Health-related quality of life after traumatic brain injury: Italian validation of the QOLIBRI

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Summary

The QOLIBRI (Quality of Life after Brain Injury) is a new international health-related quality of life (HRQoL) instrument developed for assessing the consequences of traumatic brain injury (TBI). We report the results of the Italian validation of the QOLIBRI. A total of 147 participants with TBI who had previously been discharged from the Santa Lucia Foundation rehabilitation hospital were recruited to investigate the concurrent validity of the Italian version of the QOLIBRI and to compare this instrument with several functional and cognitive-behavioral scales, taking into account various clinical parameters. The QOLIBRI met the standard criteria for internal consistency, homogeneity and test-retest reliability. The results suggest that it is very sensitive in relation to outcome as measured by the Extended Glasgow Outcome Scale (GOS-E) and other instruments for functional assessment of disability, emotions and subjective health status, including the Hospital Anxiety and Depression Scale and the Short-Form 36. The QOLIBRI avoids some of the limitations of traditional scales for quantifying residual functional capacity, such as the Glasgow Outcome Scale and the GOS-E, and may contribute to the achievement of better quality-controlled care, medical decision-making, rehabilitation planning, and measurement of well-being and HRQoL from the patient's perspective. However, a longitudinal study is needed to assess the responsiveness of the QOLIBRI to changes over time.

KEY WORDS: neuropsychological outcome, post-traumatic depression, quality of life, traumatic brain injury

Introduction

Traumatic brain injury (TBI) is a major cause of long-term disability in young people between 15 and 35 years of age (i.e., in a population with a long productive life expectancy), in whom it has a yearly incidence of 15,000 to 30,000 cases (Tagliaferri et al., 2006).

In 2013, the World Health Organization (WHO, 2013) predicted a significant rise in the incidence of road traumas in developing countries as a consequence of improved economic conditions and increased road traffic. The rehabilitation of severe TBI is often complex and requires a long period of time. It usually starts with early intervention involving interdisciplinary and intensive care and ends with post-acute rehabilitation and community re-entry (Formisano et al., 2005). The consequences of TBI are known to affect not only the patients themselves but also their families. Indeed, regardless of the severity of the injury, family members often feel high levels of strain for many years (Koskinen, 1998). Although the difficulties of social integration following TBI are mainly due to cognitive and behavioral disorders (Jennett and Teasdale, 1981), the additional presence of motor deficits can further compromise the patient's social reintegration and participation (Greenspan et al., 1996).

Individuals with unfavorable neuropsychological outcomes after severe TBI are generally unable to manage their own social life and often depend on caregivers. Their inability to achieve social and professional integration leads to frustration and can cause emotional distress and social isolation.

Objective functional indexes, such as disability severity or return to work, have traditionally been assessed as measures of TBI outcome (Green et al., 2008; Mazaux et al., 1997). However, these indicators do not help to quantify the effects of TBI on the patient's subjective perception of his/her social, psychological and physical conditions.

The Trauma Consensus Group made some recommendations (Neugebauer et al., 2002), which led to the formation of a work group aimed at developing a new TBI health-related quality of life (HRQoL) measure known as QOLIBRI (Quality Of Life After Brain Injury). It is a cross-cultural instrument developed on the basis of the main TBI literature reviews and the results of consensus meetings. Both brief and extended versions of the QOLIBRI were recently validated in a multicenter international study (von Steinbüchel et al, 2010a,b; Truelle et al., 2010; von Steinbuechel et al., 2012).

The QOLIBRI is thus a new international HRQoL instrument. It was developed to assess the subjective physical, social and psychological well-being of patients with TBI. It provides an HRQoL profile, which covers the physical, psychological, social and functional domains specifically affected in TBI, and includes additional information not provided by other scales (von Steinbüchel et al., 2010a,b).

The English QOLIBRI questionnaire consists of 37 items, divided into two sections (A and B). Section A concerns the level of satisfaction and consists of four subscales: Cognition (7 items), Self (7 items), Daily Life and Autonomy (DLA) (7 items) and Social Relationships (6 items). Section B concerns the discomfort domain and consists of two subscales: Emotions (5 items) and Physical Problems (5 items). The QOLIBRI items are rated on a five-step Likert scale: 1 (Not at all), 2 (Slightly), 3 (Moderately), 4 (Quite) and 5 (Very). Section B also provides an additional response ("Does not apply") considered as "Not at all" in this analysis, in agreement with the international validation of the QOLIBRI (von Steinbüchel et al, 2010a,b; Truelle et al., 2010; von Steinbuechel et al., 2012). To give the QOLIBRI subscales the same direction, the scores in Section B (discomfort/bother) were reversed, that is, the best situation was associated with higher scores, as in the satisfaction section. The QOLIBRI also has an overall score, which provides a summary of the HRQoL issues investigated by the QOLIBRI subscales. The QOLIBRI Overall scale consists of six items; it was developed in parallel with the 37-item QOLIBRI and was recently validated in comparison with the QOLIBRI subscales (von Steinbuechel et al., 2012). All the QOLIBRI subscale results are expressed as a percentage (0-100%) of the maximum possible score.

According to the international validation, all the QOLIBRI scales meet standard psychometric criteria in terms of internal consistency and test-retest reliability in patients without cognitive problems and in patients with lower cognitive performance (von Steinbüchel et al., 2010b).

In a recent study, the Australian version of the QOLIBRI was administered and validated in a sample of 66 patients. This version of the QOLIBRI met the standard criteria for internal consistency and homogeneity (except for the Physical Problems subscale) and test-retest reliability (except for the DLA and Emotions subscales) (Hawthorne et al., 2011).

In the present study, we aimed to validate the Italian version of the QOLIBRI questionnaire, in particular its concurrent validity. We also compared the QOLIBRI with several functional and cognitive-behavioral scales, taking into account physical and cognitive aspects such as epilepsy, hemiparesis, visual and auditory deficits, extra-cerebral injuries, communication difficulties, attention and memory dysfunction, executive functions, as well as affective and behavioral disorders.

Materials and methods

Participants

We recruited a cohort of 147 participants with TBI who had previously been discharged from the Santa Lucia Foundation rehabilitation hospital.

All the patients met the following inclusion criteria: diagnosis of TBI according to the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) criteria (WHO, 1992); time interval from TBI between three months and 15 years, in accordance with the inclusion criterion used in the multicenter International validation study of QOLIBRI (von Steinbüchel et al., 2010a,b; von Steinbuechel et al. 2012; Truelle et al., 2010); age 15 years or more at the time of TBI; age range: 17-68 years at the time of interview; outpatient status.

The exclusion criteria were: an Extended Glasgow Outcome Scale (GOS-E) score <3 (Jennett and Bond, 1975; Jennett and MacMillan, 1981); spinal cord injury; significant current or pre-injury psychiatric history or ongoing severe addiction; diagnosis of terminal illness. In addition, only patients who were able to understand and cooperate during the interview were enrolled in the study, without applying any cut-off values for cognitive performance. As part of the preliminary assessment, the patients' capacity to undergo formal psychometric evaluation was considered and those with a cognitive impairment in global logic abilities [as revealed by an Equivalent Score equal to 0 on the Colored Progressive Matrices - PM 47 (Raven et al., 1986)] and patients with aphasia [as revealed by a Token Test (De Renzi and Vignolo, 1962) score lower than 30] were excluded from the study.

As in the international validation, the questionnaires were administered through face-to-face interviews, self-reports or telephone interviews (von Steinbüchel et al., 2010a).

Assessments

The Italian version of the QOLIBRI questionnaire was obtained after two independent translations had been done from the English version and a consensus meeting had been held to agree on a fully comprehensible and accurate Italian draft consistent with the original English text. When a consensus could not be reached, the authors of the original version were consulted for additional assistance with the translation. The Italian draft of the QOLIBRI questionnaire was back-translated to ensure that there were no misinterpretations and errors in the translation.

All the patients filled in the QOLIBRI questionnaire and the Short-Form 36 (SF-36) on their own or in the presence of a psychologist, who could assist them if needed. As in the multi-center international validation study of QOLIBRI (von Steinbüchel et al. 2010a), the participants were, in general, able to fill in the questionnaire without help. Otherwise, face-to-face assistance was provided. The severity of TBI was assessed using the Glasgow Coma Scale (GCS) (Teasdale and Jennett, 1974) and was rated as severe (GCS score 3-8), moderate (GCS score 9-12) or mild (GCS score 13-15). The level of disability was assessed using the GOS-E (Wilson et al., 1998). Mood disorders were assessed using the Hospital Anxiety and Depression Scale (HADS) (Zigmond and Snaith, 1983), which is a self-report rating scale that measures anxiety and depression (10 items in each subscale). The authors suggest the following cutoffs for both subscales: scores 0 to 7 = no cases of anxiety and depression; scores 8 to 10 = doubtful cases; scores 11 and higher = valid cases of anxiety and depression. Other authors agree with these cutoff scores for the general population, inpatients (Bjelland et al., 2002) and outpatients (Olssøn et al., 2005).

Sociodemographic characteristics, severity indicators in the acute and post-acute phase, comorbidity and time since injury were recorded.

Finally, the patients were also classified in terms of the presence/absence of several physical (epilepsy, hemiparesis, visual deficit, auditory deficit, extracerebral injuries) and cognitive (communication difficulty, attention dysfunction, memory dysfunction, executive function disorders, affective and behavioral disorders) deficits. Two subscores (Physical and Cognitive) and one overall score (Clinical) were calculated by summing the scores of each clinical item (0 = patient does not have this status, and 1 = patient has this status).

All human data included in this manuscript were obtained in compliance with the regulations of ethics review committees of the Italian National Institute of Health. The research was conducted in accordance with the Helsinki Declaration.

Data analysis

The data analysis was carried out using Stata/SE 12.1 (StataCorp, College Station, Texas, USA). For each QOLIBRI subscale, a score was calculated by summation of items and presented as a percentage (0-100%) of the maximum possible score and missing data were imputed using horizontal mean imputation.

Validity was assessed by examining the relationship between the QOLIBRI scales and clinical characteristics, health outcomes and physical and mental status. Mean scores and standard deviations (SDs) were calculated for both the satisfaction and the discomfort section subscales. Spearman r_s correlation with severity indicators, comorbidity, time since injury, GOS-E, HADS and SF-36 were performed. We assumed that the two scales were: i) functionally unitary if $r_s > 0.80$; ii) shared a common construct if $r_s = 0.60\text{-}0.79$; and iii) were mostly unique but had something in common if $r_s = 0.40\text{-}0.59$. Pearson r_p correlation with age was also performed. For correlations between age and QOLIBRI scales, the interpretations were: strong if $r_p \geq 0.70$; medium if $r_p = 0.31\text{-}0.69$; weak if $r_p \leq 0.30$.

A Kruskall-Wallis non-parametric test was performed to test the equality of the medians of the different groups. To evaluate the homogeneity of the scales, Loevinger's H coefficient was used and a cutoff of 0.6 was selected to indicate strong homogeneity (Mokken, 1982).

The two-week test-retest reliability of the QOLIBRI scales was assessed in a sample of 83 patients who were randomly drawn from the cohort of 147 patients. This analysis was performed using the intra-class correlation coefficient (ICC), which was calculated between the subscale means of the two administrations. In agreement with the conventional interpretation of the ICC, a value over 0.75 was considered excellent (Fleiss, 1986; Streiner and Norman, 2006).

Sensitivity was assessed for the GOS-E and the HADS Anxiety and Depression scores. Differences between the best and worst state were described as Cohen's *d* effect sizes, where *d* = 0.20 represents a small effect, *d* = 0.50 a moderate one, and *d* ≥ 0.80 a large effect (Cohen, 1988).

As in the Australian validation, ceiling scores were examined against McHorney and Tarlov's standard of 15% (Hawthorne et al., 2011; McHorney and Tarlov, 1995).

Results

Data were collected for patients consecutively enrolled over three years. After enrollment, all the patients who met the inclusion criteria had a mean age of 31.6 years (±10.1 years); most were male (77.6%), single (64.6%) and had completed primary or secondary school (87.0%). As regards their employment status, 22.9% were unemployed, 6.2% were retired and 18.7% were students; the remaining subjects were mainly in full-time employment (27.1%) or were self-employed (13.2%). Forty-six percent were living at home supported by family or caregivers and 51% were living at home independently. Seventy-five percent of the patients had a severe TBI with a GCS score ≤ 8 in the acute phase; 9.5% had a moderate injury (GCS score = 9-12), and 15.0% had a minor injury (GCS score = 13-15). In 10.2% of the patients, coma duration was longer than 48 hours; in 33.3% it lasted 3-14 days; in 25.2%, 15-30 days; and in 31.3% more than 30 days (mean duration = 30.4 days). Coma duration was defined as time to follow commands, since, as is well known, eye opening does not necessarily mean resolution of coma, as in prolonged disorders of consciousness (vegetative state, minimally conscious state), whereas resolution of unconsciousness is defined as the ability to follow commands.

According to the GOS-E classification, 44.9% of patients showed a good recovery (17.7% had upper and 27.2% had lower good recovery, respectively), 38.1% showed moderate disability (25.2% upper and 12.9% lower moderate disability) and 17.0% showed severe disability (10.9% upper and 6.1% lower severe disability).

Most of the patients (84.2%) had at least one physical and one cognitive deficit (items were recorded as 1 in the presence of a deficit and as 0 if there was no problem); thus, both Physical and Cognitive scores indicate the number of problems present (scores ranging between 0 and 5). As regards the Physical score, 13.0% of the patients reported no problems; 34.2% reported only one problem and 52.8% more than one problem. In general, the most frequent physical problems were extracerebral injuries (53.1%) and hemiparesis (42.5%). Instead, the main cognitive problems were attention (48.3%) and memory dysfunction (47.6%). Around one in five subjects had no cognitive problems, 24.5% had only one cognitive problem, and 55.1% had more than one cognitive problem. Physical and cognitive problems seemed to be uncorrelated because the Physical and Cognitive scores were independent (Kendall's $\tau = 0.2025$; $p<0.01$).

The number of subjects showing a good recovery (GOS-E ≥ 7) was significantly higher in those who had a Physical score ≤ 1 as compared with those who had a worse Physical score ($\chi^2 = 7.76$; $p<0.05$) and in those who had a Cognitive score ≤ 1 as compared with those who had a worse Cognitive score ($\chi^2 = 7.87$; $p<0.05$).

According to the HADS scores, 22.4% of the patients showed anxiety, 25.9% were borderline, and 51.7% showed no anxiety. Depression was detected in 23.8% of the patients, 9.5% were borderline, and 66.7% were not depressed.

The mean SF-36 score was 47.7 (SD±9.2) for the physical component score (PCS) and 45.9 (±12.3) for the mental component score (MCS). Both the SF-36 mean scores were lower in patients with anxiety and depression, detected using the HADS, but the difference between patients with mood disorders and those without mood disorders was statistically significant only for the MCS (Table I).

The QOLIBRI score data distribution is shown in figure 1. The mean scores were 61.9% (±18.6) for Cognition, 65.4% (±19.4) for Self, 65.6% (±20.7) for DLA, and 61.0 (±21.6) for Social Relationships. The mean Overall score was 60.5% (±19.7). By contrast, the mean Section B (discomfort/bother) scores were: 72.4% (±26.0) for Emotions and 71.9% (±23.5) for Physical Problems. The patients' mean scores were spread across the scale ranges, but only the Self, Emotions and Physical Problems scores were significantly skewed (Self $p<0.05$; Emotions and Physical Problems $p<0.01$).

The QOLIBRI mean Overall score was significantly lower in subjects with anxiety or depression (HADS ≥ 11) than in those without anxiety (52.3% vs 65.9%, $p<0.01$) or depression (52.3% vs 64.2%, $p<0.01$).

Patients with anxiety showed significantly lower mean scores than patients without anxiety (Table II) on the Cognition (54.1% vs 68.0%, $p<0.01$), Self (61.4% vs 69.6%, $p<0.05$) and DLA (58.8% vs 69.3%, $p<0.05$) subscales. Conversely, no statistically significant difference emerged for the Social Relationships score (58.7% vs 65.3%, ns).

Instead, depressed patients showed significantly lower mean scores than patients without depression on all four Section A subscales: Cognition (54.1% vs 65.7%, $p<0.01$), Self (58.2% vs 69.1%, $p<0.01$), DLA (58.7% vs 69.6%, $p<0.01$) and Social Relationships (52.7% vs 65.4%, $p<0.01$).

Table III shows the correlations between all the QOLIBRI subscales. As expected, the highest correlation was found between the Overall scale and the four satisfaction subscales (Cognition, Self, DLA and Social Relationships). A statistically significant correlation was also found between Self and DLA.

Table IV shows the test-retest reliability and homogeneity analysis of the various scales. In the retested sample, all QOLIBRI subscales exceeded the test-retest criterion (ICC ≥ 0.75), indicating that they all showed excellent reliability. The Overall score as well as the Cognition and Self scores showed strong homogeneity (Loevinger H > 0.60), even though all the items were strongly scalable (Table IV).

Table V shows the correlations between all the QOLIBRI subscale scores, the HADS Anxiety and Depression scores, and the SF-36 PCS and MCS. As expected, with the exception of the relationship between the HADS Anxiety scores versus QOLIBRI DLA and Social Relationships (p=ns), Anxiety and Depression scores correlated negatively with all the QOLIBRI scores. Finally, SF-36 PCS correlated with QOLIBRI DLA and Physical Problems scores ($p<0.01$), whereas SF-36 MCS correlated with the QOLIBRI Cognition, Self, Overall, Emotions and Physical Problems scores ($p<0.01$).

Table I - Correlations between SF-36 mean values and HADS anxiety and depression assessment.

	SF-36 PCS mean	t test	p value	SF-36 MCS mean	t test	p value
HADS anxiety (yes)	45.7	1.5943	n.s.	41.2	3.0286	p<0.01
HADS anxiety (no)	48.9			49.2		
HADS depression (yes)	45.4	1.4013	n.s.	36.2	5.9939	p<0.01
HADS depression (no)	48.1			49.9		

Abbreviations: SF-36= Short-Form 36; PCS=physical component score; MCS=mental component score; HADS=Hospital Anxiety and Depression Scale

Like the GOS-E scores, the QOLIBRI mean scores were higher for good recovery (both lower and upper), but the differences between the mean scores were statistically significant only for the DLA subscale (Table VI).

Internal consistency was assessed for each score. All individual scale scores exceeded Cronbach's α=0.70, ranging from 0.72 (Physical Problems) to 0.86 (Self). Results indicate that all the QOLIBRI scales had good internal consistency.

According to Pearson and Spearman's correlation coefficients, the effects of age, marital status, educational level and clinical characteristics were generally very weak and had a low correlation with the QOLIBRI scales (Table VII)

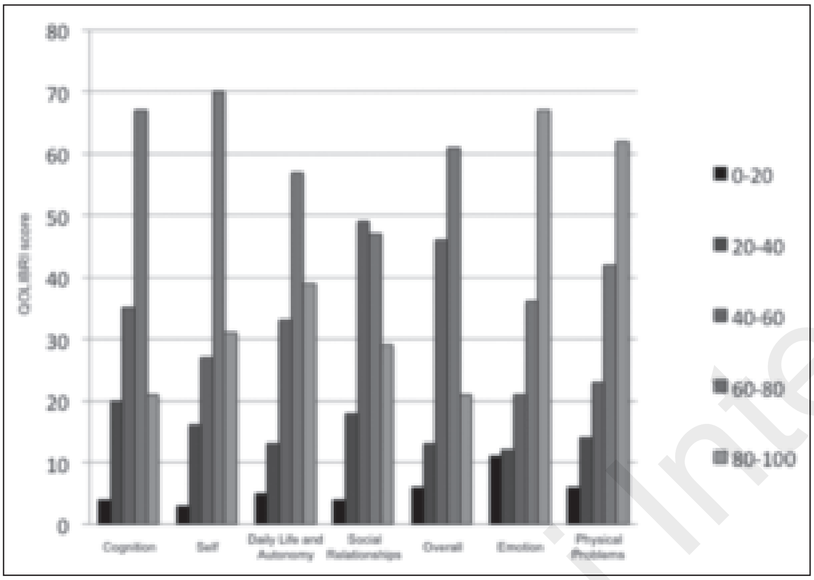

Figure 1 - Distribution of quality of life in the different domains of the QOLIBRI questionnaire.

Table II - Mean scores on QOLIBRI scales and results of HADS anxiety and depression assessment.

QOLIBRI scales	HADS-Anxiety			HADS-Depression		
	Yes	No	Significance	Yes	No	Significance
Cognition	54.1%	68.0%	p<0.01	54.1%	65.7%	p<0.01
Self	61.4%	69.6%	p<0.05	58.2%	69.1%	p<0.01
Daily Life and Autonomy	58.8%	69.3%	p<0.05	58.7%	69.6%	p<0.01
Social Relationships	58.7%	65.3%	ns	52.7%	65.4%	p<0.01
Overall	52.3%	65.9%	p<0.01	52.3%	64.2%	p<0.01
Emotions	60.6%	81.2%	p<0.01	62.4%	77.4%	p<0.01
Physical Problems	60.9%	78.3%	p<0.01	64.6%	75.6%	p<0.05

Abbreviations: QOLIBRI=Quality of Life after Brain Injury; HADS=Hospital Anxiety and Depression Scale

Table III - Correlations between the QOLIBRI scales.

	Cognition	Self	Daily Life and Autonomy	Social Relationships	Overall	Emotions	Physical Problems
Cognition	1.0000						
Self	0.6647*	1.0000					
Daily Life and Autonomy	0.6310*	0.6609*	1.0000				
Social Relationships	0.5523*	0.6353*	0.5978*	1.0000			
Overall	0.7488*	0.7656*	0.6629*	0.6743*	1.0000		
Emotions	0.4534*	0.4646*	0.3500*	0.4070*	0.4730*	1.0000	
Physical Problems	0.4791*	0.5237*	0.4879*	0.3962*	0.5595*	0.5822*	1.0000

Abbreviations: QOLIBRI=Quality of Life after Brain Injury; *Spearman correlation coefficients, p<0.01

Table IV - Homogeneity analysis of QOLIBRI scales.

	ICC	ICC (95% CI)	Loevinger H
Cognition	0.792	0.675-0.867	0.63
Self	0.830	0.737-0.898	0.67
Daily Life and Autonomy	0.897	0.840-0.934	0.60
Social Relationships	0.841	0.751-0.898	0.58
Overall	0.856	0.775-0.908	0.68
Emotions	0.835	0.742-0.894	0.48
Physical Problems	0.805	0.697-0.875	0.54

Abbreviations: QOLIBRI=Quality of Life after Brain Injury; ICC=intraclass correlation coefficient; CI=confidence interval

Table V - Correlations between QOLIBRI, HADS and SF-36.

	Cognition	Self	Daily Life and Autonomy	Social Relationships	Overall	Emotions	Physical Problems	HADS Anxiety	HADS Depression	SF-36 PCS	SF-36 MCS
Cognition	1.0000										
Self	0.6638*	1.0000									
Daily Life and Autonomy	0.6692*	0.6817*	1.0000								
Social Relationships	0.5623*	0.5832*	0.5865*	1.0000							
Overall	0.7380*	0.7539*	0.6884*	0.6625*	1.0000						
Emotions	0.3932*	0.4488*	0.3183*	0.4139*	0.4619*	1.0000					
Physical Problems	0.4786*	0.5252*	0.4747*	0.3440*	0.5500*	0.5218*	1.0000				
HADS - Anxiety	-0.3831*	-0.3041*	-0.2928	-0.2833	-0.3631*	-0.5127*	-0.4412*	1.0000			
HADS - Depression	-0.4909*	-0.4816*	-0.4628*	-0.4549*	-0.5017*	-0.4325*	-0.4161*	0.6190*	1.0000		
SF-36 PCS	0.1896	0.2397	0.3834*	0.0992	0.1720	0.1167	0.5081*	-0.2139	-0.2387	1.0000	
SF-36 MCS	0.4004*	0.4387*	0.2839	0.2759	0.4650*	0.4153*	0.3504*	-0.4180*	-0.5531*	0.0466	1.0000

Abbreviations: QOLIBRI=Quality of Life after Brain Injury; HADS=Hospital Anxiety and Depression Scale; SF-36=Short-Form 36; PCS=physical component score; MCS=mental component score. *Spearman correlation coefficients, p<0.01

Table VI - Correlations between mean QOLIBRI scales and GOS-E levels.

	Cognition	Self	Daily Life and Autonomy	Social Relationships	Overall	Emotions	Physical Problems
Severe disability	61.1	61.7	58.6	53.5	56.7	79.8	68.6
Moderate disability	58.7	62.0	59.6	57.6	54.9	67.7	66.6
Good recovery	65.0	69.6	73.4	66.7	66.7	73.6	77.7
Significance level	*0.600*	*0.063*	*0.017**	*0.850*	*0.160*	*0.079*	*0.077*

Abbreviations: QOLIBRI=Quality of Life after Brain Injury; GOS-E=Extended Glasgow Outcome Scale

Table VII - Correlations between QOLIBRI scales and age, marital status, educational level and clinical characteristics.

	Age	Marital status	Educational level	Physical problems	Cognitive problems
Cognition	-0.1665°	-0.1679*	0.1128	-0.0284	-0.0752
Self	-0.1282	-0.1209	0.0193	-0.0659	-0.0274
Daily Life and Autonomy	-0.1348	-0.1277	0.1195	-0.1689*	-0.1482
Social Relationships	-0.0580	-0.0434	0.1121	-0.0758	-0.1602
Overall	-0.1704°	-0.1462	0.1263	-0.0667	-0.1068
Emotions	-0.0443	-0.1379	0.1560	0.2122*	0.0543
Physical Problems	-0.1399	-0.1612	0.0531	-0.0924	-0.0170

QOLIBRI = Quality of Life after Brain Injury; ° Pearson correlation p<0.0; * Spearman rho p<0.05

Approximately a quarter of the patients had low physical and mental well-being, as indicated by SF-36 PCS/MCS values one SD or more below the norm. The relationships between the QOLIBRI scales and the SF-36 PCS and MCS are shown in table VIII.

The SF-36 PCS was most strongly correlated with QOLIBRI Physical Problems (r=0.56) and DLA scores (r=0.43), whereas the SF-36 MCS was most strongly correlated with the QOLIBRI Self (r=0.52), Cognition (r=0.44) and Overall scale (r=0.47) scores.

The data in table IX indicate that the relationships between the GOS-E and QOLIBRI scales are poor (a moderate correlation emerged only for the DLA score), in other words that clinical outcome seems to be independent of HRQoL. The Anxiety scale of the HADS correlated moderately with the QOLIBRI

Table VIII - Correlations between QOLIBRI scales and SF-36 scores.

	SF-36 PCS	SF-36 MCS
Cognition	0.2129*	0.4416***
Self	0.2895***	0.5151***
Daily Life and Autonomy	0.4296***	0.3367***
Social Relationships	0.1719*	0.3291***
Overall	0.2510**	0.4691***
Emotions	0.2001*	0.4018***
Physical Problems	0.5605***	0.3496***

Abbreviations: QOLIBRI=Quality of Life after Brain Injury; SF-36=Short Form 36; PCS=physical component score; MCS=mental component score.
* Pearson correlation $p<0.05$; ** Pearson correlation $p<0.01$; *** Pearson correlation $p<0.001$.

Table IX - Sensitivity of the QOLIBRI scales vs GOS-E and HADS.

	Cognition		Self		Daily Life and Autonomy		Social Relationships		Overall		Emotions		Physical Problems	
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
GOS-E 1 (lower and upper Severe Disability)	61.1	(19.4)	61.7	(24.6)	58.6	(25.2)	53.5	(20.8)	56.7	(23.8)	79.8	(19.1)	68.6	(23.7)
GOS-E 2 (lower and upper Moderate Disability)	58.7	(19.5)	62.0	(18.9)	59.6	(20.6)	57.6	(21.9)	54.9	(18.0)	67.7	(29.9)	66.6	(24.0)
GOS-E 3 (lower and upper Good Recovery)	65.0	(17.2)	69.6	(16.8)	73.4	(16.1)	66.7	(20.4)	66.7	(17.7)	73.6	(25.2)	77.7	(22.0)
	χ^2=3.316		χ^2=4.497		χ^2=15.231***		χ^2=9.447**		χ^2=11.234**		χ^2=2.691		χ^2=8.690*	
GOS-E	ρ=0.1311		ρ=0.1966*		ρ=0.3426***		ρ=0.2707***		ρ=0.2467**		ρ=-0.0219		ρ=0.2317**	
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
HADS-Anxiety (Yes)	54.1	(19.0)	61.4	(23.7)	58.8	(24.4)	58.7	(23.4)	52.3	(23.5)	60.6	(28.6)	60.9	(26.6)
HADS-Anxiety (No)	67.9	(16.4)	69.6	(17.0)	69.3	(18.7)	65.3	(20.1)	65.9	(17.2)	81.2	(20.8)	78.3	(20.2)
	χ^2=13.414***		χ^2=2.291		χ^2=4.357*		χ^2=1.587		χ^2=7.188**		χ^2=12.872***		χ^2=10.701**	
HADS-Anxiety	ρ=-0.4010***		ρ=-0.2949***		ρ=-0.2553**		ρ=-0.2556**		ρ=-0.3755***		ρ=-0.4785***		ρ=-0.4186***	
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
HADS-Depression (Yes)	54.1	(19.2)	58.2	(25.4)	58.7	(24.9)	52.7	(23.2)	52.3	(21.5)	62.4	(29.2)	64.6	(27.8)
HADS-Depression (No)	65.7	(17.4)	69.1	(16.3)	69.6	(18.4)	65.4	(20.2)	64.2	(18.5)	67.4	(22.9)	75.6	(21.6)
	χ^2=8.768**		χ^2=4.043*		χ^2=4.475*		χ^2=8.276**		χ^2=7.557**		χ^2=7.155**		χ^2=3.517	
HADS-Depression	ρ=-0.4679***		ρ=-0.4678***		ρ=-0.4604***		ρ=-0.4690***		ρ=-0.4867***		ρ=-0.4055***		ρ=-0.4147***	

Abbreviations: QOLIBRI=Quality of Life after Brain Injury; GOS-E=Extended Glasgow Outcome Scale; HADS= Hospital Anxiety and Depression Scale
Statistics: means (standard deviations, SD), Kruskall-Wallis χ^2, Spearman ρ. *** $p<0.001$; ** $p<0.01$;* $p<0.05$

Table X - Cohen's d effect size for the QOLIBRI scales by GOS-E and HADS Anxiety and Depression scores.

	Cognition	Self	Daily Life and Autonomy	Social Relationships	Overall	Emotions	Physical Problems
HADS-Anxiety	0.81	0.43	0.52	0.31	0.71	0.89	0.79
HADS-Depression	0.65	0.57	0.54	0.61	0.62	0.61	0.47
GOS-E	0.31	0.41	0.73	0.50	0.60	0.08	0.46

Abbreviations: QOLIBRI=Quality of Life after Brain Injury; GOS-E=Extended Glasgow Outcome Scale; HADS=Hospital Anxiety and Depression Scale

Cognition, Overall, Emotions and Physical Problems scales (and poorly with the other QOLIBRI scales), whereas the Depression scale of the HADS correlated moderately with all the QOLIBRI scales. However, the QOLIBRI scale mean scores were significantly higher in the case of good recovery (except for the Cognition and Emotions scores) and absence of anxiety and depression, which seems to reflect the well-known association between HRQoL and emotional states, particularly depression (Corrigan et al., 2001; Underhill et al., 2003). Sensitivity to the GOS-E, and HADS Anxiety and Depression scales shows that the QOLIBRI scores discriminated monotonically, but there were small differences between the Severe Disability and Moderate Disability GOS-E scores (Table IX). Differences between the best and worst state were described as Cohen's *d* effect sizes. All *d* values ranged between 0.30 and 0.90 except for Emotions for the GOS-E (d = 0.08). Emotions and Cognition by Anxiety showed *d* values ≥ 0.70 (0.81 and 0.89 respectively), indicating a large sensitivity effect (Table X).

Discussion

The aim of the present study was to investigate the concurrent validity of the Italian version of the QOLIBRI questionnaire and to compare this instrument with several functional and cognitive-behavioral scales, taking into account some clinical parameters.

Our data show that the Italian version of QOLIBRI, like the international version of the questionnaire, takes into account many aspects of HRQoL and provides additional information not provided by the GOS-E, HADS, or SF-36, with which the QOLIBRI shows remarkable agreement.

On average, however, the SF-36 MCS is more highly correlated with the QOLIBRI scales than the SF-36 PCS is. These results confirm the expected pattern of relationship between the SF-36 and the QOLIBRI, indicating that the information captured by the QOLIBRI Physical Problems scale is close to that captured by the SF-36 PCS and the same as that obtained with the QOLIBRI mentally oriented scales. This finding also confirms the validity of the QOLIBRI as a global measure of well-being. Although the two instruments are functionally similar, share the same construct and have some things in common, they are also unique.

This study suggests that the psychometric and predictive properties of the QOLIBRI are generally good. It also indicates the possibility of constructing a composite outcome assessment that would cover both functional and HRQoL outcomes. The proportions reaching ceiling scores exceeded 15% only for the Emotions score (16.3%), suggesting that the QOLIBRI "satisfaction" subscales and Overall scale discriminate between TBI patients.

Thanks to its characteristics, the QOLIBRI avoids some of the limitations of traditional scales for quantifying residual functional capacity, such as the GOS or GOS-E, and may contribute to the achievement of better quality-controlled care, medical decision-making, rehabilitation planning and measurement of well-being and HRQoL from the patient's perspective.

The correlations with the other measures were lower, suggesting that the QOLIBRI contributes differently to understanding the personal perception of well-being in individuals with TBI.

This study suggests that the QOLIBRI is very sensitive in relation to outcome as measured by the GOS-E and other instruments for functional assessment of disability, emotions and subjective health status, including the HADS and the SF-36.

However, the efficacy of the instrument in measuring changes over time was not investigated here even though the patients in this study were followed up for varying lengths of time after TBI.

A longitudinal study is needed to assess the responsiveness of the QOLIBRI to changes over time.

Moderate-to-severe TBI results in a variety of deficits, such as a particular cognitive impairment (Mauri et al., 2006). The impact of these deficits on family, social outcome and school/work re-entry is strictly related to patients' subjective perceptions. However, specifically assessing patients' subjective quality of life and level of self-awareness of their post-TBI deficits (Crosson et al., 1989; Toglia and Kirk, 2000; Prigatano et al., 1990; Ciurli et al., 2010; Bivona et al., 2008; Bivona et al., 2014) may open the way for evaluating the real impact of TBI on patients' lives and addressing rehabilitation on the basis of subjective concerns and life satisfaction.

Including a specific tool assessing quality of life, such as the QOLIBRI, in the routine evaluation of patients with TBI may help to improve management of the effects of TBI outcomes on patients and their families.

Efforts are under way to correlate patient self-perceived quality of life and patient quality of life as perceived by caregivers/relatives through the use of a proxy version of QOLIBRI.

The Patient Competency Rating Scale for Neurorehabilitation is the most widely used scale (Prigatano and Fordyce 1986; Borgaro and Prigatano, 2003) for screening patients in order to avoid the consequences of altered judgment and self-awareness/insight in the self-rating setting.

We did not specifically report the self-awareness level of our sample, because it was not among the aims of the present study. However, although lower self-awareness has recently been reported to be associated with higher estimates of HRQoL (Sasse et al., 2013), impaired self-awareness is not necessarily associated with better quality of life, according to our further study (submitted data).

To further investigate the issue of deficits in self-awareness, validation of a proxy-QOLIBRI version is in progress to determine whether TBI patients' judgment corresponds to that of their caregivers and to correlate possible discrepancies with the main disability indicators and TBI patients' self-awareness.

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References

Bivona U, Ciurli P, Barba C, et al (2008). Executive function and metacognitive self-awareness after severe traumatic brain injury. J Int Neuropsychol Soc 14: 862-868.

Bivona U, Riccio A, Ciurli P, et al (2014). Low self-awareness of individuals with severe traumatic brain injury can lead to reduced ability to take another person's perspective. J Head Trauma Rehabil 29:157-171.

Bjelland I, Dahl AA, Haug TT, et al (2002). The validity of the Hospital Anxiety and Depression Scale. An updated literature review. J Psychosom Res 52:69-77.

Borgaro SR, Prigatano GP (2003). Modification of the Patient Competency Rating Scale for use on an acute neurorehabilitation unit: the PCRS-NR. Brain Inj 17:847-853.

Ciurli P, Bivona U, Barba C, et al (2010). Metacognitive unawareness correlates with executive function impairment after severe traumatic brain injury. J Int Neuropsychol Soc 16:360-368.

Cohen J (1988). Statistical Power Analysis for the Behavioural Sciences. 2nd ed. Hillsdale, Lawrence Erlbaum.

Corrigan JD, Bogner JA, Mysiw WJ, et al (2001). Life satisfaction after traumatic brain injury. J Head Trauma Rehabil 16: 543-555.

Crosson C, Barco PP, Velozo C, et al (1989). Awareness and compensation in post-acute head injury rehabilitation. J Head Trauma Rehabil 4: 46 –5.

De Renzi E, Vignolo LA (1962). The Token Test: A sensitive test to detect receptive disturbances in aphasics. Brain 85: 665-678.

Fleiss JL (1986). Analysis of data from multiclinic trials. Control Clin Trials 7: 267-275.

Formisano R, Bivona U, Brunelli S, et al (2005). A preliminary investigation of road traffic accident rate after severe brain injury. Brain Inj 19:159-163.

Green RE, Colella B, Hebert DA, et al (2008). Prediction of return to productivity after severe traumatic brain injury: Investigations of optimal neuropsychological tests and timing of assessment. Arch Phys Med Rehab 89 (12 Suppl):S51-60.

Greenspan AI, Wrigley JM, Kresnow M, et al (1996). Factors influencing failure to return to work due to traumatic brain injury. Brain Inj 10: 207-218.

Hawthorne G, Kaye AH, Gruen R, et al (2011). Traumatic brain injury and quality of life: initial Australian validation of the QOLIBRI. J Clin Neurosci 18: 197-202.

Jennett B, Bond M (1975). Assessment of outcome after severe brain damage. Lancet 1:480-484.

Jennett B, MacMillan R (1981). Epidemiology of head injury. Br Med J (Clin Res Ed) 282:101-104.

Jennett B, Teasdale G (1981). Management of Head Injuries. Philadelphia, Davis.

Koskinen S (1998). Quality of life 10 years after a very severe traumatic brain injury (TBI): the perspective of the injured and the closest relative. Brain Inj 12:631-648.

Mauri M, Sinforiani E, Bono G et al (2006). Interaction between Apolipoprotein epsilon 4 and traumatic brain injury in patients with Alzheimer's disease and mild cognitive impairment. Funct Neurol 21: 223-228.

Mazaux JM, Masson F, Levin HS, et al (1997). Long-term neuropsychological outcome and loss of social autonomy after traumatic brain injury. Arch Phys Med Rehab 78: 1316-1320.

McHorney CA, Tarlov AR (1995). Individual-patient monitoring in clinical practice: are available health status surveys adequate? Qual Life Res 4:293-307.

Mokken RJ (1982). A non-parametric approach to the analysis of dichotomous item responses. Applied Psychological Measurement 6:417-430.

Neugebauer E, Bouillon B, Bullinger M, et al (2002). Quality of life after multiple trauma – Summary and recommendations of the consensus conference. Restor Neurol Neurosci 20: 161-167.

Olssøn I, Mykletun A, Dahl AA (2005). The Hospital Anxiety and Depression Rating Scale: a cross-sectional study of psychometrics and case finding abilities in general practice. BMC Psychiatry 5:46.

Prigatano GP, Altman IM, O'Brien KP (1990). Behavioural limitations that traumatic brain-injured patients tend to underestimate. Clin Neuropsichol 4: 163-176

Prigatano GP, Fordyce DJ (1986). Cognitive dysfunction and psychosocial adjustment after brain injury. In Prigatano GP, Fordyce DJ, Zeiner HK, et al (Eds). Neuropsychological Rehabilitation after Brain Injury. Baltimore, MD, John Hopkins University Press: 96-118

Raven JC, Court JH, Raven J (1986). Manual for Raven's Progressive Matrices and Vocabulary Scales (Section 2). Coloured Progressive Matrices (1986 edition with U.S. norms), London, Lewis.

Sasse N, Gibbons H, Wilson L, et al (2013). Self-awareness and health-related quality of life after traumatic brain injury. J Head Trauma Rehabil 28:464-472.

Streiner D, Norman G (2006). Health Measurement Scales: a Practical Guide to their Development and Use. 3rd ed. Oxford, Oxford Medical Publications

Tagliaferri F, Compagnone C, Korsic M, et al (2006). A systematic review of brain injury epidemiology in Europe. Acta Neurochir (Wien) 148:255-268.

Teasdale G, Jennett B (1974). Assessment of coma and impaired consciousness. A practical scale. Lancet 2: 81-84.

Toglia J, Kirk U (2000). Understanding awareness deficits following brain injury. NeuroRehabilitation 15: 57-70.

Truelle JL, Koskinen S, Hawthorne G, et al. (2010). Quality of life after traumatic brain injury: the clinical use of the QOLIBRI, a novel disease-specific instrument. Brain Inj 24:1272-1291.

Underhill AT, Lobello SG, Stroud TP, et al (2003). Depression and life satisfaction in patients with traumatic brain injury: a longitudinal study. Brain Inj 17: 973-982.

von Steinbüchel N, Wilson L, Gibbons H, et al (2010a). Quality of Life after Brain Injury (QOLIBRI): scale validity and correlates of quality of life. J Neurotrauma, 27:1157-1165.

von Steinbüchel N, Wilson L, Gibbons H, et al (2010b). Quality of Life after Brain Injury (QOLIBRI): scale development and metric properties. J Neurotrauma 27:1167-1185.

von Steinbuechel N, Wilson L, Gibbons H, et al (2012). QOLIBRI overall scale: a brief index of health-related quality of life after traumatic brain injury. J Neurol Neurosurg Psychiatry 83:1041-1047.

Wilson JT, Pettigrew LE, Teasdale GM (1998). Structured interviews for the Glasgow Outcome Scale and the extended Glasgow Outcome Scale: guidelines for their use. J Neurotrauma 15: 573-585.

World Health Organization (1992). International Statistical Classification of Diseases and Related Health Problems (tenth revision). Geneva, Switzerland

World Health Organization (2013). Global Status Report on Road Safety 2013: supporting a decade of action, Geneva, Switzerland, ISBN 978 92 4 156456 4

Zigmond AS, Snaith RP (1983). The hospital anxiety and depression scale. Acta Psychiatr Scand 67:361-370