (1.0)	1.0 (1.0)
8. My back feels like it has shrunk	47	18	4	26	5	1.2 (1.4)	1.0 (3.0)
9. My back feels lopsided (asymmetrical)	22	16	19	27	16	2.0 (1.4)	2.0 (2.0)

Values for the response categories are numbers of participants, which equal percentages because n = 100. Item wording is that of the original English FreBAQ (Wand et al. 2014); the Greek wording is given in Appendix A. SD, standard deviation; IQR, interquartile range.

3.3. Structural validity

The data were suitable for factor analysis (KMO = 0.82; Bartlett's $\chi^2(36) = 357.8$, $p < 0.001$). Both the MAP test (lowest average squared partial correlation at one factor: 0.042) and parallel analysis (only the first observed eigenvalue, 4.26, exceeded its random counterpart, 1.63; second eigenvalue 1.06 vs 1.42) indicated a single factor. In the one-factor PAF solution, all nine items loaded on the factor at or above 0.32 (range 0.32–0.77), and the factor explained 41.4% of the common variance (first initial eigenvalue

4.26, 47.3% of total variance) (Table 4). Three items had communalities below 0.40: item 7 (0.10), item 9 (0.25) and item 2 (0.30).

Sequential removal of the item with the lowest communality (item 7, then item 9, then item 2) increased the explained common variance to 45.2% (8 items), 47.9% (7 items) and 51.1% (6 items). The resulting six-item solution (items 1, 3, 4, 5, 6 and 8) met all prespecified criteria (KMO = 0.82; Bartlett's $\chi^2(15) = 258.8$, $p < 0.001$; loadings 0.64–0.79; communalities 0.41–0.63; first initial eigenvalue 3.54, 59.1% of total variance), and the MAP test and parallel analysis again supported one factor. The six-item and nine-item total scores were very strongly correlated ($\rho = 0.97$). For transparency, a two-factor solution extracted using the eigenvalue > 1 rule was also inspected; its second factor (eigenvalue 1.06) was defined almost exclusively by item 9 (pattern loading 0.87) and was not interpretable, so it was not retained.

Table 4
One-factor principal axis factoring solutions and item analysis of the FreBAQ-GR (n = 100).

Item	Loading (9-item)	h^2 (9-item)	Loading (6-item)	h^2 (6-item)	CITC (9-item)	α if item deleted (9-item)
1. Not part of body	0.77	0.60	0.79	0.63	0.70	0.83
2. Focus attention to move	0.55	0.30	–	–	0.51	0.85
3. Moves involuntarily	0.69	0.48	0.68	0.46	0.63	0.83
4. How much back is moving	0.73	0.53	0.73	0.53	0.66	0.83
5. Position of back	0.74	0.54	0.78	0.61	0.66	0.83
6. Outline of back	0.71	0.51	0.66	0.43	0.67	0.83
7. Enlarged (swollen)	0.32	0.10	–	–	0.29	0.86
8. Shrunk	0.65	0.42	0.64	0.41	0.60	0.84
9. Lopsided	0.50	0.25	–	–	0.47	0.85
Common variance explained	41.4%		51.1%			
Cronbach's α (95% CI)	0.85 (0.81–0.89)		0.86 (0.81–0.90)			
McDonald's ω	0.86		0.86			

h^2, communality at extraction; CITC, corrected item–total correlation; CI, confidence interval. KMO = 0.82 for both versions; Bartlett's test: $\chi^2(36) = 357.8$ (9-item) and $\chi^2(15) = 258.8$ (6-item), both $p < 0.001$. Items

were removed sequentially in order of lowest communality (item 7, item 9, item 2).

3.4. Construct validity

The FreBAQ-GR total score showed a moderate positive correlation with the TSK (ρ = 0.58), HADS-A (ρ = 0.50), DASS-21 stress (ρ = 0.48) and DASS-21 total (ρ = 0.45), and weak positive correlations with the HADS total (ρ = 0.34), DASS-21 depression (ρ = 0.33) and anxiety (ρ = 0.39), PCS (ρ = 0.35) and RMDQ (ρ = 0.30) (all $p < 0.01$) (Table 5). It correlated weakly and negatively with symptom duration (ρ = −0.27, $p = 0.006$) and was not significantly correlated with pain intensity (ρ = 0.17, $p = 0.09$), HADS-D (ρ = 0.10, $p = 0.31$), age, height, body mass or BMI (all $|\rho| \leq 0.17$, $p \geq 0.09$). The six-item version showed the same pattern of correlations, with coefficients differing by no more than 0.08 from those of the nine-item version. Overall, 11 of the 12 expected relationships (disability, kinesiophobia, catastrophising, HADS-A, HADS-D, the three DASS-21 subscales, age, BMI, symptom duration and pain intensity) were confirmed; the exception was the HADS-D, which was not correlated with the FreBAQ-GR. The negative direction of the weak correlation with symptom duration was not anticipated.

Table 5
Spearman's correlations (ρ) between the FreBAQ-GR and participant characteristics and clinical measures (n = 100).

Age	**FreBAQ-GR 9-item, ρ (*p*)**	**FreBAQ-GR 6-item, ρ (*p*)**
	0.17 (0.097)	**0.11 (0.283)**
Body mass index	−0.12 (0.249)	−0.17 (0.096)
Symptom duration	−0.27 (0.006)	−0.35 (< 0.001)
Pain intensity (NRS)	0.17 (0.091)	0.19 (0.060)
RMDQ	0.30 (0.003)	0.29 (0.004)
HADS-Anxiety	0.50 (< 0.001)	0.53 (< 0.001)
HADS-Depression	0.10 (0.309)	0.09 (0.350)
HADS total	0.34 (< 0.001)	0.35 (< 0.001)
DASS-21 Depression	0.33 (0.001)	0.33 (< 0.001)
DASS-21 Anxiety	0.39 (< 0.001)	0.34 (< 0.001)
DASS-21 Stress	0.48 (< 0.001)	0.45 (< 0.001)
DASS-21 total	0.45 (< 0.001)	0.42 (< 0.001)
TSK	0.58 (< 0.001)	0.60 (< 0.001)
PCS	0.35 (< 0.001)	0.33 (< 0.001)

Abbreviations as in Table 2. Height and body mass were not significantly correlated with either version ($|\rho| \leq 0.12$).

3.5. Internal consistency

Cronbach's α was 0.85 (95% CI 0.81–0.89) for the nine-item and 0.86 (0.81–0.90) for the six-item version; McDonald's ω was 0.86 for both. Corrected item–total correlations of the nine-item version ranged from 0.29 (item 7) to 0.70 (item 1); only the removal of item 7 marginally increased α (to 0.86) (Table 4).

3.6. Test–retest reliability and measurement error

The retest subsample (n = 33) had a mean (SD) FreBAQ-GR score of 11.7 (7.8) at test and 11.2 (6.9) at retest, with no systematic difference between occasions (Table 6). Test–retest reliability was excellent for both versions (nine-item $ICC_{2,1}$ = 0.96, 95% CI 0.91–0.98; six-item $ICC_{2,1}$ = 0.98, 0.96–0.99). For the nine-item version, the SEM was 1.50 points (13.1% of the grand mean; 4.2% of the scale range) and the $MDC_{95\%}$ 4.16 points (36.3% of the grand mean; 11.6% of the scale range); the Bland–Altman bias was −0.55 points with 95% limits of agreement of − 4.71 to 3.61. For the six-item version (range 0–24), the SEM was 0.77 points (10.6% of the grand mean; 3.2% of the range) and the $MDC_{95\%}$ 2.12 points (29.3%; 8.8%).

Table 6
Test–retest reliability and measurement error of the FreBAQ-GR (n = 33; 5-day interval).

9-item (0–36)	**Test, mean (SD); median (IQR)**	**Retest, mean (SD); median (IQR)**	**$ICC_{2,1}$ (95% CI)**	**SEM**	**$MDC_{95\%}$**	**Bias (95% LoA)**
	11.7 (7.8); 11.0 (14.5)	**11.2 (6.9); 11.0 (13.5)**	**0.96 (0.91–0.98)**	**1.50**	**4.16**	**−0.55 (− 4.71 to 3.61)**
6-item (0–24)	7.2 (5.3); 6.0 (9.0)	7.3 (5.0); 6.0 (9.0)	0.98 (0.96–0.99)	0.77	2.12	0.12 (− 2.00 to 2.24)

$ICC_{2,1}$, two-way random-effects, absolute-agreement, single-measurement intraclass correlation coefficient; SEM, standard error of measurement (√mean square error); $MDC_{95\%}$, minimal detectable change at 95% confidence; LoA, Bland–Altman limits of agreement (retest − test). Wilcoxon signed-rank test for test vs retest: p = 0.18 (9-item) and p = 0.53 (6-item). Grand means: 11.45 (9-item) and 7.24 (6-item).

4. Discussion

This study produced a Greek version of the FreBAQ through a standard forward–backward procedure and showed that it has full content validity according to experts, a unidimensional structure, good internal consistency, excellent test–retest reliability with low measurement error, and a pattern of correlations with clinical variables that is largely consistent with previous adaptations. The FreBAQ-GR is, to our knowledge, the first Greek patient-reported measure of back-specific body perception.

4.1. Score distribution and item endorsement

The mean FreBAQ-GR score (13.4/36) lies at the upper end of those reported for clinical CLBP samples, close to the Brazilian (14.4) (Claudio et al. 2026) and above the English (9.8) (Wand et al. 2016), Spanish (11.4) (García-Dopico et al. 2023a), French (11.0) (Homs et al. 2025) and Polish (6.6) (Budzisz et al. 2025) values. As in the Polish study, where a lower score was attributed to a mildly affected online sample (Budzisz et al. 2025), this difference most likely reflects sample characteristics: our participants were recruited on referral for physiotherapy and had moderate pain (mean NRS 5.6) and disability (mean RMDQ 10.8), as well as relatively high kinesiophobia (mean TSK 43). As in most other versions, no floor or ceiling effects were present for the total score, whereas every item was answered 'never' by more than 15% of participants (Wand et al. 2016; García-Dopico et al. 2023a; Homs et al. 2025). Individual items should therefore not be interpreted in isolation.

The pattern of item endorsement was similar to that of other versions. Item 9 ('my back feels lopsided') was among the two most frequently endorsed items, as in the original, Japanese, Polish and French versions (Wand et al. 2014; Nishigami et al. 2018; Budzisz et al. 2025; Homs et al. 2025). Homs et al. (2025) cautioned that this may partly reflect common lay beliefs that attribute LBP to spinal 'misalignment', rather than a purely perceptual phenomenon. Item 2 ('I need to focus all my attention on my back to make it move') was also commonly endorsed, consistent with the English and French data (Wand et al. 2016; Homs et al. 2025), whereas item 7 ('enlarged/swollen') was the least endorsed. The response pattern of item 8 ('shrunk') differed from previous reports. In the original Rasch analysis, item 8 was the most difficult to endorse and showed misfit, because people with high overall scores tended to score it low (Wand et al. 2016). In our sample, almost one-third of participants reported feeling their back 'smaller than its real size' often or always, and item 8 showed the strongest negative association with symptom duration among all items ($\rho = -0.44$). A plausible explanation is that the Greek wording ('Νιώθω τη μέση μου μικρότερη από το πραγματικό της μέγεθος') may have been interpreted by some respondents in terms of loss of trunk muscle bulk or a 'tight' back rather than a perceptual shrinkage; this possibility should be explored with cognitive interviews, as has been done for the Polish and Spanish versions (García-Dopico et al. 2023b; Budzisz et al. 2025).

4.2. Structural validity: nine or six items?

Two independent retention criteria, Velicer's MAP test and parallel analysis, supported a single factor, in agreement with Rasch, item response theory and confirmatory factor analysis (CFA) findings in most previous versions (Wand et al. 2016; Erol et al. 2019; Schäfer et al. 2021; García-Dopico et al. 2023a; Monticone et al. 2024; Claudio et al. 2026). The three-factor structure of the Persian version was derived from an exploratory analysis of only 50 participants (Mahmoudzadeh et al. 2020), and the possible second dimensions suggested for the Japanese and Indian versions were based on visual inspection of principal component analyses of Rasch residuals (Nishigami et al. 2018; Rao et al. 2021); moreover, component-based methods and the eigenvalue > 1 rule are known to over-extract factors (Costello and Osborne 2005). Indeed, applying the eigenvalue > 1 rule to our data also produced a second factor, but

this was essentially a single-item factor (item 9) and was not supported by either MAP or parallel analysis.

Although all nine items loaded on the single factor at or above the 0.32 threshold, the factor explained less than 50% of the common variance, and items 7, 9 and 2 had low communalities. A six-item version without these items satisfied every prespecified criterion. Items 7 and 8 have previously caused problems with model fit or item–total correlation (Wand et al. 2016; Janssens et al. 2017; Budzisz et al. 2025), and a six-item factor structure was also proposed for the region-generic Fremantle Body Awareness-General Questionnaire, from which items 7 and 8 were removed (Walton et al. 2023). Items 7 and 8 describe opposite perceptions (enlargement vs shrinkage) that are unlikely to be endorsed by the same person at the same time, which can reduce their covariance with the remaining items without implying that they lack relevance (Wand et al. 2016; Walton et al. 2023). On the other hand, the Spanish and Brazilian CFAs supported the full nine-item unidimensional model and found no grounds for item deletion (García-Dopico et al. 2023a; Claudio et al. 2026), and item 9 was retained with good fit in the region-generic version (Walton et al. 2023).

On balance, we recommend that the nine-item total score of the FreBAQ-GR be used in clinical practice and research. First, the six-item version did not perform better on any external criterion: the nine- and six-item scores were almost interchangeable (ρ = 0.97) and had very similar internal consistency, test–retest reliability and correlations with clinical variables. Second, the removed items cover content (perceived size and shape, and motor neglect) that patients and experts in this and previous studies have considered relevant (Wand et al. 2014; Budzisz et al. 2025), and their removal would reduce the content validity of the instrument. Third, retaining the original item set allows direct comparison with the original and all other language versions, as well as pooling of data across studies (Budzisz et al. 2024; Paredes Sanchez et al. 2025). Finally, item reduction based on a single exploratory analysis of 100 participants risks capitalising on sample-specific variance. The six-item structure should therefore be regarded as exploratory until it is tested with CFA in an independent, larger Greek sample.

4.3. Construct validity

Most expected relationships were confirmed. The correlation with disability (ρ = 0.30) is within the range reported for other versions (approximately 0.29–0.49) (Wand et al. 2016; Nishigami et al. 2018; Hu et al. 2022; García-Dopico et al. 2023a; Monticone et al. 2024; Budzisz et al. 2025; Claudio et al. 2026). The correlation with pain catastrophising (ρ = 0.35) is similar to those of the English, Japanese and Italian versions (0.36–0.41) and lower than those of the French and Persian versions (0.53–0.60) (Wand et al. 2014, 2016; Nishigami et al. 2018; Mahmoudzadeh et al. 2020; Monticone et al. 2024; Homs et al. 2025). The correlations with the DASS-21 subscales (0.33–0.48) were almost identical to those of the Spanish version (0.42–0.48) (García-Dopico et al. 2023a), which, together with the further evaluation of the original version that used a DASS-21 composite score (Wand et al. 2016), is one of the few other studies to have used this scale, supporting the cross-cultural equivalence of the FreBAQ-GR.

The strongest correlation was observed with kinesiophobia (ρ = 0.58), similar to the Turkish version (0.61) (Erol et al. 2019) but higher than in most others (0.14–0.40) (Wand et al. 2014; Janssens et al. 2017; Nishigami et al. 2018; García-Dopico et al. 2023a; Budzisz et al. 2025; Homs et al. 2025; Claudio et al. 2026). This is theoretically coherent with the fit-for-purpose model, according to which beliefs that the back is damaged or vulnerable promote protective, guarded movement that reduces the variety of sensory information available to update the brain's representation of the back, which in turn sustains perceptions of the back as unfamiliar, poorly controlled or misshapen (Wand et al. 2023). Similarly, the moderate correlations with anxiety and stress, but the absence of a correlation with HADS-D, suggest that disturbed back awareness in our sample was more closely linked to threat and hypervigilance than to low mood, as also found in the Japanese version, where only the anxiety subscale was associated with FreBAQ scores (Nishigami et al. 2018). Whether these associations reflect a common upstream influence (e.g., threat appraisal) or a direct relationship between perceptual and emotional processes cannot be determined from cross-sectional data (Xie 2026).

The FreBAQ-GR was not significantly correlated with average pain intensity over the previous week, consistent with the Dutch, Japanese, Persian and Polish versions (Janssens et al. 2017; Nishigami et al. 2018; Mahmoudzadeh et al. 2020; Budzisz et al. 2025), but not with the Spanish, French and Brazilian versions, where weak-to-moderate correlations were found (García-Dopico et al. 2023a; Homs et al. 2025; Claudio et al. 2026). Differences in recall period (current, 48-hour or weekly pain) and in the variability of pain intensity across samples probably account for these inconsistencies (Budzisz et al. 2025). The weak negative correlation with symptom duration was unexpected; previous studies have reported either no association or a positive one, and a recent meta-analysis found no overall relationship (Budzisz et al. 2024). In our sample, shorter symptom duration was also associated with higher kinesiophobia (ρ = −0.29), suggesting that people referred to physiotherapy in the earlier stages of chronicity may experience a more threatening and less 'familiar' back. Because the duration of symptoms was strongly skewed (median 6 months), this finding should be interpreted with caution and requires replication.

4.4. Internal consistency, reliability and measurement error

Internal consistency (α = 0.85) is in line with the pooled estimate across FreBAQ versions (α = 0.84; Paredes Sanchez et al. 2025) and with individual versions (0.74–0.91) (Mahmoudzadeh et al. 2020; Rao et al. 2021). Because unidimensionality was confirmed, α can be interpreted meaningfully, a prerequisite emphasised by COSMIN (Prinsen et al. 2018; Paredes Sanchez et al. 2025). Test–retest reliability ($ICC_{2,1}$ = 0.96) was higher than the pooled estimate (0.85; Paredes Sanchez et al. 2025) and than most individual versions (0.65–0.90) (Wand et al. 2014; Janssens et al. 2017; Nishigami et al. 2018; Hu et al. 2022; García-Dopico et al. 2023a; Monticone et al. 2024; Budzisz et al. 2025; Homs et al. 2025; Claudio et al. 2026), and similar to that of the Persian version (0.96) (Mahmoudzadeh et al. 2020). Likewise, the SEM (1.5 points) and $MDC_{95\%}$ (4.2 points) are among the smallest reported, compared with SEM values of 0.91–3.9 and MDC values of 2.5–10.8 points in previous studies (Janssens et al. 2017; Mahmoudzadeh et al. 2020; Hu et al. 2022; García-Dopico et al. 2023a; Monticone et al. 2024; Budzisz et

al. 2025; Homs et al. 2025; Claudio et al. 2026). The short (5-day) interval, supervised paper-based administration at the same time of day, and the absence of any intervening treatment probably contributed to this stability, whereas online administration and 1–2-week intervals were used in several other studies (García-Dopico et al. 2023a; Budzisz et al. 2025). A short interval may, however, increase recall of previous answers, which may inflate reliability estimates. Clinically, a change of at least 4–5 points in the FreBAQ-GR total score in an individual patient can be considered to exceed measurement error with 95% confidence, whereas the minimal important change remains to be established.

4.5. Clinical implications

The FreBAQ-GR takes only a few minutes to complete and provides information that is not captured by pain, disability or psychological questionnaires, as shown by the weak-to-moderate correlations with these measures. It can help clinicians identify Greek-speaking patients with marked disturbance of back awareness, discuss these experiences with them, and consider approaches that aim to refine back perception, such as visual feedback, sensory discrimination training, graded sensorimotor retraining, body-awareness therapies and cognitive functional therapy (Wand et al. 2012, 2013; Wälti et al. 2015; Lundwall et al. 2019; Nishigami et al. 2019; Bagg et al. 2022; Kent et al. 2023). Patients with CLBP who report more disturbed back awareness also show changes in movement control (Goossens et al. 2019; Miyachi et al. 2022), suggesting that the FreBAQ-GR may complement clinical assessment of lumbopelvic movement control.

4.6. Limitations and future research

Several limitations should be considered. Participants were recruited from a single private physiotherapy practice in Athens, which may limit generalisability to other settings (e.g., primary care, people with milder or more severe symptoms). Although the pilot participants and committee members rated the clarity of the instructions and items (an indication of comprehensibility), the relevance of the items was rated only by the expert committee, and the comprehensiveness of the questionnaire, i.e., whether any important aspect of back perception was missing, was not formally assessed by either patients or experts; in-depth cognitive interviews with patients, as recommended by COSMIN, were also not performed (Paredes Sanchez et al. 2025). The sample size was adequate for EFA but did not allow a confirmatory analysis in an independent sample, measurement invariance testing (e.g., by sex) or Rasch analysis. The retest subsample (n = 33) was smaller than the 50 participants recommended for adequate methodological quality (Mokkink et al. 2018), and stability of the condition between test and retest was assumed (no intervening treatment) rather than confirmed with a global rating of change. Known-groups validity could not be examined because no pain-free controls were included, and the Greek DASS-21 and HADS have not been specifically validated in people with LBP. Finally, responsiveness and the minimal important change of the FreBAQ-GR were not examined.

Future research should confirm the factor structure of the FreBAQ-GR with CFA in a larger and more heterogeneous sample, examine the comprehensibility of items 7 and 8 with cognitive interviews, and establish its responsiveness and minimal important change in people receiving treatments that target

sensorimotor function and body perception (Wälti et al. 2015; Bagg et al. 2022; Kent et al. 2023). Disturbed back awareness may also act as a moderator or mediator of the response to exercise and sensorimotor training, as has been examined for psychosocial factors (Wippert et al. 2021), and may relate to the differential neuroplastic changes observed in responders and non-responders to exercise therapy (de Zoete et al. 2023). Concurrent assessment of self-reported back perception, tactile and proprioceptive acuity, motor control and pain processing in the same patients will help clarify the role of body perception in CLBP (Ehrenbrusthoff et al. 2018a; Xie 2026).

5. Conclusions

The FreBAQ-GR is a cross-culturally adapted, unidimensional, internally consistent and highly reliable measure of back-specific body perception in Greek-speaking people with chronic non-specific LBP. Its scores are moderately associated with kinesiophobia, anxiety and stress and weakly associated with disability and pain catastrophising, supporting its construct validity. The nine-item total score is recommended for clinical and research use, to ensure comparability with the original and other language versions; a six-item version with a cleaner factor structure was identified, but it requires confirmation before it can be recommended.

Clinical relevance

- The FreBAQ-GR is a brief, valid and reliable measure of how the back feels to Greek-speaking people with chronic low back pain.
- Disturbed back awareness was common (53–79% endorsed each item) and only weakly related to pain intensity and disability, so it adds information to routine assessment.
- A change of about 4–5 points in the FreBAQ-GR total score exceeds measurement error in an individual patient.
- Patients with high FreBAQ-GR scores and high kinesiophobia may benefit from interventions that combine sensorimotor retraining with reduction of threat and fear of movement.

Declarations

Ethics approval and consent

The study was approved by the Research Ethics Committee of the University of West Attica (approval no. 56006/17.06.2022). All participants provided written informed consent.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

George A. Koumantakis: Conceptualization, Methodology, Formal analysis, Supervision, Writing – original draft, Writing – review & editing. **Euaggelia Ioannou:** Investigation, Data curation, Writing – original draft. **Vasileios Proiskos:** Investigation, Data curation, Writing – original draft. **Petros Tatsios:** Resources, Investigation, Writing – review & editing. **Dimitra Korda:** Investigation, Writing – review & editing. **Eleftherios Paraskevopoulos:** Formal analysis, Writing – review & editing. **Sotiria Vrouva:** Methodology, Writing – review & editing.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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