

Original Research (Preprint)

Psychometric properties of the Mongolian version of the Chalder Fatigue Scale

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Abstract: Fatigue, a prevalent condition impacting biological, psychological, and cognitive functions, affects 30–50% of the general population, with heightened prevalence (52–70%) post-COVID-19. The Chalder Fatigue Scale (CFS) is a widely used tool to assess physical and mental fatigue, but its psychometric properties in healthy Mongolian adults are underexplored. This study aimed to culturally adapt and validate the Mongolian version of the CFS, evaluating its reliability and validity per COSMIN guidelines. A cross-sectional and longitudinal study was conducted with 941 healthy Mongolian adults (500 for validation, 441 for test-retest). The CFS was adapted following Beaton et al.'s (2000) guidelines: translation, synthesis, back-translation, expert review, and pilot testing (n = 21, CVI = 1.0). Participants completed the CFS, Hospital Anxiety and Depression Scale (HADS), Brain Overwork Scale (BOS), WHOQOL-BREF, and Pittsburgh Sleep Quality Index (PSQI). Reliability was assessed via Cronbach's α and intraclass correlation coefficients (ICC) over a 14-day interval. Validity was evaluated through exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and Pearson's correlations for criterion and convergent validity. The Mongolian CFS demonstrated high internal consistency (Cronbach's α = 0.877–0.920) and good test-retest reliability (ICC = 0.745). EFA confirmed a two-factor structure (physical and mental fatigue), explaining 57.25–64% of variance (KMO = 0.901–0.938, $p < 0.001$). CFA supported this structure (RMSEA = 0.08, CFI = 0.967, TLI = 0.951). Significant correlations with HADS ($r = 0.330$ – 0.500), BOS ($r = 0.291$ – 0.409), PSQI ($r = 0.303$ – 0.417), and negative correlations with WHOQOL-BREF ($r = -0.313$ to -0.505) confirmed criterion validity. Convergent validity was strong ($r = 0.678$ – 0.866). The Mongolian CFS is a reliable and valid tool for assessing fatigue in healthy adults, suitable for research and clinical applications in Mongolia.

Keywords: Fatigue, CFS, Chronic Fatigue, Psychometrics, Reliability, Validity, Cross-Cultural Translation, Mongolia

Introduction

Fatigue is a prevalent condition that impairs biological, psychological, and cognitive functions

across populations (Adm et al., 2022). With a point prevalence of 30–50% in the general population (Ahn et al., 2020), fatigue has gained increased attention following the COVID-19 pandemic, particularly

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among individuals with heavy workloads, where prevalence rates among recovered patients range from 52–70% (Carfi et al., 2020; Townsend et al., 2021). Accurate assessment of fatigue in both clinical and healthy populations is thus critical.

The Chalder Fatigue Scale (CFS) is a concise, user-friendly tool designed to measure fatigue severity across two dimensions: physical and mental (Chalder et al., 1993; Fong et al., 2015). Originally a 14-item self-report scale, the revised 11-item version (CFS-11) demonstrates improved psychometric properties, including reliability and validity, and is widely used to assess symptom severity, screen fatigue in epidemiological studies, and evaluate treatment outcomes (Morriss et al., 1998; Jing et al., 2016). Studies in regions such as Hong Kong and Brazil have confirmed the CFS-11's robustness, with better model fit than the 14-item version (Fong et al., 2015; Cho et al., 2007).

Despite its global use, the CFS's psychometric properties in healthy adult populations, particularly in Mongolia, remain underexplored. In Mongolia, rapid urbanization and academic pressures exacerbate fatigue, yet validated fatigue assessment tools are scarce. This study aims to culturally adapt the CFS for the Mongolian population and evaluate its psychometric properties, including criterion validity, construct validity, internal consistency, test-retest reliability, and measurement error, following the COSMIN (Consensus-based Standards for the selection of health Measurement Instruments) guidelines (Mokkink et al., 2010).

Materials and Methods

Study Design

This study employed a combination of cross-sectional and longitudinal designs, adhering to international guidelines for cross-cultural adaptation and psychometric evaluation (Beaton et al., 2000; Mokkink et al., 2010). The study was conducted in two phases: (1) cross-cultural adaptation of the CFS into Mongolian, and (2) psychometric evaluation in healthy adults using COSMIN criteria. The CFS was adapted into Mongolian following Beaton et al.'s (2000) guidelines:

Translation: Two bilingual Mongolian translators, unfamiliar with the CFS, independently translated the 11-item CFS from English to Mongolian.

Synthesis: The translations were compared and synthesized into a single Mongolian version.

Back-Translation: A native English speaker fluent in Mongolian, unaware of the original CFS, back-translated the synthesized version into English.

Expert Committee Review: A committee of

researchers and translators compared the original, translated, and back-translated versions to ensure equivalence, producing a prefinal Mongolian CFS.

Pilot Testing: The prefinal version was tested on 21 adults (excluded from the main study). All participants rated the items as "clearly understandable," confirming content validity (CVI = 1.0) and suitability for the Mongolian population.

Psychometric Evaluation

The psychometric properties of the Mongolian CFS were evaluated in two samples: a validation study sample (n = 500) and a test-retest reliability sample (n = 441).

Participants

A total of 1,234 individuals provided informed consent. For the validation study, 649 participants were approached, but 149 were excluded due to incomplete responses, resulting in 500 participants. For the test-retest study, 585 participants were considered; 105 did not participate in the initial test, 87 participated only in the retest, and 39 were excluded due to incomplete data. Ultimately, 441 participants who completed both test and retest phases within a 14-day interval were included.

Data collection

Validation Study: Conducted from March 2023 to March 2024, participants completed the Mongolian CFS, Hospital Anxiety and Depression Scale (HADS), Brain Overwork Scale (BOS), WHOQOL-BREF, and Pittsburgh Sleep Quality Index (PSQI), alongside sociodemographic data (age, gender, marital status, employment, education, residency).

Test-Retest Study: Conducted from February to March 2024, 441 university students completed the CFS at baseline and after 14 days to assess test-retest reliability.

Measures

Chalder Fatigue Scale (CFS): The 11-item CFS measures physical (7 items) and mental (4 items) fatigue using two scoring methods: bimodal (0–1) and 4-point Likert (0–3). Total scores range from 0–11 (bimodal) or 0–33 (Likert) (Chalder et al., 1993; Cella & Chalder, 2010).

WHOQOL-BREF: A 26-item questionnaire assessing quality of life across four domains (physical, psychological, social, environmental). Scores range from 4–20 per domain, transformed to 0–100 (WHOQOL Group, 1996; Bat-Erdene et al., 2023).

Hospital Anxiety and Depression Scale (HADS): A 14-item scale measuring anxiety (7 items) and depression (7 items), with subscale scores from 0–21 (Zigmond & Snaith, 1983; Tumorbaatar et al., 2021).

Pittsburgh Sleep Quality Index (PSQI): A 19-item questionnaire assessing sleep quality across seven components, with global scores from 0–21 (>5 indicates poor sleep) (Buysse et al., 1989; Tumorbaatar et al., 2023).

Brain Overwork Scale (BOS): The BOS is a 10-item self-report questionnaire designed to assess mental distress through physical and behavioral symptoms, addressing limitations in emotion-focused scales. It comprises three subscales: Excessive Thinking (e.g., overthinking), Hypersensitivity (e.g., sensitivity to stimuli), and Restless Behavior (e.g., agitation). Items are rated on a 4-point Likert scale (0–3), with higher scores indicating greater distress. The Mongolian version was developed and validated in the general population, demonstrating good reliability and validity (Lkhagvasuren et al., 2023). In this study, the BOS was used to assess convergent validity, correlating mental distress with fatigue symptoms measured by the CFS.

Statistical analysis

Descriptive statistics were reported as numbers (n), percentages (%), means, and standard deviations (SD).

Reliability: Internal consistency was evaluated using Cronbach’s α (≥ 0.8 = good, ≥ 0.7 = acceptable, ≥ 0.6 = marginally acceptable). Test-retest reliability was assessed with intraclass correlation coefficients (ICC) using a two-factor mixed-effects model (< 0.5 = poor, < 0.75 = moderate, < 0.9 = good, ≥ 0.9 = excellent).

Validity: Exploratory factor analysis (EFA) with principal axis factoring and varimax rotation assessed factor structure. Suitability was confirmed by Bartlett’s test of sphericity ($p < 0.001$) and Kaiser-Meyer-Olkin (KMO) test (> 0.65). Factors with eigenvalues > 1 were retained. Confirmatory factor analysis (CFA) used maximum likelihood estimation, with fit indices: root mean squared error of approximation (RMSEA < 0.05), comparative fit index (CFI ≥ 0.8), Tucker-Lewis index (TLI ≥ 0.8), and factor loadings (≥ 0.40). Criterion and convergent validity were assessed via Pearson’s correlations with HADS, BOS, WHOQOL-BREF, and PSQI.

Software: Analyses were conducted using JAMOVI v.2.3.8, with ICC and CFA performed in IBM SPSS v.25 and AMOS v.26, respectively. Statistical significance was set at $p < 0.05$ (two-tailed).

Ethics

The study was approved by the Institutional Review Board of the Brain and Mind Research Institute, Mongolian Academy of Sciences (2022/142). All participants provided written informed consent.

Results

The study included 941 participants: 500 in the validation study (mean age: 34 ± 8 years, 54.4% male) and 441 in the test-retest study (mean age: 20.5 ± 1.72 years, 44.4% male). Most validation study participants were married (68.8%), while most test-retest participants were unmarried (90.2%). Education levels and residency varied, with 78.6% of validation participants and 70.7%

of test-retest participants living rurally (Table 1).

Reliability

Internal consistency was high, with Cronbach’s α of 0.877 (validation study) and 0.920 (test-retest study) for the total CFS score. Subdomain values were 0.861 (physical) and 0.730 (mental) in the validation study, and 0.867 (physical) and 0.787 (mental) in the test-retest study.

Table 1. Demographic Characteristics of Study Participants

Category	Validation study n=500		Test-retest study n=441		
	n/M \pm SD	%	n/M \pm SD	%	
Age	34 \pm 8		20.5 \pm 1.72		
Gender	Male	272	54.4	196	44.4
	Female	228	45.6	245	55.6
Marital status	Never married	79	15.8	398	90.2
	Married	334	68.8	7	1.6
	Other	77	15.4	36	8.2
Education	High school or below	238	47.6	372	84.3
	Bachelor 's degree or above	262	52.4	69	15.6
Residency	Urban	107	21.4	129	29.3
	Rural	393	78.6	312	70.7
Living condition	Ger	249	49.8	107	24.3
	Apartment	136	27.2	269	61
	Dormitory	115	23	65	14.7
Total	500	100	441	100	

Test-retest reliability, assessed over 14 days, showed good reliability (ICC = 0.745 for total score, 0.724 for physical, 0.708 for mental) (Table 2).

Table 2. Cronbach’s α and Intraclass Correlation Coefficients (ICC)

Items	Validation study n=500 Cronbach's α	Test-retest study n=441 ICC
Problems with tiredness	0.865	0.600
Need to rest more	0.863	0.618
Feel sleepy or drowsy	0.868	0.568
Problems starting things	0.872	0.532
Lacking in energy	0.859	0.533
Less strength in muscles	0.858	0.563
Feel weak	0.863	0.563
Difficulty concentrating	0.863	0.554
Slips of the tongue when speaking	0.870	0.539
Difficulty finding the correct word	0.870	0.530
Memory issues	0.878	0.605
CFS: Physical	0.861	0.724
CFS: Mental	0.730	0.708
CFS: Total	-	0.745

Validity

Exploratory factor analysis (EFA) identified two factors (physical and mental fatigue) with eigenvalues >1, accounting for 57.25% of variance in the validation study and 64% in the test-retest study (Figure 1).

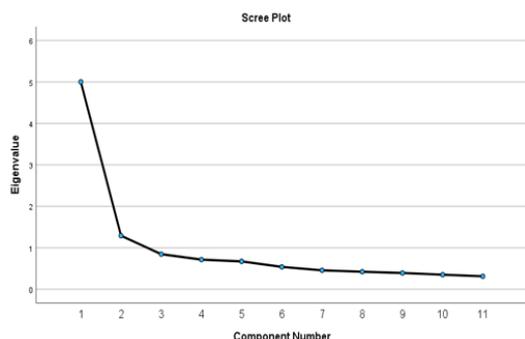


Figure1. Scree plot for 11 items of CFS (n=500) KMO values (0.901 and 0.938) and Bartlett’s test ($p < 0.001$) confirmed factor analysis suitability. Factor loadings ranged from 0.475–0.801 (physical) and 0.421–0.831 (mental) in the validation study, and 0.411–0.849 (physical) and 0.640–0.814 (mental) in the test-retest study (Table 3).

Table3. Principal Component analysis of CFS

Items	Physical	Mental
Problems with tiredness	0.779	0.151
Need to rest more	0.801	0.165
Feel sleepy or drowsy	0.747	0.137
Problems starting things	0.605	0.205
Lacking in energy	0.660	0.415
Less strength in muscles	0.584	0.521
Feel weak	0.475	0.569
Difficulty concentrating	0.379	0.666
Slips of the tongue when speaking	0.086	0.829
Difficulty finding the correct word	0.080	0.831
Memory issues	0.286	0.421
KMO=0.901		p<0.001

Confirmatory factor analysis (CFA) supported the two-factor model, with acceptable fit indices: RMSEA = 0.08, CFI = 0.967, TLI = 0.951 (Figure 2).

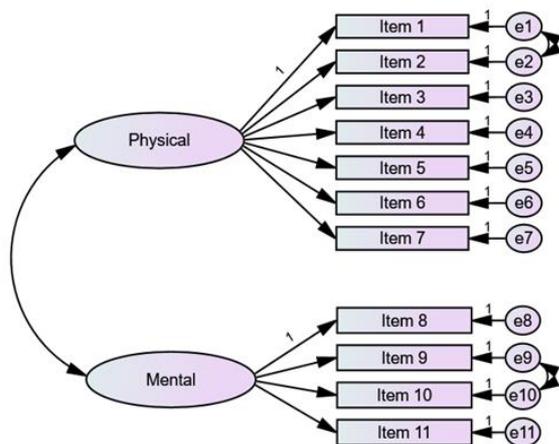


Figure2. Confirmatory factor analysis path diagram for the two domains of CFS (n = 500).

Criterion validity was demonstrated by significant correlations between CFS scores and HADS ($r = 0.330-0.500$), BOS ($r = 0.291-0.409$), and PSQI ($r = 0.303-0.417$), and negative correlations with WHOQOL-BREF domains ($r = -0.313$ to -0.505). Convergent validity was confirmed by strong inter-item correlations ($r = 0.678$ in validation study, $r = 0.866$ in test-retest study) (Table 4).

Table 4. Criterion validity and convergent validity of the CFS

Questionnaires	CFS:	CFS:	CFS:
	Physical	Mental	Total
HADS: Anxiety	0.442**	0.418**	0.469**
HADS: Depression	0.323**	0.330**	0.353**
HADS: Psychological distress	0.466**	0.454**	0.500**
BOS: Excessive thinking	0.387**	0.359**	0.409**
BOS: Hypersensitivity	0.291**	0.334**	0.334**
BOS: Restless behavior	0.310**	0.267**	0.327**
WHOQOL-BREF: Physical domain	-0.497**	-0.402**	-0.505**
WHOQOL-BREF: Psychological domain	-0.330**	-0.354**	-0.362**
WHOQOL-BREF: Social domain	-0.316**	-0.337**	-0.349**
WHOQOL-BREF: Environmental domain	-0.386**	-0.313**	-0.378**
PSQI: Total score	0.446**	0.303**	0.417**
CFS: Physical	1		
CFS: Mental	0.678**	1	
CFS: Total	0.937**	0.866**	1

* $p < 0.05$, ** $p < 0.001$, p -values were calculated using pearson’s correlations

Discussion

The Mongolian version of the Chalder Fatigue Scale (CFS) demonstrates robust reliability and validity for assessing fatigue among healthy adults, aligning with findings from studies in other languages, including Portuguese, Chinese, and Korean (Cho et al., 2007; Wong & Fielding, 2010; Ha et al., 2018). Unlike prior studies focusing on clinical populations (Cella & Chalder, 2010; Chilcot et al., 2016), this study validates the CFS in a healthy Mongolian adult population, addressing a gap in cross-cultural fatigue assessment.

The cross-cultural adaptation process ensured linguistic and cultural equivalence, with pilot testing confirming item clarity (CVI = 1.0). Psychometric evaluation revealed high internal consistency (Cronbach’s $\alpha = 0.877-0.920$) and good test-retest reliability (ICC = 0.745), consistent with global benchmarks (Wong & Fielding, 2010). The two-factor structure (physical and mental fatigue) was supported by EFA and CFA, with acceptable fit indices (RMSEA = 0.08, CFI = 0.967), reinforcing the scale’s construct validity.

Criterion validity was evidenced by significant correlations with related constructs (e.g., anxiety, depression, sleep quality) and negative correlations with quality of life, aligning with theoretical expectations. Convergent validity was strong, with inter-item correlations indicating cohesive subscales. However, the study's focus on healthy adults, primarily from Ulaanbaatar, limits generalizability to clinical or rural populations. Future research should explore the CFS's applicability in diverse Mongolian cohorts and clinical settings, and investigate longer test-retest intervals to confirm stability.

In conclusion, the Mongolian CFS is a reliable and valid tool for fatigue assessment, offering a culturally adapted instrument for research and clinical use in Mongolia. This study contributes to the global validation of the CFS and supports its application in cross-cultural fatigue research.

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Author's Contributions

B.L.: conceptualization, supervision, writing–review & editing; E.T.: data collection, analysis, writing–original draft; G.T.: data collection; T.J.: resources. All authors interpreted the data, approved the final version of the manuscript, and agree to be accountable for all aspects of the work.

Conflict of Interest Statement

The authors declare that they have no conflicts of interest to disclose.

Data Availability Statement

Data are available upon request to corresponding author.

Ethics

The study was approved by the Institutional Review Board of the Brain and Mind Research Institute, Mongolian Academy of Sciences (2022/142). All participants provided written informed consent.

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