Health and Quality of Life Outcomes

RESEARCH

Open Access

Patients reported outcome of cognitive function scale: a psychometric evaluation

José Fernando Mora-Romo[1,2], Luis Alberto Mendoza-Contreras[3], Rafael Armando Samaniego-Garay[4], Isauro García-Alonzo[4] and Filiberto Toledano-Toledano[5,6,7*]

Abstract

Background Assessment of cognitive function is essential to identify the impact of brain aging, disease or injury on individuals. The Short Form Cognitive Function Scale is a brief instrument, easy to use in clinical and research settings with simple interpretation. However, its psychometric properties have not been confirmed in the general Mexican population. The aim of this study was to determine the psychometric properties of the Short Form Cognitive Function Scale in the general Mexican population.

Methods An instrumental design was conducted with 600 participants. Analyses were performed to evaluate factor structure (exploratory and confirmatory factor analysis), reliability (internal consistency), measurement invariance, construct validity (convergent and divergent) and Know-Groups Validity.

Results A unifactorial structure of 8 items was verified with an internal consistency of $\alpha = 0.945$ and a McDonald Omega index of $\Omega = 0.946$. Measurement invariance was confirmed (ΔCFI & TLI ≤ 0.01; ΔRMSEA & SRMR ≤ 0.015), with respect to gender, age groups and geographic area of residence. Finally, the Short Form Cognitive Function Scale showed adequate convergent validity with the Subjective Well-Being variable ($r = .507$, $p < .001$), divergent with the GAD 5 ($r = -.517$, $p < .001$), and discriminant between younger and older participants (t = -5.304, $p < .001$).

Conclusions The Short Form Cognitive Function Scale version for the general Mexican population presented adequate psychometric properties that make it a valid and reliable instrument for use in non-clinical and research settings in Mexico.

Keywords Cognitive function, Cognitive impairment, Patients reported outcomes, Cognitive assessment, Mexican population

*Correspondence:
Filiberto Toledano-Toledano
filiberto.toledano.phd@gmail.com
[1]Facultad de Estudios Superiores Iztacala, Universidad Nacional Autónoma de México, Estado de México, Tlalnepantla 54090, México
[2]Unidad Académica de Psicología, Universidad Autónoma de Zacatecas, Plantel Fresnillo, Zacatecas, México
[3]Facultad de Psicología, Universidad Nacional Autónoma de México, Ciudad Universitaria, Coyoacán, México City 04510, México
[4]Unidad Académica de Psicología, Universidad Autónoma de Zacatecas, Av. Preparatoria 301, Hidráulica 98068, Zacatecas, Zacatecas, México
[5]Present address: Unidad de Investigación en Medicina Basada en Evidencias, Hospital Infantil de México Federico Gómez Instituto Nacional de Salud, Dr. Márquez 162, 06720 Doctores, Cuauhtémoc, México
[6]Unidad de Investigación Multidisciplinaria en Salud, Instituto Nacional de Rehabilitación Luis Guillermo Ibarra Ibarra, Calzada México-Xochimilco 289, Arenal de Guadalupe, 14389 Tlalpan, México City, México
[7]Dirección de Investigación y Diseminación del Conocimiento, Instituto Nacional de Ciencias e Innovación para la Formación de Comunidad Científica, INDEHUS, Periférico Sur 4860, Arenal de Guadalupe, 14389 Tlalpan, México

Background

Cognitive impairment is a major public health problem in Latin America, particularly in countries such as Mexico, where population aging represents considerable challenges [1, 2]. Recent research estimates that between 20.9% and 66.7% of Mexican adults have mild cognitive impairment, while between 2.9% and 19.9% have moderate to severe impairment [1, 3]. According to the 2021 National Survey on Health and Aging in Mexico (ENASEM), 4.7% of the adult population reported poor memory quality, 50.5% regular, 35% good, and only 9.5% excellent or very good [4].

Cognitive functions -such as attention, memory, learning, executive functions, language and perception- are essential mental skills and functions for daily life [5]. The extent to which we can execute these functions varies throughout life: improving in childhood and youth, consolidating in adulthood, and experiencing a decline during old age [6]. Assessing these functions is crucial to detect vulnerabilities due to brain aging, diseases or lesions in the cognitive and cerebral capacity of individuals [7], since their performance involves the activation of brain regions such as the premotor cortex, frontal lobe, temporal and parietal region [8, 9].

The assessment of cognitive functions has acquired relevance for the identification of the extent of brain and mental impairment associated with the progression of various diseases, such as cardiovascular [10], metabolic [11], oncological [12], psychological [13], neurodegenerative [14], and brain disorders [15].

In cardiovascular diseases, for example, prevention of cognitive decline is key to improve prognosis, decrease the risk of rehospitalizations, and optimize overall health status [16]. This is due to the decrease in cognitive function associated with cardiac dysfunction, constituting a risk factor for cardiovascular events, such as heart attacks or heart failure [17].

For metabolic diseases, such as Type 2 Diabetes Mellitus (T2DM), factors such as the toxic impact of glycemia on nerve terminals and insulin resistance have been identified, which affect neuronal survival and synaptic plasticity, contributing to cognitive impairment [18].

Regarding oncological diseases, it has been reported that treatments such as chemotherapy, hormonal and targeted therapies can affect fundamental cognitive domains, such as memory, speed of information processing, attention and executive functions, with prevalences of cognitive impairment ranging from 12 to 82% and complaints that can persist up to 20 years after treatment [12, 19].

Psychological disorders also negatively impact cognitive abilities, especially in functions such as memory, learning, concentration, and decision-making, due to chronic brain inflammation. This effect is especially noticeable in the older adult population [20].

In neurodegenerative diseases such as Alzheimer's or Parkinson's, attention, memory, executive functions and visuospatial skills are affected, due to the neurodegeneration process that alters neuronal networks and brain proteins [21, 22].

Although there are other diseases associated with cognitive alterations, these conditions are of special relevance in the Mexican population, due to their high prevalence [23]. The lack of awareness of the importance of assessing cognitive functions in Mexico endangers those affected by these conditions due to the lack of early detection of possible cognitive impairment.

Considering the increasing progress of aging in the global population [24] and in Latin-America [25], cognitive assessment will become more relevant. While aging is one of the main causes of cognitive decline, genetic and environmental factors also play an important role in increasing the risk of cognitive dysfunction [21]. Therefore, having cognitive measurement instruments that are easy to apply and interpret for the general population is essential.

In Mexico, validated instruments to assess cognitive function in the general population are limited. An example is the validation of the Montreal Cognitive Assessment (MoCA) by Aguilar-Navarro et al. [26], which reported a sensitivity of 80% and specificity of 75% to identify mild cognitive impairment, and a sensitivity of 98% and specificity of 93% for dementia. Another instrument used is the Wechsler Intelligence Test, common in neuropsychological assessment [27]. The Mini-Mental State Examination instrument has also been validated in the Mexican population, with a sensitivity of 82% and specificity of 84% [28].

In other studies, cognitive functions have been considered as an additional factor when assessing other constructs such as Functioning [29] or Quality of Life [30]. However, the main issue with studies addressing cognitive functions in a general way is that, although they focus on the reliability of the instruments, evidence of their validity has been neglected. Moreover, instruments that consider cognitive functions as part of the dimensions of a higher construct fail to identify the factorial structure adequately or to guarantee the reliability of the cognitive measurements.

In line with these considerations, an instrument that assesses cognitive functions is likely to undergo a complete psychometric analysis is the Patient-Reported Outcomes Measurement Information System (PROMIS) v2.0, which is an instrument derived from the Functional Assessment of Cancer Therapy - Cognitive Function (FACT-Cog) focused on the measurement of cognitive concerns due to the effects of cancer disease and its

treatments on cognitive functions [31]. This instrument was developed as part of the National Institutes of Health Roadmap initiatives for the development of instruments to measure aspects of health-related quality of life, initially with 78 items (36 items measuring cognitive skills and 42 cognitive concerns). However, after Multidimensional Item Response Theory analysis, it was identified that both factors could be used and interpreted separately [32]. Since the assessment of cognitive deficits (concerns), and not cognitive skills, is the commonly used parameter for the assessment of cognitive impairment, it has been recommended to use PROMIS v2.0 as the primary measure [33].

This scale has been shown to be a valid and reliable instrument in the general cancer population [34], multiple sclerosis [35], and chronic lymphocytic leukem [36], and therefore the evidence suggests that it can be considered an acceptable instrument.

However, for its proper use in the general population, it is necessary to identify operational equivalence -verification that this new population conceptualizes the construct similarly to the original population where the scale was validated-, and measurement equivalence -verification that scale presents appropriate psychometric properties in its adaptation to the new population- [37, 38]. This psychometric adaptation approach assures that measurements of cognitive functions -as well as other constructs- are valid and reliable in different contexts [39, 40].

Thus, the aim of this study was to determine the psychometric properties of the PROMIS v2.0 Short Form Cognitive Function Scale instrument in general Mexican population since, although it was previously validated in Mexican oncology population [34], the causes of cognitive impairment vary between both groups. Cancer-related inflammation accelerates physiological aging, leading to earlier and chronic cognitive impairment in cancer patients [41]. Given that psychometric properties must be validated specifically for specific populations, this study attempts to guarantee that the instrument is appropriated for the general population, as has been done in previous studies with other oncological population derivations to the general population in Mexico [42].

Materials and methods

Study design

An instrumental study [43] with a non-probabilistic convenience sample was conducted to identify the psychometric properties of a measurement instrument adapted to the general Mexican population using a non-experimental, cross-sectional design.

Participants

To determine sample size required for the Mexican population, it was calculated that 385 participants were needed considering a population of 128.5 million, a confidence level of 95% and a margin of error of 5% (https://www.calculator.net/sample-size-calculator.html?type=1%26;cl=95%26;ci=5%26;pp=50%26;ps=128500000%26;x=Calculate). In addition, sample size for this study was determined following the recommendations of Ferrando et al. [44] and Lloret-Segura et al. [45] on how to ensure consistent results in Factor Analysis. Therefore, 200–400 participants are suggested to be recruited for Exploratory Factor Analysis (EFA) and, subsequently, perform Confirmatory Factor Analysis with another 200–400 participants who were not included in the first analysis. Therefore, it was considered that a minimum of 600 participants should be recruited.

Inclusion criteria used were: (1) Participants reported that they were Mexican by birth, (2) Reporting that they were residing in Mexico at the time of answering the measurement instruments, (3) Being over 18 years old, & (4) Having an electronic device that allows them to access the Google forms platform to answer the measurement instruments. The exclusion criteria were: (1) Refusal to incorporate their data into the results report, (2) Not completing the instrument & (3) Internet instability connection to be able to send the form.

The instrument battery was administered online through the Google Forms module. A total of seven participants were excluded for not adhering to these criteria.

Measurements

Sociodemographic questionnaire

A questionnaire was used to collect information on sex, marital status, place of residence, employment status, educational level and number of children. To obtain evidence of know-groups validity, age ranges were established, expecting significant differences in cognitive functioning between older and younger groups.

PROMIS® v2.0 short form cognitive function scale

It is a short scale created from the FACT-Cog instrument, designed to measure the degree of alterations in cognitive functions in different diseases [31, 32]. It consists of eight items measuring subjective cognitive complaints during the past seven days, with responses ranging from 1 (very often) to 5 (never). The scale scores can be interpreted as the higher the score, the better the cognitive functioning. The original version has an $\alpha = 0.96$ and the adaptation in the Mexican oncology population presented an $\alpha = 0.955$, total variance explained of 73.27% and an adequate unifactorial structure (CMIN/DF = 1.265, CFI = 0.997, NFI = 0.986, GFI = 0.971, RMSEA = 0.036) [34].

Generalized anxiety scale (GAD-5)

Consists of five items to assess the degree to which individuals have experienced symptomatology related to generalized anxiety disorder, with responses ranging from 1 (strongly disagree) to 7 (strongly agree). The higher the score, the greater the anxious symptomatology. In Mexican population it presented adequate adjustment indexes (CFI = 0.993, TLI = 0.987, RMSEA = 0.07) [46] and in this study it presented an α = 0.897 (95% IC = 0.883, 0.909) with an explained variance of 64.33%, and adequate fit indices after correlate item 2 with item 4 (CMIN/DF = 1.383, CFI = 0.998, TLI = 0.996, GFI = 0.995, RMSEA = 0.025).

The scale was used to obtain evidence of divergent validity of the Short Form Cognitive Function Scale, expecting negative and moderate correlations between anxious symptomatology and correct cognitive functioning [47].

Subjective well-being scale

Developed and validated in Mexican population by Calleja & Mason [48], it consists of eight items on life satisfaction and positive affect, with responses from 1 to 7. In the original study, it presented an explained variance of 77.85%, α = 0.968 and evidence of validity (CMIN/DF = 2.45, CFI = 0.996, GFI = 0.993, RMSEA = 0.046). In this study, the explained variance was 82.74% with α = 0.974 (95% IC = 0.970, 0.977) and partially adequate fit indices (CMIN/DF = 10.344, CFI = 0.999, TLI = 0.998, GFI = 0.999, SRMR = 0.029). This scale was used to assess the convergent validity of the Short Form Cognitive Function Scale, expecting positive and moderate correlations between subjective well-being and adequate cognitive functioning [49].

Adaptation process

The Short Form Cognitive Function Scale was originally designed in English and later translated into Spanish by the original authors [31, 32]. In its validation in Mexican oncology population, Romero-Hernández et al. [34] performed a content validation by means of expert judgment and a pilot test.

For the aim of this study, the adaptation to the general population consisted of the revision of the items following the recommendations of the International Test Commission [50], since it was expected that this population might have a different understanding of cognitive functions compared to the oncology population.

The pilot tests included cognitive interviews [51] with five participants who met the inclusion criteria to ensure that the adaptation made by Romero-Hernández et al. [34] was appropriate for the general Mexican population, as well as the instructions and content of the items had a similar significance to that of the original population, and that the format of item presentation and response options were appropriate.

Five interviews were conducted in three formats: (1) a think-aloud interview, in which participants verbalized their thoughts while answering the scale; (2) two paraphrasing interviews, where participants explained in their own words the meaning of the instructions and items; and (3) two specification interviews, where they were asked to define the meaning of the scale items. As a result, no modifications to the scale were needed.

Procedure

The battery of instruments was administered online through Google Forms during the period from February 17 to October 18, 2024. Dissemination was done through social networks such as Facebook and Instagram. To participate, individuals were required to read and accept the informed consent to access the scales. To avoid missing data, the Google Forms option was activated, which prevented responses from being sent if any item was missing.

Ethical considerations

The study was approved by the Commissions of Research, Ethics and Biosafety at the Hospital Infantil de México Federico Gómez, National Institute of Health (HIM/2015/017/SSA.1207), and was complied with the Psychologist's Code of Ethics [52] guaranteeing that the conclusions were objective and derived directly from the results obtained. In addition, in accordance with article 138, participants were informed of the possible academic uses of the information generated by their services.

An informed consent was prepared following the guidelines of the American Psychological Association [53], which provided participants with details about the aim of the research, the duration of the application of instruments, as well as the related procedures. They were also informed of their right not to participate and to withdraw at any time, without consequences, and were provided with the means of contact to resolve any concerns related to the process.

In accordance with the Helsinki Declaration of the World Medical Association [54] on research involving human subjects, the voluntary participation of the participants in this study was considered, discarding those who could not give their consent in a free and informed manner. All doubts of the participants regarding the aims, financing, institutional affiliation, conflicts of interest, and possible risks or benefits derived from their participation were clarified.

Finally, in compliance with the Regulations of the General Health Law on Health Research [55], article 74 Third, the dignity, rights and well-being of the participants were respected, guaranteeing the confidentiality of the results obtained. In addition, they were informed of their right

to exclude the results if they so requested, always in accordance with the ethical and scientific principles of the research.

Data analysis

Descriptive analyses were conducted for the measures of central tendency and dispersion of the participants' scores. The measures of shape (skewness and kurtosis) were calculated as a complement to the Kolmogorov-Smirnov normality test due to concerns about the highly restrictive assumptions of this test [56]. Given that skewness of the data was less than|1| and the degree of departure from the univariate normal distribution was small (D < 0.300), the use of parametric statistics was considered appropriate. In addition, to verify the absence of floor and ceiling effects, the cumulative percentage in the bottom "Very often (Happens to me several times a day)" and top "Never" responses options were verified to be less than 30%. The corrected Index of Homogeneity (cIH) was calculated to verify that the items were sufficient correlated to assume that they are measuring the same construct (cIH > 0.400).

The data analysis process followed in this study to identify the factor structure of the scale was performed following the recommendations of Ferrando et al. [44] and Lloret-Segura et al. [45]. To analyze the factor structure of the Short Form Cognitive Function Scale the first 300 participants from the database of 600 were split for Exploratory Factor Analysis and internal consistency analyses. The Exploratory Factor Analysis (EFA) was performed using the "*psych*" package in R. The feasibility of the EFA was assessed using the Kaiser-Meyer-Olkin test (KMO > 0.800) and Bartlett's test of sphericity (p <.05), as well as Measures of Sampling Adequacy (MSA > 0.800).

To identify the number of factors that constitute the scale, a parallel analysis was performed using the "*paran*" package, retaining the factors whose adjusted Eigen values were greater than the 95th percentile of the estimated variance.

Due to compliance with univariate normality, the structure of five response options and a sample of 300 participants, it was decided to specify a Pearson correlation matrix. The AFE was performed using the maximum likelihood extraction method with an orthogonal rotation method via Quartimax due to being a short scale, parallel analysis is expected to identify a single overall factor [45]. A cut-off point of 0.400 was established for the factor loadings [44].

To estimate the internal consistency of the scale, Cronbach's alpha coefficient (α) and omega coefficient (Ω), along with their confidence intervals (95% CI), were calculated, considering values over 0.800 as adequate.

The last 300 participants were employed for Confirmatory Factor Analysis (CFA). Multivariate normality of the data was verified through Mardia's test. Since the multivariate kurtosis was significant (Multivariate kurtosis = 100.74, p <.001), it was determined to implement the Unweighted Least Squares method in the CFA with the "*Lavaan*" package in R.

To assess model fit, the following parameters were calculated [57]: chi-square test (X^2, p >.05), relative X^2 (CMIN/DF < 3), Comparative Fit Index (CFI > 0.950), Normalized Fit Index (NFI >. 900), the Non-Normed Fit Index (TLI > 0.950), the Goodness of Fit Index (GFI > 0.900) and its adjusted version (AGFI > 0.850), Root Mean Square Residual (RMSR < 0.05) and the Approximation Error (RMSEA < 0.08). In addition, the Average Variance Extracted was calculated to obtain evidence of convergent internal validity (AVE > 0.500) [58].

Measurement invariance and construct validity were assessed using the whole dataset (n = 600). Measurement invariance were tested on gender (Women and Men), geographic area of residence (North, Central and South Mexico) and age ranges (Group 1 = 18 to 36 years, Group 2 = 37 to 52 years, and Group 3 = 53 and older). For this purpose, four models were compared: (1) the unrestricted model (configurational or baseline), (2) the metric model (weak invariance) with restrictions on factor loadings; (3) the scalar model (strong invariance) with restrictions on factor loadings and intercepts, and 4) the strict invariance model, with restrictions on factor loadings, intercepts and residuals.

Changes in X^2 (p >.05), CFI and TLI (differences <|0.01|), and RMSEA and RMSR (differences < 0.015) were used to assess compliance with invariance, following the recommendations of Cheung & Rensvold [59].

Finally, construct validity of the Short Form Cognitive Function Scale was assessed by Pearson correlations to identify its convergent and divergent validity whose coefficients were interpreted as Negligible (r = 0 –.100), Weak (r =.101 –.399), Moderate (r =.400 –.699), Strong (r =.700 –.899), and Very strong (r =.900 –.999) [60]. Know-Groups Validity [61] was analyzed using Student's t-test for independent samples, contrasting two groups by age defined by the sample median (45 years) establishing Group 1 (participants aged 18 to 45 years) and Group 2 (participants older than 45 years). For t-test for independent samples, Standardized Mean Differences (SMD) were calculated with effect sizes 0 to 0.50 Small, 0.501 to 0.800 medium, and > 0.801 large effect [62]. Parametric statistical tests were used since the scores obtained on the Subjective Well-being (D = 0.109, gl = 600, p =.001; Skewness = – 0.361, Kurtosis = -1.03) and Generalized Anxiety (D = 0.085, gl = 600, p =.001; Skewness = – 0.154, Kurtosis = -1.06) scales were observed to closely follow a univariate normal distribution.

Table 1 Descriptive analysis and corrected Homogeneity Index ($n = 600$)

Item	$\bar{X}$ (S.D.)	K-S (*p*)	Skewness	Kurtosis	cHI
1	4.71 (1.70)	0.187 (0.001)	−0.429	−0.858	0.706
2	4.65 (1.75)	0.184 (0.001)	−0.388	−0.949	0.833
3	4.52 (1.77)	0.179 (0.001)	−0.345	-1.020	0.830
4	4.31 (1.85)	0.163 (0.001)	−0.212	-1.132	0.832
5	4.43 (1.99)	0.175 (0.001)	−0.295	-1.159	0.782
6	4.59 (1.94)	0.181 (0.001)	−0.359	-1.044	0.804
7	4.41 (1.90)	0.175 (0.001)	−0.317	-1.065	0.816
8	4.37 (1.81)	0.156 (0.001)	−0.215	−0.997	0.629

Note: S.D: Standar Deviation, K-S: Kolmogorov-Smirnov Test, cIH: corrected Homogeneity Index

Source: Own elaboration

Results

Descriptive analysis

The final sample consisted of 600 participants. The age of the participants ranged from 18 to 74 years (M = 45, S.D. = 12.60), of whom 469 (78.2%) were women and 131 (21.1%) were men. In terms of marital status, the most common were single (208 participants, 34.7%), married (202 participants, 33.7%), and in a relationship (105 participants, 17.5%). Regarding educational level, most had graduate degree (258 participants, 43%), and most were currently employed (330 participants, 71.3%). Regarding family status, 300 participants (64.8%) had children (364, 60.7%), with 2 being the mean number of children reported, while 163 (35.2%) had no children. Finally, people were geographically distributed in the following mexican zones: north (178 participants, 29.7%), center (334 participants, 55.7%) and south (88 participants, 14.7%).

Regarding the measurements variables, the Kolmogorov-Smirnov test for normality was significant. However, given that the degree of departure from the normal curve was small (D < 0.300), the skewness of the items was within an acceptable range of −0.492 to −0.091, the kurtosis ranged from 2.07 to 2.36, and the means of all items were close to the theoretical mean (3), it can be considered that the assumptions of univariate normality are met (Table 1).

The responses frequency was examined to verify the absence of ceiling or floor effects, ensuring that there were no more than 30% of accumulated responses in the upper or lower responses. Reactive 5 presented the highest percentage of cumulative responses in the lower response (11.3%), while reactive 6 obtained the highest percentage in the upper response (21.5%). The results of the cIH suggest that the items measure the same construct, with values ranging from 0.629 (item 8) to 0.833 (item 2).

Exploratory factor analysis (EFA)

The feasibility analyses showed adequate results, with a KMO value = 0.930, measures of sampling adequacy (MSA) ranging from 0.910 to 0.970 and a significant Bartlett's test of sphericity ($X^2 = 2063.84$, df = 28, $p = .001$).

Table 2 Exploratory Factor Analysis Results ($n = 300$)

Item	Factor loadings	Communalities
2. Parece como si mi cerebro no funcionara tan bien como siempre. [2. It seems as if my brain doesn't work as well as usual.]	0.899	0.808
3. He tenido que esforzarme más de lo normal para seguir el hilo de lo que estoy haciendo. [3. I have had to work harder than usual to keep track of what I am doing.]	0.891	0.794
4. He tenido problemas para alternar entre distintas actividades que requieren pensar. [4. I have had trouble alternating between different activities that require me to think.]	0.870	0.756
5. He tenido problemas para concentrarme. [5. I have had trouble concentrating]	0.832	0.693
7. He tenido problemas para formar mis pensamientos. [7. I have had trouble forming my thoughts]	0.822	0.676
6. Me he tenido que esforzar mucho para poner atención, de lo contrario cometo errores. [6. I have had to try very hard to pay attention, otherwise I make mistakes.]	0.818	0.669
1. He pensado con lentitud. [1. I have been thinking slowly]	0.785	0.616
8. He tenido problemas para hacer sumas y/o restas mentalmente. [8. I have had trouble doing addition and/or subtraction mentally.]	0.698	0.487
Total Explained Variance: 68.73%		

Source: Own elaboration

Parallel analysis identified that only one factor explained a variance above the 95th percentile, therefore a single-factor model was specified using the maximum likelihood method and orthogonal rotation via Quartimax. The results of the AFE, including factor loadings, communalities and total variance explained, are presented in Table 2.

Internal consistency

Internal consistency was adequate, with values of α = 0.945 (95% CI = 0.935, 0.953) and Ω = 0.946 (95% CI = 0.936, 0.955).

Confirmatory factor analysis (CFA)

The single-factor model was evaluated by CFA using the Unweighted Least Squares method due to multivariate non-normality (Multivariate kurtosis = 100.74, $p < .001$). Model fits were adequate since it was observed

a $X^2 = 46.594$, df = 20, $p = .001$, CMIN = 2.329, CFI = 0.998, TLI = 0.998, NFI = 0.997, GFI = 0.998, aGFI = 0.997, RMSEA = 0.047 (90% IC = 0.030, 0.065), SRMR = 0.031. As for the Average Variance Extracted, an appropriate value of AVE = 0.657 was obtained. The final factorial structural model is presented in Fig. 1.

Measurement invariance

In the analysis of measurement invariance, it was possible to identify a strict invariance when comparing the factor structure between gender (Women and Men) and geographical residence area (North, Central and South of Mexico) of the participants ($p > .05$).

For age range, only up to scalar invariance (strong invariance) was achieved. When reviewing the standardized residuals of the scalar model, it was possible to identify that participants in group 2 (ages 37 to 52 years) presented different parameters, especially lower standardized means compared to the other two groups of participants. The results of these analyses are presented in Table 3.

Construct validity

Evidence of construct validity was found as a positive moderate correlation was observed between cognitive functions and subjective well-being ($r = .507$, 95% CI = 0.445, 0.564, $p = .001$), and a negative moderate correlation with anxiety ($r = -.517$, 95% CI = – 0.573, – 0.455, $p = .001$).

The scale also showed evidence of know-groups validity by significantly differentiating younger and older people according to the score obtained on the measurement instrument (t = -5.304, df = 598, $p = .001$). However, contrary to expectations, participants aged 18 to 45 years obtained the lowest scores (M = 3.07, S.D. = 1.01), while participants aged 46 years and older had the highest scores (M = 3.51, S.D. = 0.980) with a small effect size of SMD = – 0.441.

Discussion

The aim of this study was to determine the psychometric properties of the Short Form Cognitive Function Scale in the general Mexican population, since it had previously only been validated in the Mexican oncology population. In addition, other validity evidence were presented in this study, such as convergent internal validity (AVE), convergent, divergent, and Know-groups validity validity, as well as evidence of measurement invariance in relevant sociodemographic variables.

Although different instruments have been used in the Mexican population to assess cognitive function, such as the Mini-Mental State Examination, the Mini-Cognitive

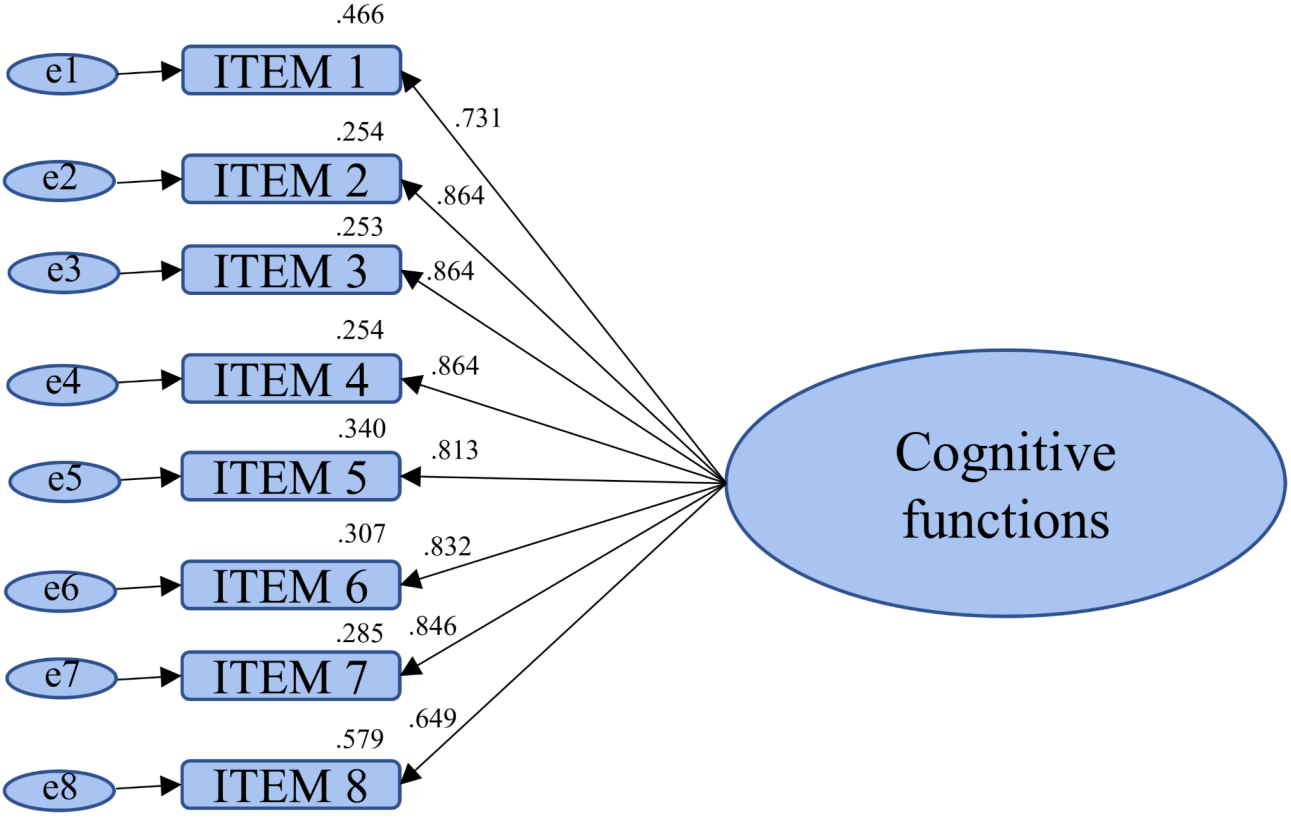

Fig. 1 Structural model

Table 3 Analysis of measurement invariance by gender, age ranges and geographic residence areas ($n = 600$)

Gender	**X^2(gl)**	**X^2/gl**	**CFI**	**TLI**	**RMSEA (CI 90%)**	**SRMR**		**ΔX^2**	**ΔCFI**	**ΔTLI**	**ΔRMSEA**	**ΔSRMR**
M1. Configurational model	51.024(40)	1.27	0.999	0.999	0.030 (0.000, 0.053)	0.030						
M2. Measurement model	63.735(47)	1.35	0.999	0.999	0.035 (0.000, 0.054)	0.033	**M2 vs. M1**	12.711(7), $p = .079$	0	0	0.004	0.003
M3. Scalar invariance	67.354(54)	1.24	0.999	0.999	0.029 (0.008, 0.049)	0.034	**M3 vs. M2**	3.618(7), $p = .822$	0	0	−0.006	0.001
M4. Strict invariance	81.880(62)	1.32	0.999	0.999	0.033 (0.005, 0.051)	0.037	**M4 vs. M3**	14.526(8), $p = .069$	0	0	0.004	0.003
Age ranges	**X^2(gl)**	**X^2/gl**	**CFI**	**TLI**	**RMSEA (CI 90%)**	**SRMR**		**ΔX^2**	**ΔCFI**	**ΔTLI**	**ΔRMSEA**	**ΔSRMR**
M1. Configurational model	51.024(40)	1.27	0.999	0.999	0.030 (0.000, 0.053)	0.030						
M2. Measurement model	115.026(74)	1.55	0.997	0.997	0.053 (0.033, 0.071)	0.045	**M2 vs. M1**	51.451(14), $p = .001$	−0.002	−0.003	0.035	0.012
M3. Scalar invariance	127.902(88)	1.45	0.997	0.997	0.048 (0.028, 0.065)	0.048	**M3 vs. M2**	12.877(14), $p = .536$	0	0.001	−0.005	0.003
M4. Strict invariance	178.961(104)	1.72	0.995	0.996	0.060 (0.045, 0.075)	0.055	**M4 vs. M3**	51.059(16), $p = .001$	−0.002	−0.001	−0.012	0.007
Geographic residence area	**X^2(gl)**	**X^2/gl**	**CFI**	**TLI**	**RMSEA (CI 90%)**	**SRMR**		**ΔX^2**	**ΔCFI**	**ΔTLI**	**ΔRMSEA**	**ΔSRMR**
M1. Configurational model	61.712(60)	1.02	0.999	0.999	0.012 (0.000, 0.045)	0.032						
M2. Measurement model	85.157(74)	1.15	0.999	0.999	0.028 (0.000, 0.051)	0.038	**M2 vs. M1**	23.472(14), $p = .053$	0	0	0.016	0.005
M3. Scalar invariance	89.919(88)	1.02	0.999	0.999	0.010 (0.000, 0.040)	0.039	**M3 vs. M2**	4.735(14), $p = .989$	0	0	−0.017	0.002
M4. Strict invariance	114.419(104)	1.10	0.999	0.999	0.022 (0.000, 0.044)	0.044	**M4 vs. M3**	24.5(16), $p = .079$	0	0	0.012	0.005
Cut-off points		< 3	> 0.950	> 0.950	< 0.08	< 0.05		$p > .05$	≤ 0.01	≤ 0.01	≤ 0.015	≤ 0.015

Examination, the Clock Test and the MoCa [26, 63], due to the design of these instruments, it had not been possible to conduct a complete psychometric analysis such as the present study, or that of Romero-Hernández et al. [34], to examine the factor structure, measurement invariance, or construct validity of a measurement focused on cognitive assessment. This lack of psychometric analysis was one of the limitations pointed out by Torres-Castro et al. [63] in their critical review of these instruments.

The results corroborated excellent fit indices and a unifactorial structure observed in previous studies [34] and in the original version [32].

Excellent internal consistency indices were identified, although slightly lower than those reported in the original translation by Romero-Hernández et al. [34]. Nevertheless, the indices remained above 0.900, both in Cronbach's Alpha and Omega coefficients, as well as a total variance explained above 60%, indicating excellent internal consistency (≥ 0.90) [64, 65].

The Short Form Cognitive Function Scale proved to be a valid and reliable instrument to assess the frequency of subjective complaints related to the cognitive status of the Mexican population, independently of gender (Men and Women), geographical area of residence (North, Central and South Mexico) or age range (18 to 36 years, 37 to 52 years and 53 years and older). Having a valid instrument that does not depend on these characteristics is fundamental for professional practice since gender differences have been identified that influence cognitive decline, such as the so-called cognitive reserve [66], which refers to the physiological resources that allow the brain to maintain its optimal functioning despite damage or alterations resulting from neurodegeneration [67].

Therefore, the implementation of screening for the frequency of subjective cognitive complaints could be useful to identify times when the threshold of cognitive reserve is about to be exceeded due to aging-related brain deterioration or brain health risk behaviors [68].

Regarding differences by age, although the factor structure of the Short Form Cognitive Function Scale was found to be equally valid for participants of the different age ranges analyzed in this study, an unexpected result was related to know-groups validity. The results showed that younger participants (18 to 45 years) reported significantly lower scores than participants older than 46 years, suggesting that, the older the age, the lower the perceived impairments in cognitive functions.

This finding seems to contradict the extensive literature indicating that age is a key factor in cognitive decline. To explain this phenomenon, two models of the effect of aging on brain functions have been proposed [69]: (1) the dedifferentiation theory, which suggests that the loss of specific brain functions in cognitive tasks is due to deficits in the dopaminergic regulatory system that promotes the loss of specific cortical characterizations; and (2) the compensation theory, which posits that older adults activate more brain areas to compensate for the loss of functions in regions such as frontal-medial cortex, prefrontal, parietal, precuneus, and cingulate-posterior cortex compared to younger adults.

Given that the participants in this study were from a nonclinical population, compensation theory could partially explain why older participants scored higher cognitive performance than younger participants. This finding is consistent with reports by Deary et al. [70] who suggest that compensatory brain functions may explain why age-associated brain deterioration does not necessarily translate into cognitive decline.

Also, at work, especially in individuals at highly productive ages who are starting their professional careers or facing academic pressures, can generate elevated levels of stress and cognitive overload. This stress can have a negative impact on cognitive functioning, which could lead younger people to perceive greater cognitive impairment [71].

Convergent validity, on the other hand, provides evidence on the importance of psychosocial variables, by considering their relationship with adequate cognitive functioning. In this sense, it has been observed that well-being in older adults may act as a protective factor against cognitive impairment, although the mechanisms and brain processes involved are not yet fully established [72].

Although the evidence on the consideration between anxious symptomatology and cognitive alterations is not conclusive [47, 73], the results of divergent validity in this study suggest that such a relationships could exist, at least in the general Mexican population. However, further studies such as those conducted in England through cohort studies [74] or in the United States through longitudinal studies [75] are required to establish this relationship with greater certainty.

These findings have several implications for professional practice. First, having a brief, valid and reliable instrument for the general population allows professionals to perform assessments more accurately in a variety of contexts, not just in clinical settings, where cognitive functions may be affected by different situations of daily life, such as working conditions [76], indoor environmental qualities [77] or sleep habits [78].

This kind of instrument would facilitate the early detection of cognitive problems in apparently healthy individuals, making possible preventive interventions before the cognitive impairment aggravates [79, 80]. In addition, its use favors the comparison of data in different populations and contexts, both nationally and internationally.

Moreover, the reporting of the psychometric properties of the instrument ensures that the cognitive function of the general population is accurately measured, which enables the early identification of cognitive alterations and the taking of preventive actions to improve the quality of life and well-being of the poblation before their problems become significant [80–82].

Limitations

Finally, some limitations should be noted. The validity and reliability of the scale could vary in populations with chronic diseases or conditions associated with cognitive decline that have not been evaluated in this study, such as people with cardiovascular disease, diabetes mellitus, chronic pain, multiple sclerosis, or neurodegenerative diseases. Another limitation is the need to test for measurement invariance in people with different educational levels, which was not possible in this study due to fewer than 50 participants with studies up to elementary school ($n = 2$), middle school ($n = 12$), and high school ($n = 46$).

Another limitation is that the reliability of the instrument is based only on internal consistency coefficients. In this respect, a test-retest could have strengthened the results reported. However, due to the remote application of the measurement instruments, and the anonymity of the participation of the individuals in this study, it was not possible to establish a follow-up contact or identify the responses of the participants in order to match their responses from the first application (test) with a possible second application (retest), so it is suggested that additional research should explore alternative ways to support the reliability of the instrument through these alternatives to strengthen the reliability results of the Short Form Cognitive Function Scale (PROMIS v2.0) presented so far.

A final limitation is the possible unrepresentativeness of the sample. Although an appropriate sample size was obtained for the size of the Mexican population, it could not be considered a representative sample, since a stratified randomized sampling method by geographical areas of the country would have to be chosen.

Conclusions

The Mexican version of the Short Form Cognitive Function Scale for the general population presents adequate psychometric properties and fit indicators, making it a brief, valid and reliable instrument for use in non-clinical and research settings in Mexico. This study highlights the importance of psychometrically validated measurement instruments to assess the state of cognitive functions in the general Mexican population. The availability of valid and reliable assessment tools would allow adequate diagnostic evaluations, which will facilitate the design of effective strategies for the prevention of cognitive decline, as well as for interventions or rehabilitation in response to diseases that may lead to cognitive decline, such as chronic illnesses.

Abbreviations

T2DM	Type 2 Diabetes Mellitus
MoCA	Montreal Cognitive Assessment
CFI	Comparative Fit Index
GFI	Goodness of Fit Index
RMSEA	Root mean squared error of approximation
TLI	Tucker-Lewis Index
SRMR	Root Mean Square Residual
cIH	Corrected Index of Homogeneity
EFA	Exploratory Factor Analysis
CFA	Confirmatory Factor Analysis
KMO	Kayser-Meyer-Olkin
MSA	Measures of Sampling Adequacy
AVE	Average Variance Explained

Acknowledgements

The authors thank Angel Gabriel Uribe Zamorano for his support.

Author contributions

Conceptualization, J.F.M.R. and L.A.M.C.; methodology, J.F.M.R. and L.A.M.C.; software, J.F.M.R.; validation, J.F.M.R., L.A.M.C., R.A.S.G., I.G.A. and F.T.T.; formal analysis, J.F.M.R., L.A.M.C and F.T.T.; investigation, J.F.M.R. and L.A.M.C; resources, F.T.T.; data curation, J.F.M.R.; writing—original draft preparation, J.F.M.R., L.A.M.C., R.A.S.G., I.G.A. and F.T.T.; writing—review and editing, R.A.S.G., I.G.A. and F.T.T.; visualization, J.F.M.R.; supervision, F.T.T.; project administration, J.F.M.R., R.A.S.G., and I.G.A.; funding acquisition, F.T.T. All authors have read and agreed to the published version of the manuscript.

Funding

Hospital Infantil de México Federico Gómez National Institute of Health, research project HIM/2015/017/SSA.1207, "Effects of mindfulness training on psychological distress and quality of life of the family caregiver", with the main researcher Filiberto Toledano-Toledano, Ph.D., received federal funds. The source of federal funds did not control the study design, data collection, analysis, interpretations, or decisions regarding publication.

Data availability

The data that support the findings of this study are available from correspondence author upon reasonable reasons due to the preservation of anonymity of the participants.

Declarations

Ethics approval and consent to participate

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Commissions of Research, Ethics and Biosafety at the Hospital Infantil de México Federico Gómez, National Institute of Health (HIM/2015/017/SSA.1207). Informed consent was obtained from all subjects involved in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 17 December 2024 / Accepted: 3 February 2025
Published online: 12 February 2025

References

1. Reyes RJT, Maytorena RS, Núñez JRG, Ríos MIA, Zazueta AGA, Herrera GO. Deterioro cognitivo y riesgo de caídas en adultos mayores en Culiacán Sinaloa México. Dilemas Contemp Educ Política Valores. 2023;10:1–16.

2. Rivas-Sucari HC, Rodríguez-Eguizabal JL. Salud cognitiva en El adulto mayor, Un reto para la salud pública. Gac Médica México. 2024;160:233–4.
3. Silva A, Guerrero R, Beltrán V, Silva M. Deterioro cognitivo e independencia del adulto mayor en El centro de México. Rev Científica Psicol Eureka. 2019;16:90–103.
4. Instituto Nacional de Estadística y Geografía [INEGI]. Encuesta Nacional sobre Salud y Envejecimiento en México (ENASEM) 2021 [Internet]. 2022 [cited 2024 Nov 17]. Available from: https://www.inegi.org.mx/programas/enasem/2021/
5. Huppert F, Gardener E, McWilliams B. Cognitive function. Retire Health Relatsh Older Popul Engl. The Institute for Fiscal Studies; 2004. pp. 223–42.
6. Nouchi R, Kawashima R. Improving cognitive function from children to Old Age: a systematic review of recent smart ageing intervention studies. Adv Neurosci. 2014;2014:235479.
7. Stern Y, Arenaza-Urquijo EM, Bartrés-Faz D, Belleville S, Cantilon M, Chetelat G, et al. Whitepaper: defining and investigating cognitive reserve, brain reserve, and brain maintenance. Alzheimers Dement J Alzheimers Assoc. 2020;16:1305–11.
8. Leisman G, Moustafa AA, Shafir T, Thinking. Walking, talking: Integratory Motor and cognitive brain function. Front Public Health. 2016;4:94.
9. Wang L, Liang X, Wang J, Zhang Y, Fan Z, Sun T et al. Cerebral dominance representation of directed connectivity within and between left-right hemispheres and frontal-posterior lobes in mild cognitive impairment. Cereb Cortex N Y N. 1991. 2023;33:11279–86.
10. Gorodeski EZ, Hashmi AZ. Integrating assessment of cognitive status in elderly cardiovascular care. Clin Cardiol. 2019;43:179–86.
11. Tahmi M, Palta P, Luchsinger JA. Metabolic syndrome and cognitive function. Curr Cardiol Rep. 2021;23:180.
12. Lange M, Joly F, Vardy J, Ahles T, Dubois M, Tron L, et al. Cancer-related cognitive impairment: an update on state of the art, detection, and management strategies in cancer survivors. Ann Oncol. 2019;30:1925–40.
13. Vermeulen T, Lauwers T, Van Diermen L, Sabbe BG, van der Mast RC, Giltay EJ. Cognitive deficits in older adults with psychotic depression: a Meta-analysis. Am J Geriatr Psychiatry off J Am Assoc Geriatr Psychiatry. 2019;27:1334–44.
14. Krellman JW, Mercuri G. Cognitive interventions for neurodegenerative disease. Curr Neurol Neurosci Rep. 2023;23:461–8.
15. Wang J, Wang Y, Cai X, Xia W, Zhu J. A review: Visuospatial Dysfunction in patients with the Cerebral Small Vessel Disease. Neuroscience. 2024;552:47–53.
16. Shimoda T, Suzuki S, Mizukoshi D, Saori W, Yokoshima E, Terai T. Examination of the proportion and characteristics of cognitive function changes during hospitalization in patients with cardiovascular diseases. PLoS ONE. 2024;19:e0309306.
17. Luksiene D, Sapranaviciute-Zabazlajeva L, Tamosiunas A, Radisauskas R, Bobak M. Lowered cognitive function and the risk of the first events of cardiovascular diseases: findings from a cohort study in Lithuania. BMC Public Health. 2021;21:792.
18. Karvani M, Simos P, Stavrakaki S, Kapoukranidou D. Neurocognitive impairment in type 2 diabetes mellitus. Horm Athens Greece. 2019;18:523–34.
19. Flynn MJ, Abolhosseini S, Gamboa J, Campbell TS, Carlson LE. Mindfulness-based interventions and cognitive function in cancer survivors: a systematic review and meta-analysis. J Psychosoc Oncol Res Pract. 2023;5.
20. Du M, Liu M, Liu J. The mutual longitudinal mediating effects of psychological and physical disorders on cognitive impairment among older adults. J Affect Disord. 2024;362:477–84.
21. Lamptey RNL, Chaulagain B, Trivedi R, Gothwal A, Layek B, Singh J. A review of the Common Neurodegenerative disorders: current therapeutic approaches and the potential role of Nanotherapeutics. Int J Mol Sci. 2022;23:1851.
22. Hansson O. Biomarkers for neurodegenerative diseases. Nat Med. 2021;27:954–63.
23. Escamilla-Nuñez MC, Castro-Porras L, Romero-Martinez M, Zárate-Rojas E, Rojas-Martínez R. Detección, diagnóstico previo y tratamiento de enfermedades crónicas no transmisibles en adultos mexicanos. Ensanut 2022. Salud Publica Mex. 2023;65:s153–62.
24. Rudnicka E, Napierała P, Podfigurna A, Męczekalski B, Smolarczyk R, Grymowicz M. The World Health Organization (WHO) approach to healthy ageing. Maturitas. 2020;139:6–11.
25. Hambleton IR, Caixeta R, Jeyaseelan SM, Luciani S, Hennis AJM. The rising burden of non-communicable diseases in the Americas and the impact of population aging: a secondary analysis of available data. Lancet Reg Health Am. 2023;21:100483.
26. Aguilar-Navarro SG, Mimenza-Alvarado AJ, Palacios-García AA, Samudio-Cruz A, Gutiérrez-Gutiérrez LA, Ávila-Funes JA. Validez Y confiabilidad del MoCA (Montreal Cognitive Assessment) para El tamizaje del deterioro cognoscitivo en méxico. Rev Colomb Psiquiatr. 2018;47:237–43.
27. Bauselas E. Estudio De validación De La batería Luria-DNA frente a las escalas de inteligencia Wechsler (WAIS-III) en estudiantes universitarios. Rev Mex Neurocienc. 2007;8:531–8.
28. Ostrosky-Solís F, López-Arango G, Ardila A. Sensitivity and specificity of the Mini-mental State examination in a spanish-speaking population. Appl Neuropsychol. 2000;7:25–31.
29. Castañeda-Franco M, Becerra-Palars C, Tirado-Durán EG, Yoldi-Negrete M, Juárez-García FL. Propiedades psicométricas De La Prueba Breve De Funcionamiento (FAST) en pacientes con diagnóstico de trastorno bipolar en México. Psicol Salud. 2020;30:123–31.
30. De Peña E, Aguilar Gaytán SS, Suárez Mendoza AA, Reyes Terán G. Validación Mexicana De La Escala MOS-HIV De calidad de vida en pacientes infectados por El VIH. Rev Panam Salud Pública. 2007;21:313–9.
31. Cella D, Yount S, Rothrock N, Gershon R, Cook K, Reeve B, et al. The patient-reported outcomes Measurement Information System (PROMIS): progress of an NIH Roadmap cooperative group during its first two years. Med Care. 2007;45:S3–11.
32. Lai J-S, Wagner LI, Jacobsen PB, Cella D. Self-reported cognitive concerns and abilities: two sides of one coin? Psychooncology. 2014;23:1133–41.
33. Patient-Reported. Outcomes MEasurement Information System. Cognitive Function. 2019.
34. Romero-Hernández AX, Galindo-Vázquez Ó, Penedo FJ, Bargalló-Rocha JE. Propiedades psicométricas del instrumento PROMIS® v2.0 Función Cognitiva Forma Breve (SF-8) en población oncológica mexicana. Gac Mex Oncol. 2022;21:119–28.
35. Stuifbergen AK, Becker H, Perez F, Morison J, Kullberg V, Todd A. A randomized controlled trial of a cognitive rehabilitation intervention for persons with multiple sclerosis. Clin Rehabil. 2012;26:882–93.
36. Valentine TR, Weiss DM, Jones JA, Andersen BL. Construct validity of PROMIS® cognitive function in cancer patients and noncancer controls. Health Psychol off J Div Health Psychol Am Psychol Assoc. 2019;38:351–8.
37. Furr R. Psychometrics: an introduction. SAGE; 2018.
38. Streiner D, Norman G, Cairney J. Health measurement scales: a practical guide to their development and use. Oxford University Press; 2015.
39. Han H-R, Kim MT, Weinert C. The psychometric evaluation of Korean translation of the Personal Resource Questionnaire 85-Part 2. Nurs Res. 2002;51:309–16.
40. Mendoza-Contreras LA, Domínguez Trejo B, Guillén Núñez MDR, Rodríguez Medina DA, Pardo XM, Estapé T, et al. Psychometric properties of the short-form McGill Pain Questionnaire (SF-MPQ) in adult Mexican cancer patients with chronic pain. Palliat Support Care. 2025;23:e20.
41. Di Meglio A, Vaz-Luis I. Systemic inflammation and cancer-related frailty: shifting the paradigm toward precision survivorship medicine. ESMO Open. 2024;9:102205.
42. Galindo Vázquez O, Mendoza-Contreras LA, Flores-Juárez J, Núñez-Hernández J, Calderillo-Ruiz G, Meneses-García A et al. Propiedades psicométricas del Instrumento de Evaluación de Funcionalidad en el Tratamiento para Enfermedades Crónicas (FACT-GP) en población general mexicana. Cienc Psicológicas [Internet]. 2022 [cited 2025 Jan 20]; Available from: https://revistas.ucu.edu.uy/index.php/cienciaspsicologicas/article/view/2732
43. Ato M, López-García JJ, Benavente A. Un Sistema De clasificación De Los diseños de investigación en psicología. Psicol Ann Psychol. 2013;29:1038–59.
44. Ferrando P, Lorenzo-Seva U, Hernández-Dorado A, Muñiz J. Decalogue for the factor analysis of test items. Psicothema. 2022;1:7–17.
45. Lloret-Segura S, Ferreres-Traver A, Hernández-Baeza A, Tomás-Marco I. El análisis factorial exploratorio de Los ítems: una guía práctica, revisada y actualizada. Psicol. 2014;30:1151–69.
46. Astudillo-García CI, Austria-Corrales F, Rivera-Rivera L, Reynales-Shigematsu LM, Gómez-García JA, Séris-Martinez M et al. Measurement invariance of the GAD-5 Generalized Anxiety Disorder Scale in a Mexican general population sample. Front Psychiatry [Internet]. 2022 [cited 2024 Dec 9];13. Available from: https://www.frontiersin.org/journals/psychiatry/articles/https://doi.org/10.3389/fpsyt.2022.973134/full
47. Nyberg J, Henriksson M, Wall A, Vestberg T, Westerlund M, Walser M, et al. Anxiety severity and cognitive function in primary care patients with anxiety disorder: a cross-sectional study. BMC Psychiatry. 2021;21:617.
48. Calleja N, Mason T. Escala de Bienestar Subjetivo (EBS-20 y EBS-8): Construcción y Validación. Rev Iberoam Diagnóstico Eval [Internet]. 2020 [cited 2024

Dec 9];55. Available from: https://www.aidep.org/sites/default/files/2020-04/RIDEP55-Art14.pdf
49. Hill NL, McDermott C, Mogle J, Munoz E, DePasquale N, Wion R, et al. Subjective cognitive impairment and quality of life: a systematic review. Int Psychogeriatr. 2017;29:1965–77.
50. Muñiz J, Elosua P, Hambleton R. Directrices Para La traducción Y adaptación De Los tests: segunda edición. Psicothema. 2013;2:151–7.
51. Willis G. Cognitive Interviewing: A tool for improving questionnaire design [Internet]. London: SAGE Publications Ltd; 2005 [cited 2024 Dec 9]. Available from: https://methods.sagepub.com/book/cognitive-interviewing
52. Sociedad Mexicana de Psicología. Código Ético Del Psicólogo. México: Trillas; 2013.
53. American Psychological Association. Ethical principles of psychologists and code conduct [Internet]. 2017. Available from: https://www.apa.org/ethics/code/ethics-code-2017.pdf
54. World Medical Association. WMA Declaration of Helsinki– Ethical Principles for Medical Research Involving Human Participants [Internet]. 2013. Available from: https://pdf-it.dev.acw.website/please-and-thank-you?url=https://www.wma.net/policies-post/wma-declaration-of-helsinki/%26;pdfName=wma-declaration-of-helsinki
55. Secretaría de Salud. Reglamento de la ley general de salud en materia de investigación para la salud [Internet]. 2022. Available from: https://www.diputados.gob.mx/LeyesBiblio/ref/lgs/LGS_ref131_16may22.pdf
56. Ghasemi A, Zahediasl S. Normality tests for statistical analysis: a guide for non-statisticians. Int J Endocrinol Metab. 2012;10:486–9.
57. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct Equ Model Multidiscip J. 1999;6:1–55.
58. Fornell C, Larcker D. Evaluating Structural equation models with unobservable variables and measurement. J Mark Res. 1981;18:39–50.
59. Cheung GW, Rensvold RB. Evaluating goodness-of-fit indexes for Testing Measurement Invariance. Struct Equ Model Multidiscip J. 2002;9:233–55.
60. Schober P, Boer C, Schwarte LA. Correlation coefficients: appropriate use and interpretation. Anesth Analg. 2018;126:1763–8.
61. Davidson M, Known-Groups, Validity. Encycl Qual Life Well- Res [Internet]. Springer, Cham; 2023 [cited 2025 Jan 20]. pp. 3764–3764. Available from: https://link.springer.com/referenceworkentry/https://doi.org/10.1007/978-3-031-17299-1_1581
62. Cohen J. Statistical power analysis for the behavioral sciences [Internet]. Academic Press; 1988. Available from: https://doi-org.pbidi.unam.mx:2443/10.1016/C2013-0-10517-X.
63. Torres-Castro S, Mena-Montes B, González-Ambrosio G, Zubieta-Zavala A, Torres-Carrillo N, Acosta-Castillo G, et al. Escalas De Tamizaje cognitivo en habla hispana: una revisión crítica. Neurología. 2022;37:53–60.
64. George D, Mallery P. IBM SPSS Statistics 26 Step by Step: A Simple Guide and Reference [Internet]. Routledge; 2019 [cited 2024 Dec 9]. Available from: https://doi.org/10.4324/9780429056765
65. Moral J. Revisión De Los criterios para validez convergente estimada a través de la Varianza Media Extraída. Psychol Av Discip. 2019;13:25–41.
66. Giacomucci G, Mazzeo S, Padiglioni S, Bagnoli S, Belloni L, Ferrari C, et al. Gender differences in cognitive reserve: implication for subjective cognitive decline in women. Neurol Sci. 2022;43:2499–508.
67. Mazzeo S, Padiglioni S, Bagnoli S, Bracco L, Nacmias B, Sorbi S, et al. The dual role of cognitive reserve in subjective cognitive decline and mild cognitive impairment: a 7-year follow-up study. J Neurol. 2019;266:487–97.
68. Lazar RM, Howard VJ, Kernan WN, Aparicio HJ, Levine DA, Viera AJ, et al. A primary care agenda for Brain Health: A Scientific Statement from the American Heart Association. Stroke. 2021;52:e295–308.
69. Zhao S, Li Y, Shi Y, Li X. Cognitive Aging: How the Brain Ages? In: Zhang Z, editor. Cogn Aging Brain Health [Internet]. Singapore: Springer Nature; 2023 [cited 2024 Dec 9]. pp. 9–21. Available from: https://doi.org/10.1007/978-981-99-1627-6_2
70. Deary IJ, Corley J, Gow AJ, Harris SE, Houlihan LM, Marioni RE, et al. Age-associated cognitive decline. Br Med Bull. 2009;92:135–52.
71. Bufano P, Di Tecco C, Fattori A, Barnini T, Comotti A, Ciocan C, et al. The effects of work on cognitive functions: a systematic review. Front Psychol. 2024;15:1351625.
72. Glover CM, Stewart CC, Yu L, Wilson RS, Lamar M, Bennett DA, et al. Psychological well-being relates to Healthcare and Financial decision making in a study of predominantly white older adults. J Appl Gerontol off J South Gerontol Soc. 2023;42:1770–80.
73. Leonard K, Abramovitch A. Cognitive functions in young adults with generalized anxiety disorder. Eur Psychiatry J Assoc Eur Psychiatr. 2019;56:1–7.
74. John A, Desai R, Saunders R, Buckman JEJ, Brown B, Nurock S, et al. Salivary cortisol in longitudinal associations between affective symptoms and midlife cognitive function: a British birth cohort study. J Psychiatr Res. 2022;151:217–24.
75. Ahn S, Mathiason MA, Yu F. Longitudinal cognitive profiles by anxiety and depressive symptoms in American older adults with subjective cognitive decline. J Nurs Scholarsh off Publ Sigma Theta Tau Int Honor Soc Nurs. 2021;53:698.
76. Leso V, Fontana L, Caturano A, Vetrani I, Fedele M, Iavicoli I. Impact of Shift Work and Long Working hours on Worker Cognitive functions: current evidence and Future Research needs. Int J Environ Res Public Health. 2021;18:6540.
77. Wang C, Zhang F, Wang J, Doyle JK, Hancock PA, Mak CM, et al. How indoor environmental quality affects occupants' cognitive functions: a systematic review. Build Environ. 2021;193:107647.
78. Taillard J, Sagaspe P, Philip P, Bioulac S. Sleep timing, chronotype and social jetlag: impact on cognitive abilities and psychiatric disorders. Biochem Pharmacol. 2021;191:114438.
79. Cremers LGM, Huizinga W, Niessen WJ, Krestin GP, Poot DHJ, Ikram MA, et al. Predicting Global Cognitive decline in the General Population using the Disease State Index. Front Aging Neurosci. 2019;11:379.
80. Park HL, O'Connell JE, Thomson RG. A systematic review of cognitive decline in the general elderly population. Int J Geriatr Psychiatry. 2003;18:1121–34.
81. Jiménez DIJ, Ojeda MFV, Vargas MEV. Intervención Neuropsicológica para estimular las funciones cognitivas de atención, memoria y percepción en Los adultos mayores. Cienc Lat Rev Científica Multidiscip. 2023;7:6816–36.
82. Valderrama FP, Rivera CF, Cárdenas VP, Acosta RP, Alvarez OA, Hernández JMR, et al. Relación entre calidad de vida y deterioro cognitivo en adultos mayores activos. Rev Peru Cienc Act Fis Deporte. 2019;6:9–9.

Publisher's note