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# Adaptation and validation of the self-report version of the scale for measuring quality of life in people with acquired brain injury (CAVIDACE)

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**Abstract**

**Purpose** The disability and resulting dependence after acquired brain injury (ABI) significantly reduces quality of life (QoL), making the correct assessment of QoL important. However, the instruments currently used to assess QoL are either reductionist, including only health-related aspects, or, like the CAVIDACE scale, are based on multidimensional models but ignore the individual's perspective. Therefore, the purpose of this study is to validate the self-report version of the CAVIDACE scale.
**Method** The sample consisted of 345 adults with ABI aged between 18 and 91 years ($M = 54.83$; SD $= 14.91$). The participants' QoL was evaluated by professionals and family members and by the participants themselves, using the original version of the CAVIDACE scale and an adapted self-report version. The following complementary variables were also measured: social support, depression, community integration, and resilience.
**Results** The results supported the internal structure of the scale based on the theoretical model. According to this model, QoL is composed of eight first-order intercorrelated domains (RMSEA = 0.050, CFI = 0.891, TLI = 0.881). The internal consistency, determined by omega rank, was adequate in seven of the eight domains, ranging between 0.66 (PW) and 0.87 (SI). The convergent and discriminant validity of the scale was very good overall.
**Conclusions** The self-report version of the CAVIDACE was demonstrated to be a specific instrument with very good psychometric properties and is a very useful complement in the assessment of QoL in people with ABI.

**Keywords** Quality of life · Acquired brain injury · Self-report · Psychometric properties · CAVIDACE Scale

## Introduction

Acquired brain injury (ABI) is the result of a sudden injury to a healthy brain that produces various physical, cognitive, emotional, and behavioural consequences [1, 2] that persist over time [3] and affect both the person who experiences the injury and the people around them [4]. According to the Survey on Disability, Personal Autonomy, and Situations of Dependence (EDAD 2008) in Spain, 420.064 people live with ABI [5]. A total of 78% of these cases were caused by stroke, and the remaining 22% were caused by traumatic brain injury (TBI) and other causes.

The numerous persisting sequelae after ABI lead to great dependence and disability and, consequently, significantly affect the patient's quality of life (QoL) [6–11]. This impact on QoL, together with the high prevalence of ABI, has led to an increasing interest in the study of QoL.

Some characteristics of ABI, such as severity [12–14], the degree of disability after the injury [15–17], and the presence of a greater number of physical and cognitive deficits [18, 19], are related to reduced levels of QoL. Other sociodemographic factors, such as living alone, also seem to negatively affect QoL [20], although it has also been observed that people who live independently without the need for support have better QoL [12]. On the one hand, numerous studies suggest that variables such as anxiety and depression, especially the latter, exert a very negative influence on QoL [6, 15, 17, 18, 21–26], while other variables, such as resilience, exert a great protective effect [27, 28]. On

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the other hand, it has been found that in many cases, social support after ABI is inadequate, and satisfaction with social support is low, which is associated with a decrease in QoL [25, 29, 30]. Likewise, community participation and integration appear to be fundamental aspects of satisfaction with life and QoL after ABI [15–17, 25]; thus, it is important to encourage patients return to an active working life.

Traditionally, the approach to the concept of QoL in the field of ABI has been mainly focused on the measurement of health-related personal outcomes (i.e., health-related quality of life—HRQoL). There are several instruments available to assess HRQoL in ABI, both generic and disease-specific ones. The disease-specific scales are replacing the traditional generic scales, like the Medical Outcomes 36-Item Short Form Health Survey (SF-36) [31], which although are useful to compare the QoL between different populations, were not specifically adjusted for the population with ABI. The European Brain Injury Questionnaire (EBIQ) and the Quality of life in Brain Injury (QOLIBRI) [32] are examples of disease-specific instruments. EBIQ is focused on three aspects: cognitive, emotional, and social difficulties, while the QOLIBRI contains six domains: cognition, self, daily life and autonomy, social relationships, emotions, and physical problems. They use both self-report and proxy (others' report) measures and are very helpful in the clinical practice with ABI's patients. However, their evaluation focuses, to a greater extent and in a limited way, on those aspects most related to functional, physical and emotional health, neglecting in the evaluation other aspects beyond health (e.g., rights, self-determination, interpersonal relationships, or personal development).

Hence, it is necessary to consider more complete and integrated models, that also include contextual factors [33] and reflect a psychosocial approach that goes beyond health-related aspects. For example, the current model of Schalock and Verdugo defines QoL as *"a multidimensional phenomenon composed of core domains influenced by personal characteristics and environmental factors"* [34, 35]. It frames QoL as comprising eight domains: emotional well-being (EW), interpersonal relationships (IR), material well-being (MW), personal development (PD), physical well-being (PW), self-determination (SD), social inclusion (SI), and rights (RI). This model, backed by years of national and international research, has been widely used in the field of intellectual and developmental disabilities [34]. However, in recent years, it has been utilized successfully in people with mental illness, physical and sensory disabilities, and elderly people [36]. In 2018, the Schalock and Verdugo's model was used to develop an instrument that can holistically evaluate the QoL in people with ABI. The resulting instrument was the Scale for Measuring Quality of Life in Acquired Brain Injury (La Escala para la Evaluación de la Calidad de Vida de Personas con Daño Cerebral, CAVIDACE) [37], which was subjected to an extensive process of construction and validation [38, 39]. The development of the scale was based on an extensive review of the scientific literature, a group discussion with professionals who provide services to people with ABI, and a Delphi study—a methodology that involved 14 experts in ABI to provide content validity for a pool of 120 items that made up the field-test version of the CAVIDACE scale. Then, a test validation process was carried out with 421 adults with ABI, selecting the most relevant and significant items, leaving a 64-item final version which fits the eight domains of the model and that counts with very good internal consistency and inter-rater reliability.

In addition to suggest that QoL is best measured like a multidimensional construct, Schalock and Verdugo consider that QoL has universal and cultural properties, has objective and subjective components, and is influenced by personal and social factors [34, 36], which means that the core domains are the same for everyone, although they may vary individually in relative value and importance. This conclusion highlights the importance of using self-report measures, whenever possible, to more accurately determine QoL [40–42]; allowing the individual to express their needs, objectives, and desires [43], and providing professionals with valuable information for the personal rehabilitation process [44]. Data from third-party reports should be taken with caution because it does not always correlate sufficiently with self-report data [45–49]. Despite this, the use of self-report measures in the population with ABI should also be pursued with caution and as a complement to other measures [12] because factors such as the presence of anosognosia could affect the results. For example, Formisano et al. [47] found that people with anosognosia rated their QoL lower than those who accurately perceived their deficit [47]. However, there are studies that show the opposite effect [7, 50].

As mentioned previously, the construction and validation of the CAVIDACE scale was a very important milestone for the evaluation of QoL in the population with ABI. However, the scale is designed to be answered by a third party (professional, family, etc.), leaving the affected person out of the evaluation process. To overcome this limitation and get a comprehensive QoL evaluation tool based on a multidimensional model that includes the evaluation of the person with ABI, this study adapted and validated a self-report version of the CAVIDACE scale. In this process, it was important to reduce the original version to facilitate the understanding and responsiveness of the person with ABI, which usually presents major cognitive problems for the maintenance of attention [51].

## Method

### Participants

The study included a total of 393 people with ABI who received specialized services and support at 27 centres and organizations throughout the Spanish territories. The inclusion criteria for participation were (a) having experienced an ABI, (b) being 16 years or older, (c) receiving services and support at a specific care centre for people with ABI, and (d) having signed informed consent.

More than half of the sample was male ($n=210$, 61%), with ages between 18 and 91 years ($M=54.83$; SD = 14.91), and normally distributed. It is worth noting the low percentage of subjects who returned to work or study after injury (3%), as well as the low frequency of people living independently (12.4%). Regarding clinical variables, the high percentage of disability in the sample ($M=74.46$; SD = 14.78) stand out, as well as the high prevalence of stroke as the main aetiology of the injury (62.6%), followed by TBI (23.1%). Table 1 shows the clinical and sociodemographic variables of the participants.

The participants' QoL was evaluated by a direct care professional, a family member and by the person with ABI. In addition, the person with ABI had to complete a series of test that were complementary to the QoL evaluation. To be included in the sample of respondents, professionals and family members had to know the person being evaluated for at least 3 months, in different contexts, and for extended periods of time. For the person with ABI to be included, they had to have sufficient cognitive abilities to understand and respond to the questions raised. It was up to the professional to determine whether the user was eligible to participate and to provide appropriate help as needed. Finally, of the 393 people with ABI involved in the study, only 345 were considered able to respond to pertinent self-report questions. The proxy evaluation was answered by 474 informants: 131 professionals, mostly neuropsychologists *($n=79$),* and 343 relatives, mainly partners ($n=149$). Each professional responded almost three questionnaires on average ($M=2.63$) and each family member responded only to their relatives' questionnaire. Table 2 summarizes the main characteristics of the informants.

**Table 1** Sociodemographic and clinical characteristics of the ABI sample ($N=345$)

| | Frequency (%) |
|---|---|
| Gender ($n=344$) | |
| Male | 210 (61%) |
| Female | 134 (39%) |
| Age (years) ($n=341$) | |
| Mean (SD) | 54.83 (14.91) |
| Range | 18–91 |
| Civil status ($n=337$) | |
| Married/cohabitating | 178 (52.8%) |
| Single | 94 (27.9%) |
| Separated/divorced | 47 (13.9%) |
| Widow | 18 (5.3%) |
| Prior employment status ($n=335$)/current employment status ($n=337$) | |
| Working | 190 (56.7%)/3 (0.9%) |
| Studying | 23 (6.9%)/7 (2.1%) |
| Unemployed | 33 (9.9%)/13 (3.9%) |
| Unable to work | 11 (3.3%)/194 (57.6%) |
| Retired | 73 (21.8%)/108 (32%) |
| Other | 5 (1.5%)/12 (3.6%) |
| Type of household ($n=217$) | |
| Independent flat | 27 (12.4%) |
| Residential centre | 33 (15.2%) |
| Sheltered flat | 3 (14%) |
| Family home | 154 (71%) |
| Type of centre ($n=272$) | |
| Day centre | 112 (41.2%) |
| Rehabilitation centre | 160 (58.8%) |
| Type of support ($n=316$) | |
| Intermittent | 40 (12.7%) |
| Limited | 34 (10.8%) |
| Extensive | 85 (26.9%) |
| Generalized | 157 (49.7%) |
| Percentage of disability ($n=259$) | |
| Mean (SD) | 74.46 (14.78) |
| Range | 20–100 |
| Time since the injury (years) ($n=319$) | |
| Mean (SD) | 6.95 (6.92) |
| Range | 0.5–47.5 |
| Localization of the injury ($n=312$) | |
| Right hemisphere | 117 (37.5%) |
| Left hemisphere | 102 (33.7%) |
| Bilateral | 93 (29.8%) |
| Aetiology of the injury ($n=334$) | |
| Cerebrovascular accident | 209 (62.6%) |
| Traumatic brain injury | 77 (23.1%) |
| Cerebral anoxia | 11 (3.3%) |
| Cerebral tumours | 14 (4.2%) |
| Infection diseases | 8 (2.4%) |
| Other | 15 (4.5%) |

### Development of the self-report version of the CAVIDACE scale

The first step in the process of adapting the original version of the CAVIDACE scale to create the self-report version entailed the rewording of the items from third to

**Table 1** (continued)

| | Frequency (%) |
|---|---|
| Current health conditions | |
| Physical disability | 298 (86.4%) |
| Cognitive deficit | 272 (78.8%) |
| Sensory disability | 173 (50.1%) |
| Language and communication | 157 (45.5%) |
| Mental health problems/emotional disorder | 110 (31.9%) |
| Behavioural problems | 102 (29.6%) |
| Associated chronic pain | 60 (15.4%) |
| Epilepsy | 55 (15.9%) |
| Others | 10 (2.9%) |

first person (*e.g.*, i15 *"He/she enjoys leisure time with his/her friends"* → *"I enjoy leisure time with my friends")*. Two members of the research team who were familiar with the entire construction and validation process of the scale completed this task. A visual response system (see Fig. 2 in Appendix) accompanied the Likert-type response scale to aid in respondents' understanding, a technique the authors have applied in other self-report scales used to evaluate QoL in people with other types of disabilities [42].

## Instruments

### CAVIDACE scale

The CAVIDACE scale is a specific instrument for evaluating the QoL of adults with ABI from the perspective of an external observer who knows the person well. It consists of 64 items organized around the 8 domains of the QoL model of Schalock and Verdugo (8 items per domain), and items are answered using a Likert-type response format with four options: 0 = *never*, 1 = *sometimes*, 2 = *frequently*, and 3 = *always*. The CAVIDACE also collects a large amount of sociodemographic and clinical data, as well as questions concerning the informant. It was constructed using a detailed Delphi study [38] and has obtained very good reliability and validity data: The internal consistency is good to excellent for the eight domains (ordinal alpha ranges from 0.77 to 0.93), and the inter-rater reliability is very high (0.97) [39].

### CAVIDACE scale (self-report version)

The self-report version of the CAVIDACE scale used for this study consists of 64 items written in the first person and divided into the 8 domains of the Schalock and Verdugo model. The items are answered using a Likert-type response format with four options: 0 = *never*, 1 = *sometimes*, 2 = *frequently,* and 3 = *always*.

**Table 2** Characteristics of the professionals' and relatives' sample ($N = 474$)

| Professionals ($n$=131) | Frequency (%) |
|---|---|
| Gender | |
| Male | 71 (20.9%) |
| Female | 268 (79.1%) |
| Profession | |
| Neuropsychologist | 79 (23.6%) |
| Occupational therapist | 67 (20%) |
| Physiotherapist | 64 (19.1%) |
| Speech therapist | 40 (11.9%) |
| Psychologist | 33 (9.9%) |
| Pedagogue | 15 (4.5%) |
| Social worker | 9 (2.7%) |
| Social educator | 8 (2.4%) |
| Medical | 7 (2.1%) |
| Nurse | 6 (1.8%) |
| Nursing assistant | 3 (0.9%) |
| Others | 4 (1.2%) |
| Frequency of contact | |
| Several times per week | 257 (76.3%) |
| Once a week | 70 (20.8%) |
| Once per 2 weeks | 9 (2.7%) |
| Once a month | 1 (0.3%) |
| **Relatives ($n$=343)** | **Frequency (%)** |
| Gender | |
| Male | 95 (32.1%) |
| Female | 201 (67.9%) |
| Relationship | |
| Partners | 149 (49.8%) |
| Parents | 83 (27.8%) |
| Sons or daughters | 31 (10.4%) |
| Siblings | 28 (9.4%) |
| Legal guardian | 2 (0.7%) |
| Others | 6 (2%) |
| Frequency of contact | |
| Several times per week | 250 (94.7%) |
| Once a week | 8 (3%) |
| Once per 2 weeks | 4 (1.5%) |
| Once a month | 2 (0.8%) |

### Patient health questionnaire (PHQ-9)

The PHQ-9 is a 9-item measure that evaluates the nine criteria of depression listed in the Diagnostic and Statistical Manual of Mental Disorders, Fourth edition (DSM-IV) [52]. Scores can vary from 0 to 27, with higher scores indicating more severe levels of depression. The PHQ-9 has been validated in people with ABI [53] and has been adapted to Spanish [54], with good psychometric properties in both cases. This questionnaire on depression is consistent with the recent updates of the DSM-V diagnostic manual [55].

### Community integration questionnaire (CIQ)

The CIQ is a scale composed of 15 items that measure community integration in the population with ABI [56]. The scale yields a score ranging from 0 to 29. Higher scores indicate greater integration and fewer participation restrictions. Good psychometric properties have been obtained for the Spanish version [57]. The corrected version proposed by Sander et al. was used [58]; in this version, items 4 and 10 of the original scale are eliminated as they are very ambiguous in their interpretation.

### Connor–Davidson resilience scale (CD-RISC)

The CD-RISC is a scale composed of 25 items that measures an individual's resilience [59]. A total score is calculated using the sum of all item scores; it ranges from 0 to 100, with higher scores indicating greater resilience. Studies that have analysed the psychometric properties of the CD-RISC have shown that it has good psychometric properties [59]. It has been used with a variety of neurological conditions, including ABI [60].

### Social support questionnaire-6 (SSQ6)

The SSQ6 is a 6-item measure of social support comprising a reduced version of the original scale [61]. The respondent indicates the number of people available to provide support in each of the six areas and then rates his or her overall satisfaction with this level of social support. The SSQ6 has been used with people with ABI and has shown generally good psychometric properties [62]. Two scores can be obtained: mean support (range 0 to 6) and mean satisfaction (range 1 to 6).

## Procedure

Professionals and participating centres were recruited primarily via email and telephone. On numerous occasions, the professionals we contacted referred us other centres, thus producing a snowball effect. The study was disseminated through congresses and conferences and was posted on the university website.

Once a centre showed interest, a member of the research team visited it to provide all the necessary information about the study. There were three centres that, although they showed initial interest in the study, finally did not participate in it. It was the decision of each centre to determine the degree of involvement in the study and the number of patients who were going to participate in it, making a randomized selection when not all users were going to participate. All participating centres were given the option of completing the study tests online or in a paper format, but all the centres ($n = 27$) opted for paper tests. This allowed us to send printed copies to the centre upon request.

Next, the professionals had to contact the users and their families to give them information about the study, obtain informed consent, and distribute the appropriate tests. In those cases in which the professional considered that the patient could not complete the scale, even with the pertinent aids, this part of the evaluation was omitted. The filling of the tests was carried out in each centre, with the exception of the families who had the option to take home the test, complete it there and return it within a maximum period of one week. Once the participants completed the assessments, they were to return the documents to the research team, which was committed to providing feedback on the results. Contact through email and telephone was continuous throughout the process. The field work for the implementation of this phase was carried out from November 2017 to November 2018.

Ethical approval of the study was obtained from the Bioethics Committee of the University of Salamanca. Written informed consent was obtained from both the people with ABI and their family. In cases of legal incapacity, only the informed consent of the legal representative was obtained. Personal and clinical data were collected, stored and protected in accordance with Organic Law 15/1999 of December 23 for the Protection of Personal Data (LOPD 15/1999), and the confidentiality and anonymity of the participants were maintained. An identification code was assigned to each participant in the study, so that personal data such as their name and surname was not handled.

## Statistical analysis

The psychometric properties of the 64 items were analysed to reduce the number of the items in each domain with the best properties according to four criteria: (a) the mean value of the scores of each of the items, (b) the corrected homogeneity indices (CHI) of the items, (c) the distribution of the responses, and (d) the content of the items. This procedure was very similar to that followed in the validation of the original scale [39].

The factor validity of the model containing eight correlated first-order factors was evaluated with a confirmatory factor analysis (CFA). The model was estimated using the weighted least squares with a mean and variance adjustment (WLSMV). Previously, several exploratory analyses were performed to obtain a preliminary approximation of the data and detect possible errors and evaluations that could be discarded. The fit of the model was examined by the root mean square error of approximation (RMSEA), the comparative fix index (CFI), and the Tucker–Lewis Index (TLI). The CFI and TLI values above 0.90 and 0.95, as the RMSEA values below 0.08 and 0.05 indicate acceptable and good levels of fit, respectively [63].

Scores on the CAVIDACE scale were summarized using descriptive statistics means, standard deviations, and ranges. The floor and ceiling values for the scale were calculated [64].

The reliability of the scale was evaluated in terms of internal consistency using omega rank, the domain–domain correlation, and the items-corrected domain correlation. To consider an acceptable value of reliability using the omega coefficient these must be between 0.70 and 0.90, although in some circumstances values higher than 0.65 can be accepted [65].

On the one hand, the convergent and discriminant validity of the scale was determined with a multitrait-multimethod CFA approach [66]. To evaluate discriminant validity, we determined domain–domain correlations, the correlations between the self-report version and the responses obtained from professionals and family members, and the square root of the average variance extracted (AVE) for each factor. For a factor be considered to have adequate discriminant validity, the AVE value must be greater than the highest observed correlation between that factor and the other factors [67]. On the other hand, the convergent validity of CAVIDACE was examined by calculating the correlations with satisfaction with social support, depression, community integration, and resilience. Positive correlations between QoL's scores and satisfaction with social support, community integration and resilience, and negative correlations with depression, were expected. Pearson's correlation coefficients (r) were calculated; a r value greater than 0.6 indicates a strong correlation, values from 0.4 to 0.59 indicate a moderate correlation, and values from 0 to 0.39 indicates a weak correlation [68]. We also checked whether the correlations obtained were significantly different depending on the QoL's domain, using a calculation for the test of the difference between two dependent correlations with one variable in common [69]. The result was a *z*-score which was compared in a 2-tailed fashion to the unit normal distribution. By convention, values greater than |1.96| were considered significant.

The known-group method for examining validity was applied to test whether CAVIDACE could discriminate individuals according to the type of household, the time since the injury, the severity of disability, and the number of current health conditions. Independent *t* tests has been used for variables that had two groups and one-way ANOVA with post hoc comparisons for the variables with three groups. To determine the groups within each variable, the division criteria established in the data collection were followed in the variable type of household. In time since injury and disability percentage, we used theoretical criteria, and in the case of number of current health conditions, it was calculated through the mean level. For the type of household, it was expected to find better results of QoL in the IR domain for those who live with their families or in a sheltered flat and better QoL in the SD and SI domain for those who live independently. For the rest of the variables, it was expected to find higher levels of QoL when ABI was more recent, in patients with a low percentage of disability, and low indices of comorbidity, for the eight QoLs' domains.

Data analysis was performed with Statistical Package for the Social Sciences (SPSS, v.25), AMOS v.18, and MPLus 7.0. A significance level equal to or less than 0.05 was established for all statistical tests.

## Results

### Reduction of the items

The analysis of the psychometric properties of the items allowed the selection of those items that performed better within the scale, which reduced the number of items to a more manageable and reliable level. This analysis was based on four criteria that were performed by domain (see Table 3). First, according to the mean, all items with a mean higher than 2.5 were eliminated. This criterion allowed for the elimination of the nine items with the highest ceiling effect (e.g., i39 *"I follow appropriate hygiene routines (e.g. teeth, hair, nails, body,* etc.*) and personal imagen routines (e.g. clothing appropriate to my age, the occasion,* etc.*)"* with $M = 2.82$). The second step was to calculated the CHI of the items using the corrected Pearson's item–scale correlation. Given the size of the sample, the minimum value for the selection of an item was set at 0.30 [70]. Twelve items with scores below 0.30 were eliminated (e.g., i26 *"I have difficulty concentrating (e.g., when reading or following a conversation)"*).

We analyzed the distribution of responses to avoid the answers accumulating mainly in one response option instead of being distributed in a normal way (i.e., skewness). Seven items were eliminated because more than 60% of the sample was in one option (e.g., i12 "*I show affection towards others (e.g. partner, family, friends,* etc.*)"*). Finally, and to avoid compromising the content validity, the analysis considered the content of the items to avoid eliminating items that were especially relevant to this population and to exclude duplicates in meaning and content. A total of four items were eliminated (e.g., i56 *"I have access to public services in my community (e.g. bookshops, health centre, city council,* etc.*)"*). According

**Table 3** Eliminated items in the final version of the self-report scale

| | 1st step $M \geq 2.5$ | 2nd step CHI < 0.300 | 3nd step Skewness | 4th step Content |
|---|---|---|---|---|
| EW | i06 | i02, i07 | | |
| IR | | i11, i16 | i12 | |
| MW | _i20*_, _i21*_,_i22*_, i23, i24 | | i17 | |
| PD | | i26, i27, i31 | | |
| PW | i39 | _i34*_, i36, i40 | | |
| SD | | | i46, i48 | i42 |
| SI | | | | i49, i50, i56 |
| RI | _i63*_, _i64*_ | i58, i60 | _i57*_, i61, _i62*_ | |
| N items | 4 (9) | 11 (12) | 5 (7) | 4 |

*CHI* corrected homogeneity indexes, *EW* emotional well-being, *IR* interpersonal relations, *MW* material well-being, *PD* personal development, *PW* physical well-being, *SD* self-determination, *SI* social inclusion, *RI* rights

*Items that should have been removed but were maintained by test content criteria

to the same content criteria, it was necessary to keep eight of the items previously deleted: five of the items removed for the mean criteria, one of the items deleted for the CHI, and finally, two of the items removed for their skewness.

The application of these criteria to the set of 64 initial items allowed us to select the five items per domain with the best psychometric properties, resulting in a scale of 40 items. The domains had a floor effect of 0–0.3% and a ceiling effect of 2.1–21.7%. Table 4 summarizes the means, standard deviations, ranges, floors and ceiling effect, and corrected item-total correlation for domains.

## Factorial validity

The fit of the model with 8 correlated factors was adequate ($\chi^2(712) = 1333.9$, $p < 0.001$, RMSEA = 0.050 (0.046–0.054), CFI = 0.891, TLI = 0.881). The model was able to fairly clearly retrieve the theoretical structure of the construct because the target loads were significant ($p < 0.05$) and almost greater than 0.50. The factorial loads ranged between 0.27 and 0.85. Figure 1 shows the standardized coefficients.

The correlations between the factors in the self-report version (Table 5) showed a range between 0.13 (PW-SD) and 0.51 (PD-SD). The correlations obtained with the factors of the professional and family scales were greater than 0.30, except for the MW and RI domains ($\mathrm{MW}_{\mathrm{relatives}} - \mathrm{MW}_{\mathrm{users}} = 0.29$, $\mathrm{RI}_{\mathrm{professionals}} - \mathrm{RI}_{\mathrm{users}} = 0.19$, and $\mathrm{RI}_{\mathrm{relatives}} - \mathrm{RI}_{\mathrm{users}} = 0.17$).

## Internal consistency

The corrected item-total correlation for domains ranged from 0.17 to 0.68, with items in the IR and RI domains having items with correlations below 0.30. In the case of the IR domain, item 9 *("I have the relationship I wish to have with my loved ones")* was the only item that had a coefficient lower than 0.30; in the RI domain, only item 57 *("People around me treat me with respect (e.g. they speak to me in an appropriate tone, do not infantilise me, use positive terms, avoid negative comments in public, avoid speaking about*

**Table 4** Summary of means, standards deviations, range, % floor and ceiling, and the corrected item–total correlation by domains ($N$= 345)

| Domains (no. of items) | n | Mean (SD) | Min | Max | % Floor | % Ceiling | Corrected item–scale correlation | Omega rank (40 items) | Omega rank (64 items) |
|---|---|---|---|---|---|---|---|---|---|
| Emotional well-being (5) | 344 | 10.59 (3.05) | 0 | 15 | 0 | 3.9 | 0.29–0.59 | 0.77 | 0.82 |
| Interpersonal relations (5) | 345 | 10.13 (3.06) | 0 | 15 | 0 | 5.1 | 0.17–0.56 | 0.84 | 0.83 |
| Material well-being (5) | 344 | 12.06 (3.01) | 1 | 15 | 0 | 21.7 | 0.44–0.64 | 0.82 | 0.88 |
| Personal development (5) | 345 | 9.21 (3.25) | 0 | 15 | 0 | 2.1 | 0.35–0.49 | 0.73 | 0.74 |
| Physical well-being (5) | 345 | 10.71 (3.11) | 2 | 15 | 0 | 8.7 | 0.31–0.38 | 0.66 | 0.76 |
| Self-determination (5) | 344 | 10.11 (3.74) | 0 | 15 | 0 | 8.1 | 0.39–0.50 | 0.81 | 0.85 |
| Social inclusion (5) | 345 | 8.71 (4.06) | 0 | 15 | 0.3 | 7.2 | 0.53–0.68 | 0.87 | 0.89 |
| Rights (5) | 343 | 12.13 (2.62) | 3 | 15 | 0 | 15.1 | 0.27–0.42 | 0.72 | 0.79 |

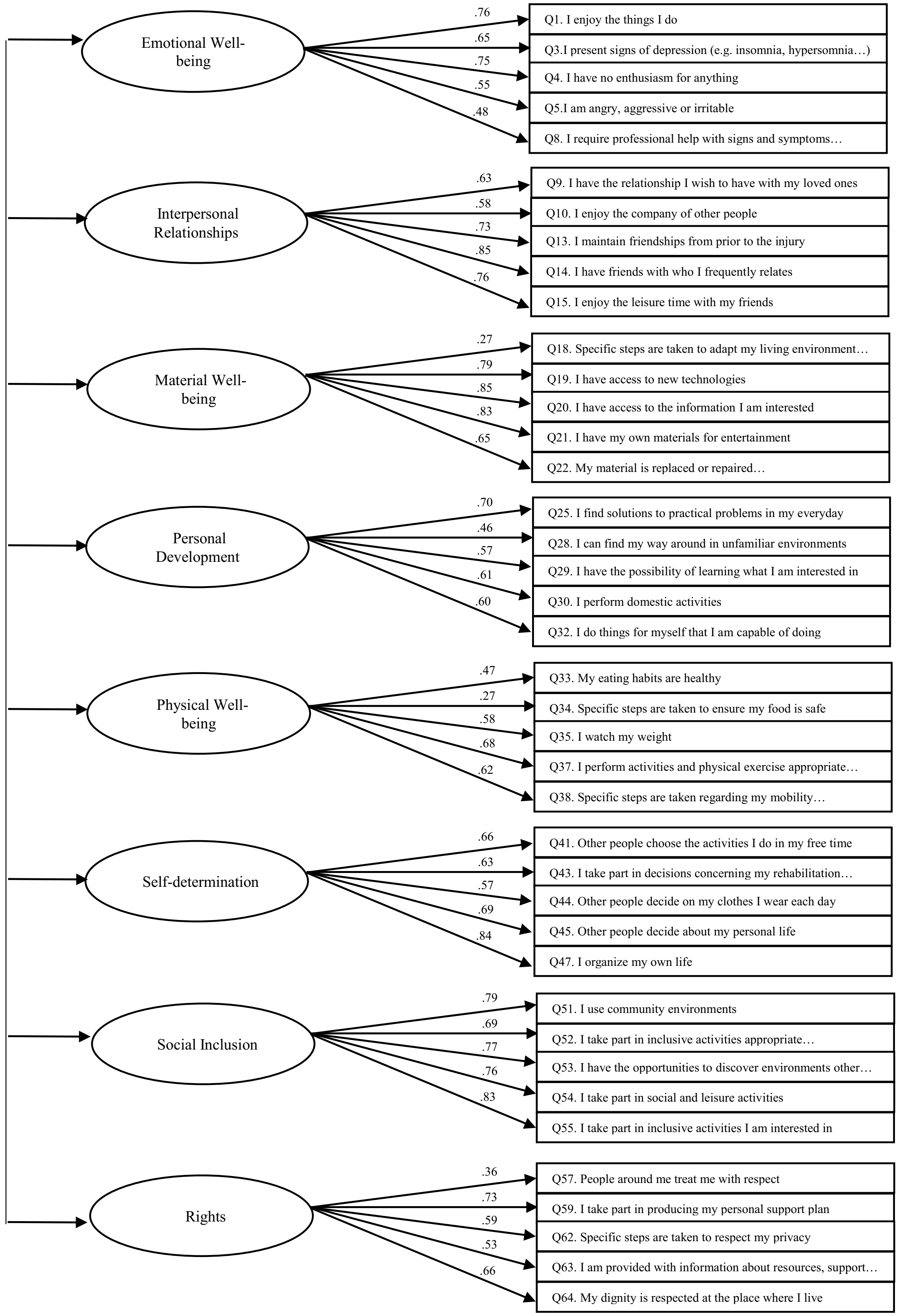

**Fig. 1** Standarized coefficients item-domain

**Table 5** Correlations between the eight domains in the self-report scale and correlations between the scales of users-professionals, users-relatives, and professional-relatives

| | **Users** | | | | | | | | **Professionals** | | | | | | | | **Relatives** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Users** | EW | IR | MW | PD | PW | SD | SI | RI | EW | IR | MW | PD | PW | SD | SI | RI | EW | IR | MW | PD | PW | SD | SI | RI |
| EW | **(.65)** | | | | | | | | | | | | | | | | | | | | | | | |
| IR | .34*** | **(.72)** | | | | | | | | | | | | | | | | | | | | | | |
| MW | .14* | .35*** | **(.71)** | | | | | | | | | | | | | | | | | | | | | |
| PD | .29*** | .37*** | .36*** | **(.60)** | | | | | | | | | | | | | | | | | | | | |
| PW | .18** | .22*** | .34*** | .28*** | **(.54)** | | | | | | | | | | | | | | | | | | | |
| SD | .15** | .26*** | .32*** | .51*** | .13* | **(.68)** | | | | | | | | | | | | | | | | | | |
| SI | .31*** | .43*** | .44*** | .45*** | .31*** | .36*** | **(.77)** | | | | | | | | | | | | | | | | | |
| RI | .20*** | .36*** | .50*** | .36*** | .32*** | .34*** | .41*** | **(.59)** | | | | | | | | | | | | | | | | |
| **Professionals** | | | | | | | | | | | | | | | | | | | | | | | | |
| EW | __.48__*** | .28*** | .12* | .23*** | .15** | .21*** | .19*** | .25*** | **(.66)** | | | | | | | | | | | | | | | |
| IR | .26*** | __.48__*** | .20*** | .18** | .09 | .20*** | .28*** | .21*** | .59*** | **(.75)** | | | | | | | | | | | | | | |
| MW | .18** | .23*** | __.36__*** | .22*** | .13* | .22*** | .27*** | .14* | .25*** | .48*** | **(.80)** | | | | | | | | | | | | | |
| PD | .13* | .30*** | .21*** | __.44__*** | .07 | .46*** | .16** | .24*** | .53*** | .53*** | .44*** | **(.72)** | | | | | | | | | | | | |
| PW | .13* | .13* | .09 | .13* | __.30__*** | .09 | .11 | .15** | .30*** | .30*** | .41*** | .31*** | **(.62)** | | | | | | | | | | | |
| SD | .03 | .30*** | .25*** | .39*** | .06 | __.58__*** | .23*** | .25*** | .41*** | .53*** | .47*** | .79*** | .20*** | **(.82)** | | | | | | | | | | |
| SI | .18** | .28*** | .24*** | .31*** | .16** | .36*** | __.49__*** | .19*** | .38*** | .59*** | .48*** | .48*** | .29*** | .50*** | **(.77)** | | | | | | | | | |
| RI | .15** | .28*** | .21*** | .29*** | .14* | .28*** | .21*** | __.19__*** | .34*** | .49*** | .52*** | .55*** | .47*** | .61*** | .41*** | **(.67)** | | | | | | | | |
| **Relatives** | | | | | | | | | | | | | | | | | | | | | | | | |
| EW | __.37__*** | .27*** | .12* | .16** | .16** | .19** | .17** | .24*** | __.53__*** | .39*** | .29*** | .36*** | .15** | .35*** | .24*** | .31*** | **(.60)** | | | | | | | |
| IR | .16** | __.49__*** | .13* | .14* | .13* | .10 | .17** | .22*** | .35*** | __.52__*** | .31*** | .31*** | .13* | .34*** | .29*** | .26*** | .59*** | **(.72)** | | | | | | |
| MW | .10 | .26*** | __.29__*** | .21*** | .09 | .17** | .19** | .16** | .10 | .27*** | __.46__*** | .28*** | .12* | .35*** | .32*** | .33*** | .29*** | .38*** | **(.74)** | | | | | |
| PD | .13* | .26*** | .23*** | __.43__*** | .25*** | .44*** | .23*** | .28*** | .35*** | .38*** | .39*** | __.65__*** | .20*** | .64*** | .43*** | .45*** | .54*** | .52*** | .47*** | **(.64)** | | | | |
| PW | .20** | .18** | .13* | .05 | __.36__*** | -.07 | .17** | .11 | .01 | .08 | .17** | .00 | __.26__*** | -.02 | .11* | .10 | .28*** | .35*** | .36*** | .23*** | **(.61)** | | | |
| SD | .07 | .26*** | .21*** | .39*** | .17** | __.59__*** | .15** | .25*** | .33*** | .36*** | .33*** | .63*** | .14* | __.76__*** | .42*** | .46*** | .46*** | .46*** | .42*** | .76*** | .07 | **(.75)** | | |
| SI | .19** | .27*** | .19** | .22*** | .10 | .21*** | __.39__*** | .18** | .21*** | .34*** | .37*** | .28*** | .09 | .33*** | __.48__*** | .21*** | .36*** | .54*** | .43*** | .49*** | .30*** | .38*** | **(.75)** | |
| RI | .08 | .23*** | .20** | .25*** | .05 | .23*** | .18*** | __.17__** | .15** | .29*** | .22*** | .34*** | .23*** | .41*** | .28*** | __.41__*** | .28*** | .42*** | .57*** | .50*** | .42*** | .48*** | .47*** | **(.59)** |

Square root of the AVE is on the diagonal (in bold and between brackets). The inter-factor correlations (in bold) and correlations between the three versions of the scale are out of the diagonal

*EW* emotional well-being, *IR* interpersonal relationships, *MW* material well-being, *PD* personal development, *PW* physical well-being, *SD* self-determination, *SI* social inclusion, *RI* rights

*$p<0.05$, **$p<0.01$, ***$p<0.001$

**Table 6** Correlation between CAVIDACE and global scores of other scales, using Pearson's correlation coefficients ($n = 240$)

| Domains | Satisfaction with social support | Community integration | Resilience | Depression |
|---|---|---|---|---|
| Emotional well-being | .18* | .12* | .38*** | – .50*** |
| Interpersonal relationships | .27*** | .38*** | .25*** | – .28*** |
| Material well-being | .27*** | .23*** | .14* | – .17** |
| Personal development | .18** | .36*** | .43*** | – .22*** |
| Physical well-being | .18** | – .03 | .19** | – .07 |
| Self-determination | .02 | .42*** | .26*** | – .05 |
| Social inclusion | .19** | .29*** | .31*** | – .19** |
| Rights | .22*** | .14* | .18** | – .14* |

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

*me as I were not there, etc.)"*) had a coefficient lower than 0.30. Omega rank fluctuated between 0.66 (PW) and 0.87 (SI). Acceptable omega values (> 0.70) were found for seven of the eight domains. The domain–domain correlations were moderate in the majority of cases. The correlations between domains in the self-report scale varied between 0.14 (PW-SD) and 0.51 (PD-SD) (see Table 5).

## Convergent validity

In the multitrait–multimethod analysis, we found that the square root of the AVE was higher than the inter-domain correlations for all domains on the self-report version, suggesting good discriminant validity. The same happened with the proxy version for professionals and relatives, expect for the PD domain in the relatives' answer, in which there were a higher correlation in the domain–domain (PD-SD = 0.74). Correlations between the same factors in the scales of users-professionals and users-relatives were always higher than the correlations between the different domains, except for the RI domain ($EW_{professionals} - RI_{users} = 0.25$ and $PD_{relatives} - RI_{users} = 0.28$).

Mostly domains of the CAVIDACE scale, except PW and SD in some cases, were significantly and positively correlated with the scales of satisfaction with social support, community integration, and resilience and were negatively correlated with depression (Table 6).

When analyzing the differences between correlations, no significant differences were found in case of satisfaction with social support. The correlation obtained between the variable community integration and the SD domain is significantly higher than that obtained between community integration and EW ($z = 3.807$, $p < 0.001$), MW ($z = 2.729$, $p = 0.003$), and RI ($z = 4.030$, $p < 0.001$); likewise, the correlation obtained between IR and community integration was significantly greater than those obtained between community integration and the domains of EW ($z = 3.688$, $p < 0.001$), MW ($z = 2.174$, $p = 0.03$), and RI ($z = 3.463$, $p < 0.001$). In the case of the resilience variable, the PD domain correlated significantly higher than IR ($z = 2.702$, $p = 0.007$), MW ($z = 4.220$, $p < 0.001$), PW ($z = 3.344$, $p < 0.001$), SD ($z = 2.886$, $p = 0.004$), and RI ($z = 3.683$, $p < .001$) did. The same happened with the correlations obtained between the resilience and the EW, which were significantly higher than those obtained with MW ($z = 2.996$, $p = 0.003$), PW ($z = 2.445$, $p = 0.015$), and RI ($z = 2.600$, $p = 0.009$). Finally, the depression scale correlated with the EW domain significantly higher than the IR ($z = -3.343$, $p < 0.001$), MW ($z = -4.328$, $p < 0.001$), PD ($z = -4.060$, $p < 0.001$), SI ($z = -4.534$, $p < 0.001$), and RI ($z = -4.867$, $p < 0.001$).

## Known-groups validity

Significant differences were found for the type of household in the domains of IR and SD; for the time elapsed since the injury in IR, PD, PW, and SD; for the number of health conditions (comorbidity) in EW, IR, PD, SD, and SI; and finally, for the percentage of disability, in the SD domain (Table 7). In all cases, a higher QoL was found in those who had experienced ABI more recently, had fewer health problems, and had a lower percentage of disability. Regarding the type of household, in the IR domain, we found significant higher QoL levels in people who were living with their families or in a sheltered flat than the patients who live in a residential centre, and in the SD domain significant higher levels of QoL among people who lived independently than in other groups.

# Discussion

The main objective of this article was to describe the adaptation and validation process applied to the self-report version of the CAVIDACE scale to create a specific instrument that takes the opinion of the person with ABI into account when evaluating his or her QoL. This work is in line with other

**Table 7** Univariate analysis of CAVIDACE scores for groups: type of household, time since the injury, current health conditions, and disability percentage

| | | Domains | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | EW | IR | MW | PD | PW | SD | SI | RI |
| Type of household | | | | | | | | | |
| Independent flat ($n = 27$) | M (SD) | 11.00 (3.38) | 10.35 (3.78) | 11.77 (2.76) | 10.30 (2.83) | 10.38 (3.29) | 12.30 (2.90) | 9.04 (4.06) | 12.31 (2.29) |
| Family home and sheltered flat ($n = 155$) | M (SD) | 10.43 (3.21) | 10.46 (3.24) | 11.95 (2.99) | 9.04 (3.25) | 10.33 (3.14) | 9.96 (3.57) | 8.97 (3.93) | 12.15 (2.69) |
| Residential centre ($n = 33$) | M (SD) | 9.94 (3.16) | 8.30** (4.97) | 11.16 (3.62) | 8.24 (3.66) | 11.09 (3.24) | 8.00*** (4.30) | 7.16 (4.42) | 11.00 (2.93) |
| Differences' group | | | *2–3*** | | | | *1–2***<br>*1–3****<br>*2–3** | | |
| Time since the injury | | | | | | | | | |
| ≤ 2 years ($n = 81$) | M (SD) | 10.73 (2.97) | 11.63 (2.72) | 12.41 (3.05) | 10.25 (3.19) | 11.65 (2.83) | 10.99 (3.34) | 8.35 (4.21) | 12.55 (2.54) |
| > 2 years ($n = 236$) | M (SD) | 10.65 (3.08) | 9.80*** (3.67) | 12.07 (2.88) | 8.92** (3.21) | 10.34** (3.11) | 9.82* (3.81) | 8.81 (4.09) | 12.09 (2.65) |
| Current health conditions (number) | | | | | | | | | |
| ≤ 5 conditions ($n = 215$) | M (SD) | 10.88 (3.00) | 10.56 (3.47) | 12.19 (2.82) | 9.72 (3.25) | 10.81 (3.13) | 10.68 (3.55) | 9.10 (4.08) | 12.27 (2.54) |
| > 5 conditions ($n = 129$) | M (SD) | 10.12* (3.07) | 9.43** (3.89) | 11.83 (2.29) | 8.40*** (3.09) | 10.56 (3.08) | 9.15*** (3.87) | 8.07* (3.96) | 11.90 (2.74) |
| Disability percentage | | | | | | | | | |
| ≤ 65% ($n = 50$) | M (SD) | 10.90 (2.85) | 10.40 (3.42) | 12.16 (2.70) | 9.80 (3.19) | 9.58 (3.07) | 11.20 (2.94) | 9.77 (3.51) | 12.24 (2.55) |
| > 65% ($n = 206$) | M (SD) | 10.72 (3.05) | 9.94 (3.80) | 12.13 (2.98) | 8.86 (3.20) | 10.71 (3.07) | 9.48** (3.81) | 8.83 (4.06) | 12.08 (2.68) |

*Group 1* independent flat, *Group 2* family home and sheltered flat, *Group 3* residential centre, *EW* emotional well-being, *IR* interpersonal relationships, *MW* material well-being, *PD* personal development, *PW* physical well-being; *SD* self-determination, *SI* social inclusion, *RI* rights

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

attempts to provide self-report measurements of QoL in people with disabilities, such as the INICO-FEAPS scale [42] or the INTEGRAL scale [71]. The results suggest that this adaptation of the scale has good psychometric properties, as was also true of the original scale, and shows adequate evidence of reliability and validity.

The internal consistency was good for all subscales (except in the PW domain), and the values obtained in the trial version of the scale (64 items) were similar to those obtained in the final reduced version (40 items). This domain had lower internal consistency values compared with the rest of the domains too in other similar self-reporting scales [42] and in the validation test of the original scale [39]. The results indicated that reliability did not decrease significantly, despite a significant reduction in the number of items. The reduction in the number of items resulted in a much more manageable scale to be answered by the person with ABI, taking into account the severe problems with understanding, concentration, and attention spans that are common to this population [72]. In this sense, the use of a visual response format along with the written response options considerably improved the respondents' understanding of the scale, as has been shown for other scales, such as the aforementioned INICO-FEAPS [42].

The results supported the internal structure of the scale based on the theoretical model of Schalock and Verdugo in which the QoL is composed of 8 first-order intercorrelated domains, in line with the recent studies with the model, using proxy or self-report measures [39, 42, 73]. However, in this case the model showed values of CFI and TLI slightly below the optimal level, as was the case on the original scale [39]. It is possible that the accumulation of multiple but small and non-substantive errors of specification can lead to a substantial decrease in fit [74]. In addition, it is necessary to consider that the cut-off values traditionally used to judge fit are largely arbitrary [75].

Regarding the convergent and discriminant validity of the scale, the SI domain was the most prominent, while the RI domain had the worst discriminatory power. Again, these results are in line with those obtained with the original scale and with other QoL instruments in populations with other types of disabilities [42]. The RI domain had a low-discriminant capacity too when the relative and professional answered the scale, and not only in the case of the user, which leads us to confirm that items are formulated in a too generic way. Weaker correlations have been found between family members' and users' scores than between professionals' and users' scores; this finding is in line with the few studies that have been carried out on the subject [47, 49]. As it appears, families have a greater unknowledge of the patient's real situation, and could be more influenced in some cases for higher degree of social desirability.

As expected, moderate significate positive correlations were obtained between the SD domain and community integration and between the PD domain and resilience, while a moderate negative correlation was found between EW and depression. In an increasing number of studies, resilience was correlated with a better QoL [76] and a greater internal locus of control [77], both of which are closely linked to the PD. Similarly, many studies have linked greater community integration with higher levels of QoL [15–17, 25] and community integration at the employ level with greater SD [12]. Finally, the negative influence of depression on QoL, specifically on the EW of the user, has also been amply demonstrated [15, 26]. These differences found supported the good convergent and discriminant validity of the scale.

Thus, the self-report version of the CAVIDACE scale is a tool with high concurrent validity that discriminates among different population groups within a sample of people with ABI as a function of type of housing, time since the injury, current health conditions, and percentage of disability. First, with respect to the type of housing, we observed significantly higher scores on the SD domain for patients who lived independently [12] and higher scores in IR for those who lived with relatives or in a sheltered flat, having more opportunities for interaction. We expected to find better QoL in SI for patients who live independently but the levels were similar to those living with their family or in a sheltered flat. Apparently, living with your family or in a sheltered flat also favours social inclusion. Second, we found worse scores among those who sustained their injury more than two years ago. These differences were significant in the domains of IR, PD, PW and SD. There are many studies that support these results [3, 78]. It could be for the ageing of the population, the stabilization of the sequelae [13, 79], or even the decrease in protective factors, such as resilience [80]. Third, better QoL levels were found in almost all domains for those who had fewer comorbidity, as found by Khan et al. in their study [19]. These differences were not significant in the MW, PW, and RI domains. Finally, we also found that the scale discriminated between people with ABI as a function of disability percentage, and significant differences were found only in the SD domain. There seems to be a tendency toward a reduced ability to make decisions when the person with ABI has high percentages of disability.

Some limitations of the study should be mentioned. First, the sample recruitment process was based on convenience sampling and the snowball method. This procedure is extremely useful for obtaining the population samples necessary for a validation study, but because it is non-probabilistic, it poses problems when generalizing the data to the entire population. Second, it would have been wise to use an objective rapid test that to determine the participant's functioning and whether the evaluation tests could be applied. Leaving this decision in the hands of professionals introduces a good amount of subjectivity, even though it was strictly controlled by the research team and the professionals acted on clinical judgement based on their knowledge of the person with ABI and his or her clinical history. Finally, the last limitation is the lack of use of another instrument to evaluate QoL, which would have provided more evidence of convergent validity in the validation process.

In conclusion, the results of this study support the good psychometric properties of the self-report version of the CAVIDACE scale. The use of a multidimensional instrument with these characteristics is extremely beneficial both in the context of the research and in the clinical one. In clinic, having the individual identify their most important needs helps to establish more appropriate objectives for rehabilitation. In addition, the aggregated results derived from the use of the scale allow professionals to detect the aspects of their organization that require improvement, thus opening a door to organizational change. Future lines of research should focus on the more detailed study of the differences among evaluation perspectives of QoL, the differences between self-reports and instruments reports by others, and on the analysis of the variables that affect QoL. Other extremely important lines of research include the use and validation of both versions of the CAVIDACE scale in other languages and contexts.

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## Compliance with ethical standards

**Conflict of interest** There are no financial or any other type of conflict of interest for the authors of this manuscript.

**Ethical approval** This project has been reviewed and accepted by the bioethics committee of the University of Salamanca.

**Informed consent** Informed consent was obtained from all individual participants included in the study and their relatives. In case of legal incapacity, the informed consent was obtained from the legal representative.

## Appendix

See Fig. 2.

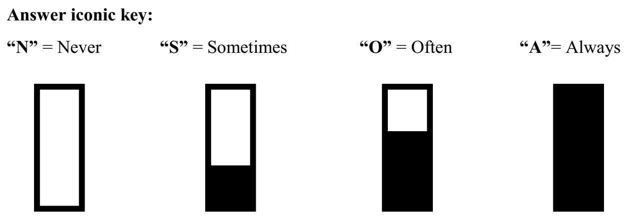

**Fig. 2** Visual system respond

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