

RESEARCH PAPER

QOLIBRI Overall Scale: a brief index of health-related quality of life after traumatic brain injury

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ABSTRACT

Background The Quality of Life after Brain Injury (QOLIBRI) scale is a recently developed instrument that provides a profile of health-related quality of life (HRQoL) in domains typically affected by brain injury. However, for global assessment it is desirable to have a brief summary measure. This study examined a 6-item QOLIBRI Overall Scale (QOLIBRI-OS), and considered whether it could provide an index of HRQoL after traumatic brain injury (TBI).

Methods The properties of the QOLIBRI-OS were studied in a sample of 792 participants with TBI recruited from centres in nine countries covering six languages. An examination of construct validity was undertaken on a subsample of 153 participants recruited in Germany who had been assessed on two relevant brief quality of life measures, the Satisfaction With Life Scale and the Quality of Life Visual Analogue Scale.

Results The reliability of the QOLIBRI-OS was good (Cronbach's $\alpha=0.86$, test-retest reliability =0.81) and similar in participants with higher and lower cognitive performance. Factor analysis indicated that the scale is unidimensional. Rasch analysis also showed a satisfactory fit with this model. The QOLIBRI-OS correlates highly with the total score from the full QOLIBRI scale ($r=0.87$). Moderate to strong relationships were found among the QOLIBRI-OS and the Extended Glasgow Outcome Scale, Short-Form-36, and Hospital Anxiety and Depression scale ($r=0.54$ to -0.76). The QOLIBRI-OS showed good construct validity in the TBI group.

Conclusions The QOLIBRI-OS assesses a similar construct to the QOLIBRI total score and can be used as a brief index of HRQoL for TBI.

After traumatic brain injury (TBI) difficulties are commonly present in physical, cognitive, emotional, psychosocial and daily life domains.^{1–3} Outcome assessment after TBI has traditionally focused on functional status, but over recent years there has been increasing awareness of the need to supplement assessment of functional status by measures that capture the patient's own perspective on quality of life (QoL).⁴ Patient reported outcome (PRO) instruments are being advocated generally for use in the evaluation of interventions.⁵ PROs are increasingly used in a clinical context, and they are an emerging area in TBI research.⁶

A desire to measure PROs has led to growing use of self-report tools to assess health-related quality of life (HRQoL) in brain injury.^{7–9} HRQoL measures address the consequences of health conditions for QoL, rather than assessing general QoL, and they are particularly appropriate when the aim is to understand the effects of a condition such as TBI. The Quality of Life after Brain Injury (QOLIBRI) assessment is a recently developed descriptive system for HRQoL after TBI.^{9–10} The QOLIBRI was created in response to the need for a comprehensive disease-specific measure for TBI,¹¹ and was constructed simultaneously in six languages by an international multidisciplinary team. The process of development was guided by WHO concept of QoL,¹² and a model proposed by von Steinbüchel *et al.*¹³ The final version of the QOLIBRI is a 37-item scale with six subscales covering areas of well-being and functioning that are typically affected by TBI, and a total score which provides a summary of HRQoL. The areas include the domains 'cognition' and 'self' that are not contained in generic health status measures such as the Short-Form-36 (SF-36).¹⁴ The QOLIBRI has satisfactory psychometric properties and provides information about outcome additional to that given by the SF-36 or the Extended Glasgow Outcome Scale (GOSE).^{9–10, 15}

The QOLIBRI offers a profile of HRQoL after TBI, but for global assessment a single overall score is all that is required. Short assessments are popular in research studies and clinical work, and they are particularly useful in TBI because patient fatigue is often a problem¹⁶ and cognitive impairment may interfere with attention and comprehension.¹

Single-item measures of QoL have been used in TBI studies,^{17–18} but there is wide variation in question format and options for response. Diener¹⁹ criticised single-item measures, noting among other shortcomings that they are inherently unreliable and that they leave the person to integrate different aspects of QoL. In practice, some participants may simply choose to respond on the basis of their current emotional state and not make a considered judgement. Multiple-item questionnaires generally have better psychometric properties, and the most widely used in TBI is the Satisfaction With Life Scale (SWLS).²⁰ The SWLS is a 5-item scale which has been suggested as a potential 'gold standard' in the assessment of subjective QoL in disability²¹ and

was recently identified as a core outcome measure for TBI.⁶ The SWLS has been shown to be robust psychometrically in a variety of groups,²² but there is no formal validation in the TBI population. In fact, the SWLS may not be entirely appropriate for use after TBI: the questions do not specifically refer to life after brain injury, but evaluate the whole life course,²³ and the last item (Item 5: 'If I could live my life over, I would change almost nothing') might appear incongruous to someone who has suffered a TBI.²⁴

To meet the need for a brief TBI-specific HRQoL scale, we developed a 6-item scale requiring an overall judgement of different aspects of HRQoL. The QOLIBRI Overall Scale (QOLIBRI-OS) was developed in parallel with the 37-item QOLIBRI questionnaire. The current study had three aims: (1) to determine whether the QOLIBRI-OS has satisfactory psychometric properties; (2) to examine whether this brief 6-item HRQoL scale is comparable with 37-item QOLIBRI total score; and (3) to study the construct validity of the QOLIBRI-OS in comparison with other brief well-being instruments.

METHODS

Data collection

The psychometric properties of the QOLIBRI-OS were examined in an international data set, involving 792 participants after TBI predominantly recruited as convenience samples from centres in nine countries covering six languages (Dutch, English, Finnish, French, German and Italian) and described in detail elsewhere.¹⁰ Data were collected by medical personnel and psychologists. The analysis of construct validity was undertaken on a subsample of 153 participants recruited in Germany who had been assessed on relevant brief QoL measures. The characteristics of these samples are shown in table 1.

The QOLIBRI-OS and other questionnaires were administered by self-report (mail or participant present at the clinic), face-to-face interview or administration over the telephone (see table 1). In the case of face-to-face contact, the GOSE and interviewer checklist were completed at the same time. If the questionnaires were mailed then the GOSE and clinician checklist were completed by telephone interview. Test-retest reliability was investigated in an international subsample of 375 participants by repeat administration after an interval of 2 weeks. Country coordinators were asked to recruit patients for retest. The aim was to exceed the recommended minimum of 20 patients retested per language,²⁵ and include at least a third of patients in total.

Inclusion criteria for the study were: aged 17 or more at the time of recruitment (and at least 15 years old at the time of injury in order to exclude paediatric injuries), 3 months–15 years postinjury, diagnosis of TBI on ICD-10 criteria and able to give informed consent. Exclusion criteria were: GOSE <3, spinal cord injury, the presence of a significant current or preinjury psychiatric condition or ongoing severe addiction, a diagnosed terminal illness, and inability to understand, cooperate and answer questions. Participating centres obtained local ethics approval; consent was obtained from all participants in accord with local procedures.

Measures

QOLIBRI-OS

The QOLIBRI-OS consists of six novel items that assess overall satisfaction with facets of life relevant to people with TBI (online appendix 1). Areas covered by the questionnaire include physical condition, cognition, emotions, function in daily life, personal and social life, and current situation and future pros-

Table 1 Characteristics of the samples of patients with TBI

	All cases	Test-retest sample	German language
N	792	375	153
Gender			
Male	570 (72%)	269 (72%)	103 (67%)
Female	222 (28%)	106 (28%)	50 (33%)
Age (years)			
17–30	270 (34%)	119 (32%)	33 (22%)
31–44	247 (31%)	108 (29%)	28 (18%)
45–68	275 (35%)	148 (39%)	92 (60%)
Highest educational qualification			
Diploma or degree	260 (35%)	90 (28%)	49 (32%)
Technical or trade certificate	216 (29%)	122 (37%)	55 (36%)
School/other	260 (35%)	114 (35%)	48 (33%)
GCS (24 h worst)			
Severe: 3–8	463 (58%)	196 (52%)	40 (26%)
Moderate: 9–12	75 (10%)	39 (10%)	17 (11%)
Mild: 13–15	254 (32%)	140 (37%)	96 (63%)
Major lesion			
None	116 (15%)	53 (14%)	36 (24%)
Focal	416 (53%)	218 (59%)	108 (73%)
Diffuse	250 (32%)	99 (27%)	4 (3%)
Years since injury			
<1 year	93 (12%)	37 (10%)	19 (12%)
1–<2 years	102 (13%)	43 (12%)	23 (15%)
2–<4 years	202 (26%)	113 (30%)	50 (33%)
4–18 years	392 (50%)	180 (48%)	61 (40%)
Rehabilitation			
Current	255 (33%)	94 (26%)	6 (4%)
Previous	394 (51%)	182 (49%)	79 (52%)
No rehabilitation	128 (16%)	93 (25%)	68 (44%)
Employment status			
Employed full-time	168 (23%)	80 (21%)	60 (39%)
Relationship status			
Single	301 (41%)	118 (36%)	27 (18%)
Partnered	349 (47%)	170 (52%)	111 (73%)
Past partnered	90 (12%)	39 (12%)	14 (9%)
Living arrangements			
Independent	418 (57%)	186 (57%)	111 (73%)
Supported	319 (43%)	141 (43%)	42 (27%)
Number of comorbid health conditions			
0–3	314 (41%)	121 (33%)	63 (41%)
4–6	225 (29%)	128 (35%)	39 (26%)
7 and more	234 (30%)	113 (31%)	51 (33%)
Self-reported health status			
Healthy	528 (72%)	230 (72%)	96 (64%)
Unhealthy	202 (28%)	91 (28%)	55 (36%)
GOSE at follow-up			
Severe disability (3–4)	143 (18%)	86 (23%)	13 (8%)
Moderate disability (5–6)	432 (54%)	178 (48%)	53 (34%)
Good recovery (7–8)	217 (28%)	111 (30%)	87 (57%)
Questionnaire administration			
Self-completed, face-to-face	240 (30%)	130 (35%)	4 (3%)
Self-completed, mail	323 (41%)	162 (43%)	149 (97%)
Interview, face-to-face	215 (27%)	72 (19%)	0
Interview, telephone	13 (2%)	11 (3%)	0

GCS, Glasgow Coma Scale; GOSE, Extended Glasgow Outcome Scale; TBI, traumatic brain injury.

pects. Responses to each item were scored 1 ('Not at all') to 5 ('Very'), and the sum of all items was converted arithmetically to a percentage scale, with 0 representing the lowest possible HRQoL on the questionnaire and 100 the best possible HRQoL.

HRQoL, disability and mood

Measures were included from four areas relevant to assessing scale validity: self-rated generic health status was assessed by the SF-36 Health Survey (Version 1¹⁴) and summarised as Physical and Mental Component Scores. TBI-specific HRQoL was captured by the QOLIBRI.^{9 10} Emotional distress and symptoms were assessed with the Hospital Anxiety and Depression Scale (HADS²⁶). Disability was assessed by the GOSE.²⁷

Brief measures of QoL

Two brief measures of QoL and well-being were included in the instruments administered to the German language sample (N=153). A Quality of Life Visual Analogue Scale (QoL-VAS)²⁸ was chosen as a representative single-item QoL measure. Participants are asked to estimate their QoL over the past week by marking a scale between 'Worst imaginable QoL' and 'Perfect QoL'. The position of the mark is measured with a ruler to give a QoL score. The QoL-VAS has been shown to have satisfactory reliability and validity in cancer patients.²⁸ The SWLS²⁰ was included because it is a popular multi-item well-being assessment. Given potential cognitive issues among those with TBI we simplified its administration by using five response options rather than seven.²⁹ The internal consistency of this modified scale was high ($\alpha=0.89$) and comparable with the original scale.²² However, we found that reliability in a TBI sample was even greater ($\alpha=0.94$) when the last item was deleted, suggesting that this item does not fully fit the construct in our sample.²⁴

Demographic, health status and clinical information

Demographic characteristics, current health conditions and clinical data for participants were collected at interview and from case notes. Self-reported health status was assessed by asking respondents whether they considered themselves 'healthy' or 'unhealthy'.¹² The information taken from case notes included the date of injury, cause of injury, site of major head injury and the worst GCS score in the first 24 h.

Cognitive performance

Cognitive status was measured in a subsample of participants using either the Mini Mental State Examination (MMSE)³⁰ or the Telephone Interview for Cognitive Status (TICS) screening instruments.³¹ Cut-offs on the TICS and MMSE of 32/33 and 27/28, respectively, were used to define groups with lower and higher cognitive performance.

Core versus optional measures

The core data set collected by all centres consisted of the QOLIBRI-OS, QOLIBRI, GCS, GOSE, SF-36, HADS, and demographic and clinical information. Optional assessments included the MMSE or TICS, and centres could also add additional specific assessments. The German language study included relevant brief measures of QoL.

Statistical approaches

We used both classical psychometric and item response theory approaches for QOLIBRI-OS construction. The steps are summarised below (1–3), and a detailed rationale is given elsewhere.^{9 10} For the analysis described in part (1), we used the international sample, and carried out subgroup analysis for reliability; for part (2), the analysis was carried out with the international sample; and for part (3), we analysed data from a subsample from Germany. Unless otherwise noted, analyses were carried out using PASW/AMOS 18 (IBM Corporation, Armonk, New York, USA).

(1) QOLIBRI-OS psychometrics

Item level

An endorsement index¹² was calculated (items are considered problematic if they have <10% of responses in two adjacent categories for at least half the language versions), and item frequencies were inspected for floor and/or ceiling effects (>60% of cases at the maximum or the minimum of the scale). Means were calculated for each item and skewness examined; conventionally, items with skewness >1 are considered for removal.

Scale reliability and unidimensionality

Internal consistency was assessed using Cronbach's α . An α of 0.70 is regarded as acceptable for group comparisons,³² and over 0.90 is desirable for individual clinical applications.³³ The fit of items was examined using corrected item-total correlations (CITCs). CITCs conventionally should be over 0.40.¹²

To test the assumption of unidimensionality of the QOLIBRI-OS we applied confirmatory factor analysis. We used structural equation modelling (SEM, maximum likelihood method) to evaluate the fit of the data to a single-factor model. Conventional criteria for SEM fit are that the comparative fit index should be above 0.95 and that the root mean square error of approximation should be close to or below 0.06.³⁴

Rasch analysis was carried out using Winsteps 3.66 (Winsteps.com, Chicago, Illinois, USA). The analysis assessed scale reliability (person separation index) and the fit of items to the Rasch model. For large sample sizes the mean square is preferred to the Z statistic as a measure of fit, and satisfactory fit is indicated by values between 0.70 and 1.30.³⁵

Test–retest reliability was assessed using intraclass correlation (ICC). ICC values of 0.40–0.75 are interpreted as fair to good, and values over 0.75 as excellent.²⁵ Differences between groups were interpreted using Cohen's d effect size.³⁶

(2) Comparison with QOLIBRI

Spearman correlations were calculated between the QOLIBRI-OS and the scales of the full QOLIBRI.

(3) Construct validity

The validity of the QOLIBRI-OS was examined through Spearman correlations with other outcome measures in the

Table 2 Cronbach's α and test–retest reliability (ICC) of the QOLIBRI-OS for the total sample, separately for language versions and subgroups with low and high MMSE/TICS scores

	Total Sample	Dutch	English	Finnish	French	German	Italian	Low MMSE/TICS	High MMSE/TICS
N	792	99	97	156	148	153	139	103	171
Cronbach's α	0.86	0.79	0.91	0.88	0.82	0.89	0.81	0.88	0.87
N	375	27	54	49	129	116	–	81	119
ICC	0.81	0.81	0.69	0.86	0.75	0.86	NA	0.81	0.82

ICC, intraclass correlation; MMSE, Mini Mental State Examination; QOLIBRI-OS, Quality of Life after Brain Injury Overall Scale; TICS, Telephone Interview for Cognitive Status.

Table 3 Rasch analysis and CFA: item location measure (logits) and Rasch fit statistics; standardised estimates of loading (λ) from CFA

QOLIBRI-OS items	Rasch					CFA λ
	Item measure	Infit	Infit Z	Outfit	Outfit Z	
Physical condition	0.04	1.02	0.33	1.01	0.17	0.70
Cognition	0.29	1.15	2.86	1.14	2.74	0.64
Emotions	-0.05	1.02	0.33	0.99	-0.18	0.69
Daily life	-0.56	0.86	-2.81	0.86	-2.72	0.75
Personal/social	0.0	0.92	-1.56	0.91	-1.77	0.74
Current situation/future prospects	0.28	0.98	-0.37	0.99	-0.18	0.72

CFA, confirmatory factor analysis; QOLIBRI-OS, Quality of Life after Brain Injury Overall Scale.

subsample from Germany. Non-parametric correlations were used because some of the variables were ordinal. Steiger's test⁵⁷ was used to assess whether correlations were significantly different.

RESULTS

Item characteristics and scale properties

There were very few missing responses on QOLIBRI-OS items (0%–0.25%; no more than one item per participant). All items met the endorsement criterion, and no item showed ceiling or floor effects. All items showed some skewness, but this was within acceptable limits (range -0.12 to -0.52). The skew indicated positive HRQoL. CITCs ranged from 0.59 to 0.69.

Cronbach's α was 0.86 which was excellent for a 6-item scale, and all items made a positive contribution to α . Internal consistency was also satisfactory to good in the six language versions (see table 2). In a subsample of 274 participants, either MMSE or TICS scores were available. Internal consistency of the QOLIBRI-OS was similar in subgroups with lower cognitive performance (N=103; TICS <33 or MMSE <28) and higher cognitive performance (N=171; TICS >32 or MMSE >27) (see table 2). Table 2 also indicates very good test-retest reliability of the scale in the total sample. Test-retest reliability (ICCs) was measured in five language groups and was satisfactory to good. Test-retest reliability was also comparably good in the groups of participants with lower and higher cognitive performance. The QOLIBRI-OS sum score significantly increased from first to second assessment, but the effect size was very small (d=0.07, p=0.05).

Confirmatory factor analysis demonstrated that a model with one underlying factor had a reasonable fit (comparative fit index =0.98; root mean square error of approximation =0.07; $\chi^2=39.62$, df=9, p(χ^2)<0.001), although, not unexpectedly with a large sample size, the p value of χ^2 reached significance. Estimates for item loadings on the underlying factor are shown in table 3.

On Rasch analysis the person separation index was 2.46 and reliability was 0.86, indicating a good ability to sort respondents into different levels of HRQoL. All items had correctly ordered category and threshold measures. The values of infit and outfit shown in table 3 are well within criteria for fit to the Rasch model. Item location measures ranged from -0.56 logits for the 'Daily life item' (ie, the easiest to endorse positively) to 0.29 logits for Cognition (ie, the hardest to endorse positively). The relatively limited range of item locations indicates that distributions of responses to different items were similar.

The relationship of the QOLIBRI-OS to the QOLIBRI

The QOLIBRI-OS total score correlated strongly with the QOLIBRI total ($\rho=0.87$). The QOLIBRI-OS score was also

strongly related to all QOLIBRI scales: the Self scale ($\rho=0.81$, p<0.001), the Daily Life and Autonomy scale ($\rho=0.75$, p<0.001), the Cognition scale ($\rho=0.74$, p<0.001), the Social Relationships scale ($\rho=0.63$, p<0.001), Physical Problems ($\rho=0.60$, p<0.001) and the Emotions scale ($\rho=0.56$, p<0.001). All QOLIBRI-OS items showed strong positive correlations with the QOLIBRI total score ($\rho=0.64$ to $\rho=0.70$), suggesting that the QOLIBRI-OS items contributed equally to assessment of the HRQoL construct.

The relationship between the QOLIBRI total score and the QOLIBRI-OS is shown in figure 1. The scatterplot indicates that scores obtained are strongly related. The mean score for the QOLIBRI-OS was 58.0 (SD=21.5) and the mean QOLIBRI total from the full instrument was 64.6 (SD=18.2). The mean score on the QOLIBRI-OS was significantly lower than the QOLIBRI total score (t=17.3, df=791, p<0.001), and the SD on the QOLIBRI-OS was significantly larger (F-test, p<0.0001). The coefficient of variation of the QOLIBRI-OS was larger than for the QOLIBRI total: 0.37 (95% CIs 0.35 to 0.39) versus 0.28 (95% CIs 0.27 to 0.30). Thus, in keeping with the use of a smaller set of items, variation was greater on the 6-item scale than the 37-item scale.

The relationship of QOLIBRI-OS with other outcome assessments

This analysis was conducted using the German language sample, and scale scores for this group are given in table 4. Table 5 shows the relationships of QOLIBRI-OS to age, GCS injury severity,

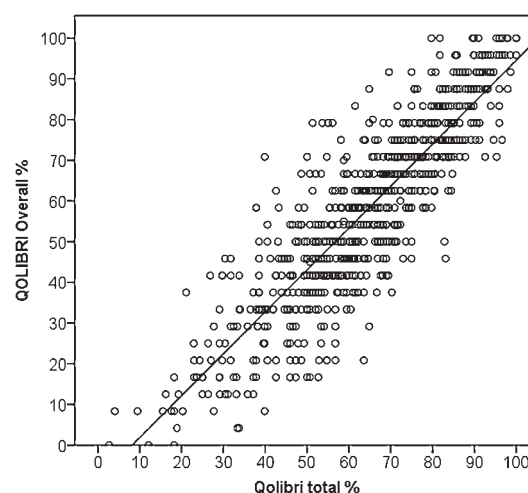


Figure 1 Scatterplot of Quality of Life after Brain Injury Overall Scale (QOLIBRI-OS) scores against QOLIBRI total scores. The fit line is from linear regression and has $R^2=0.76$.

Table 4 Means and SDs of scales in the German language sample (N=153)

Scale	Mean	SD
QOLIBRI total (0–100)	71.82	17.24
QOLIBRI-OS (0–100)	64.73	20.80
SWLS (5–35)	24.03	6.76
QoL-VAS (0–100)	60.26	23.41
GOSE	6.54	1.28
SF-36—Physical Component Score (T-score)	47.75	11.08
SF-36—Mental Component Score (T-score)	46.51	11.18
HADS anxiety (0–21)	5.88	4.11
HADS depression (0–21)	5.41	4.16

The scores on the SWLS have been adjusted to match the standard version which is scored on a 5–35-point scale.

GOSE, Extended Glasgow Outcome Scale; HADS, Hospital Anxiety and Depression Scale; QoL-VAS, Quality of Life Visual Analogue Scale; QOLIBRI-OS, Quality of Life after Brain Injury Overall Scale; SF-36, Short-Form-36; SWLS, Satisfaction With Life Scale.

time since injury and three outcome assessments that are relevant to construct validity (GOSE, SF-36 and HADS). For comparison, the same relationships are shown for the QOLIBRI total score and the SWLS and QoL-VAS.

Relationships among the QOLIBRI-OS and age, injury severity, and time since injury were weak and not statistically significant ($p < 0.20$). In contrast, the scale showed strong relationships with outcome assessments ($p > 0.50$). The strongest relationships were with HADS Depression and Anxiety scores, and the SF-36 Mental Component Score, confirming the importance of mood and mental health for HRQoL. However, there were also strong relationships ($p > 0.50$) with the GOSE and the SF-36 Physical Component Score, indicating that disability and physical health were strongly associated with responses on the QOLIBRI-OS. The QOLIBRI-OS and QOLIBRI total score showed very similar relationships with age, GCS, time since injury, GOSE, SF-36 and HADS. The SWLS shows a similar pattern of correlations (table 5); however, the correlations for the SWLS are significantly lower than the QOLIBRI-OS with the GOSE ($z = 2.29$, $p < 0.05$), the Physical Component Score ($z = 3.09$, $p < 0.01$) and the HADS Anxiety scale ($z = 3.03$, $p < 0.01$). In general, the correlations of QoL-VAS with the other outcome assessments are weaker than with the QOLIBRI measures, and it has the weakest relationship with the GOSE ($\rho = 0.32$, z for the comparison with QOLIBRI-OS = 3.29, $p < 0.01$).

DISCUSSION

The study demonstrated that the QOLIBRI-OS has satisfactory psychometric properties. The internal consistency and test–retest reliability of the scale are acceptable and appear unaffected by cognitive status, at least in this sample. Indeed,

the internal consistency was good for a short scale assessing six areas of HRQoL. Furthermore, both factor and Rasch analyses indicate that the scale is unidimensional. All of the items in the QOLIBRI-OS are presented as ‘satisfaction’ judgements. Satisfaction judgements are intended to encourage an element of self-reflection in contrast to simply asking people to report feelings that they experience. We were concerned that in places this construction might seem a bit strained: for example, asking people to report satisfaction with their emotional state. However, SEM and Rasch analyses indicated that all the items had a good fit with the construct.

Analysis showed that the QOLIBRI-OS was highly correlated with the total score from the full QOLIBRI, indicating that essentially the same construct was being measured. It was noted that the coefficient of variation was higher with the short scale than the full QOLIBRI, and the absolute values obtained on the short scale were lower. Higher variation in the QOLIBRI-OS is no doubt due to the difference in length of the questionnaires: differences in responses on a shorter scale will have a greater impact on variability than on a longer scale. The lower mean value on the short scale presumably reflects the content of the items, which are quite global in comparison with the more specific items on the full QOLIBRI. Bearing these points in mind, the QOLIBRI-OS can be considered as a tool when a short index of HRQoL after TBI is needed. The full QOLIBRI is a comprehensive HRQoL assessment, but the QOLIBRI-OS may be useful for screening for HRQoL or in situations where workload has to be minimal. The QOLIBRI-OS was related particularly strongly to the first three QOLIBRI subscales (Cognition, Self, Daily Life and Autonomy). It thus captures areas such as cognition and changes in the self that are relevant to TBI and not well assessed by popular measures of generic HRQoL or self-rated health status such as the SF-36.

The issue of the potential influence of cognitive impairment on QoL judgements is important,³⁸ but remains relatively unexplored in the TBI literature. In this study, we employed the MMSE or TICS as screening measures for cognitive impairment, and this allowed us to divide patients into those performing at a lower and higher level. However, the MMSE and TICS were not designed to give differentiated diagnoses for different types of cognitive impairment after head injury. In our study, they showed ceiling effects consistent with lack of sensitivity to cognitive impairment in TBI. Furthermore, they do not assess all aspects of cognition that are important in HRQoL judgements. Level of insight is commonly supposed to be of particular importance, but it remains an aspect of cognition that is difficult to operationalise. Concern about the influence of cognitive impairment is likely to be one of the main reservations about the use of PROs in TBI. Within the constraints of the present methodology we did not find evidence that cognitive impairment influenced the reliability of the QOLIBRI-OS scale, and as

Table 5 Spearman correlations in the German sample (N=153) of quality of life assessments with age, GCS, time since injury and outcome measures relevant for construct validity

	Age	GCS	Time since injury	GOSE	SF-36 PCS	SF-36 MCS	HADS anxiety	HADS depression
QOLIBRI total	−0.06	0.08	−0.10	0.58*	0.58*	0.64*	−0.70*	−0.78*
QOLIBRI-OS	−0.06	0.10	−0.08	0.56*	0.53*	0.61*	−0.65*	−0.75*
SWLS	0.08	0.05	−0.03	0.45* **	0.38* ***	0.54*	−0.51* ***	−0.70*
QoL-VAS	0.07	0.01	0.02	0.32* ***	0.43*	0.49*	−0.41* ***	−0.54* ***

* $p < 0.001$. Steiger's t test (two-tailed) for a difference with the QOLIBRI-OS correlation: ** $p < 0.05$, *** $p < 0.01$.

GCS, Glasgow Coma Scale; GOSE, Extended Glasgow Outcome Scale; HADS, Hospital Anxiety and Depression Scale; MCS, Mental Component Score; PCS, Physical Component Score; QOLIBRI-OS, Quality of Life after Brain Injury Overall Scale; QoL-VAS, Quality of Life Visual Analogue Scale; SF-36, Short-Form-36; SWLS, Satisfaction With Life Scale.

a very short assessment it may lend itself for use with patients with cognitive impairment.

In addition to issues already mentioned, the current study had a number of other limitations. Responsiveness to change is an important characteristic that was not possible to investigate in the current design. Most assessments were carried out late after injury (3 months to 15 years) at a time when acceptance and coping may have been quite complete. Overall ratings and the associations with functional scales may be very different at earlier phases. A full examination of the effect of time since injury thus awaits further investigation, as does the influence of injury severity.⁹ The samples from different countries were not matched for clinical and demographic characteristics, and this limited direct comparisons between different language versions of the scale. The majority of the cases were recruited through brain injury rehabilitation centres, and there are evidently substantial inter-country differences in admission policies for rehabilitation making matching of samples particularly difficult. As a consequence of the recruitment strategy there was a relatively small proportion of participants with moderate injuries. A further shortcoming of this study is the lack of morphological information on the extent and localisation of brain injury as a factor possibly influencing HRQoL.

The QOLIBRI-OS showed expected patterns of relationships with other measures, confirming the construct validity of the scale. There was a strong relationship with the GOSE, indicating that the scale was sensitive to disability caused by TBI. There were also strong relationships with the two component scores on the SF-36, suggesting the importance of physical and mental health to HRQoL. There are limitations to the comparison of the QOLIBRI-OS with generic measures such as the SF-36 because the aspects of HRQoL that are assessed differ. In this respect, perhaps the strongest evidence for the construct validity of the short scale comes from its relationship with the full QOLIBRI. The QOLIBRI-OS and QOLIBRI total showed similar relationships with other measures, supporting the idea that the two scales are measuring the same HRQoL construct.

However, there is little value in adding another measure of HRQoL to an already crowded and confusing field unless it is more useful than currently available measures. We have argued elsewhere that the QOLIBRI covers areas not included in generic measures such as the SF-36.⁹ In this study, we compared the QOLIBRI-OS with two other brief assessments of QoL. The QoL-VAS showed a relatively weak association with the GOSE, suggesting that it was less sensitive to TBI-related disability. Single item measures are likely to be less reliable and this may also contribute to the weaker relationships observed for the QoL-VAS. The SWLS is a popular and well-accepted measure of QoL after TBI.^{6, 39} However, there are issues with its use as a measure of HRQoL. Like others,²⁴ we found that one of the SWLS items did not fit the construct fully. The SWLS encourages survey of the whole life course, rather than evaluating the specific effects of TBI, and is perhaps best regarded as reflecting general well-being.

In relation to its three aims the study showed that: (1) the QOLIBRI-OS has satisfactory to good psychometric properties; (2) the score from the QOLIBRI-OS is highly correlated with the full QOLIBRI; and (3) the QOLIBRI-OS shows expected relationships with other measures of outcome, and appears more strongly related to measures such as the GOSE than other brief well-being assessments. In conclusion, the QOLIBRI-OS fills a gap in the brief assessments currently available to measure HRQoL after TBI.

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Data sharing statement The database is under the management of the QOLIBRI Steering Committee, and researchers who contributed to the data set can request access. Use of the data is monitored by the QOLIBRI Methodological Centre.

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QOLIBRI Overall Scale: a brief index of health-related quality of life after traumatic brain injury

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