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Use of the WHOQOL-BREF for Evaluating Persons with Traumatic Brain Injury

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ABSTRACT

This study examined psychometric properties of a brief version of the World Health Organization Quality of Life questionnaire (WHOQOL-BREF) among persons with traumatic brain injury (TBI) and the relations of the WHOQOL-BREF domains, including physical capacity, psychological well-being, social relationships, and environment, to different indicators of TBI severity. Of the 354 eligible and available subjects from 22 hospitals in northern Taiwan over a 6-month period, 199 completed telephone interviews during data collection. Three indicators of TBI severity were used: the Glasgow Coma Scale, the presence of post-traumatic amnesia, and the abbreviated injury scale to the head. All domain scores of the WHOQOL-BREF had nearly symmetrical distributions: low percentages of ceiling and floor values (0 ~ 3%), low missing rates (0 ~ 0.5%) for all but one item (43.2%), and very good internal consistency (0.75 ~ 0.89) and test-retest reliability (0.74 ~ 0.95). The WHOQOL-BREF also exhibited excellent known-groups validity, as well as very good responsiveness and convergent validity with regard to employment, independence in daily life activities, social support, and depression. After adjustment for potential confounders, almost none of the domain scores of the WHOQOL-BREF significantly differed in the severity levels of the three severity indicators. In conclusion, the WHOQOL-BREF is an appropriate health-related quality of life (HRQL) instrument for persons with TBI. Furthermore, the initial severity of the TBI might not be suitable for predicting levels of HRQL in persons with TBI.

Key words: health-related quality of life; injury severity; reliability; traumatic brain injury; validity

INTRODUCTION

Traumatic brain injury (TBI) is a leading cause of death in both developed and developing countries (Frankowski, 1986; Lee, et al., 1990), and the economic impacts of TBIs are enormous; for instance, their costs in the United States were estimated to be $37.8 billion in 1985 (Max et al., 1991). More importantly, those people

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who survive TBI often sustain lifelong disabilities and face negative consequences in a variety of aspects of their health (O'Shanick, 1986). Accordingly, health-related quality of life (HRQL) measures, based on a person subjective appraisal of his/her own physical functioning, psychological functioning, and social interactions (Guyatt et al., 1993; Schipper et al., 1996), are appropriate for characterizing the impacts of these multiple consequences among persons with TBI. Furthermore, since clinicians and other health workers often underestimate the impacts of psychological aspects and emphasize the importance of the physical symptoms and signs among patients (Rothwell et al., 1997; Tennstedt et al., 1992), information on the HRQL can help identify the long-term needs for health care, as well as determine the success of healthcare programs among persons with TBI (van Baalen et al., 2003).

HRQL measures such as the Sickness Impact Profile (SIP) (Klonoff et al., 1986b; McLean et al., 1984; Temkin et al., 1988), the Short Form 36 (SF-36) (Findler et al., 2001; Mackenzie et al., 2002), and the Life Satisfaction Index-A (LSI-A) (Webb et al., 1995) have been applied to persons with TBI. More recently, the World Health Organization (WHO) cross culturally developed a short form of the WHO Quality of Life questionnaire (i.e., the WHOQOL-BREF), and defined HRQL as "individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns" (The WHOQOL Group, 1998). The use of this instrument for people with TBI seems to be promising in terms of its excellent validity and reliability among a variety of populations across many countries (WHO, 1996). However, its validation for persons with TBI has not yet been reported.

On the other hand, results for the relationship of the HRQL to TBI severity are inconsistent. Some studies reported that people with serious TBIs had lower HRQL scores than those with mild TBIs (Klonoff et al., 1986a; Kreuter et al., 1998); however, some reports recorded a reverse finding (Brown et al., 2000; Findler et al., 2001). There are several possible reasons to which these inconsistencies can be attributed. First, these studies used different indicators, including the Glasgow Coma Scale (GCS) (Teasdale and Jennet, 1974), the presence of post-traumatic amnesia, and the Abbreviated Injury Scale to the head (AIS-H) (AAAM, 1990), to evaluate the severity of TBI. However, the sensitivities of these indicators may differ considerably for HRQL scores. Furthermore, strong confounders, such as education level, alcohol consumption prior to the injury, and other variables in the relationship of TBI severity and HRQL scores, were not controlled in previous studies. Finally, the relationship of the severity of TBI and HRQL scores also depends on characteristics of the study sample; for example, scores for the HRQL tend to be more homogenous if persons with serious TBIs who have difficulty with verbal communication are not included (Johnston & Miklos, 2002).

This study examined psychometric properties of the WHOQOL-BREF in persons with TBI and determined the relations of severity indicators of TBI to four WHOQOL-BREF domain scores, with adjustment for potential confounders.

METHODS

Study Subjects and Procedures

Twenty-two hospitals in northern Taiwan, considered by the Head and Spinal Cord Research Group in Taiwan to have the ability to manage traumatic head injuries (Hung et al., 1992), were selected to recruit eligible subjects during a 6-month period from January 1 to June 30, 2002. Newly diagnosed traumatic brain injuries were identified by the presence among the discharge diagnoses of any of the following codes of the International Classification of Diseases, 9 rev. (ICD-9: 800 ~ 801.9, 803 ~ 804.9, and 850 ~ 854.9). In order to avoid double counting, patients transferred from other hospitals were excluded. In the 6-month period, 675 eligible subjects, including 173 with GCS scores at admission of 3–8, 155 with scores of 9–13, and 347 with scores of 14 or 15, were identified. The GCS scores were originally computed as the sum of coded values for three behavioral responses: eye opening, best verbal response, and best motor responses, with scores of 3 ~ 8, 9 ~ 12, and 13 ~ 15 indicating severe, moderate, and mild injuries, respectively (Teasdale and Jennet, 1974). However, it has recently been suggested to include patients with a GCS of 13 in the moderate head injury group, as their risk of complications is similar to that of patients with a GCS score of 9–12 (WHO, 1980).

All patient information—phone number, age, gender, education, time and cause of injury, alcohol consumption prior to injury (yes/no), post-traumatic amnesia (yes/no), GCS score at admission, and GOS score at discharge—was extracted from hospital records. The phone number was used to conduct subsequent telephone interviews. The GOS is a 5-point scale: death, vegetative state, severe disability, moderate disability, and good recovery (Jennet and Bond, 1975). Additionally, by reviewing medical charts, an attending neurosurgeon computed AIS-H scores for these subjects. The AIS-H is a list of possible head injuries, with each patient assigned a severity value from 1 (minor) to 6 (fatal), based on a combination of anatomic lesions (location, size, and multi-

plicity) and impairment of consciousness (length of unconsciousness and nontransient neurological deficits) (AAAM, 1990).

Telephone interviews were also conducted with 354 patients (when phone numbers were available) to collect information on marital status, employment, cognition, independence in activities of daily living (ADL), social support, depression, and the HRQL. Interview procedures and interviewer attitudes on the telephone were standardized through participation in a training course of 4 h duration. Among these subjects, 199 were interviewed, 85 had died, 17 survived in a vegetative state, and 53 declined to be interviewed. For the 321 subjects who could not be reached by existing phone numbers, their national identification numbers and names were used to search national mortality data from 2002 to 2003 in the Department of Health, Executive Yuan, ROC; 39 subjects were matched. Of the remaining subjects, 42 had incorrect phone numbers, 55 had no or disconnected phones, 4 were hospitalized, 79 had moved out of their original house, and 102 had no information available. For each of the subjects without information, five attempts were made to reach them, three at night and two during the day. A flow diagram of the study population is shown in Figure 1.

Compared to nonparticipants, the participants had higher GCS scores (13.3 vs. 12.0 points) and fewer associated injuries (45 vs. 55% being positive); however, no significant differences were detected respectively in other characteristics such as age at injury (47.2 vs. 43.2 years), gender (66 vs. 65% males), time since injury (1.1 vs. 1.0 years), and injury cause (55 vs. 58% motor vehicle crashes). This research was approved by the Institutional Review Board of Taipei Medical University, Taipei, Taiwan.

WHOQOL-BREF

As shown in the Appendix, the standard WHOQOL-BREF contains 26 items, 2 items from the overall quality of life and general health facet (Q1 and Q2) and 1 item from each of the remaining 24 health-related facets (The WHOQOL Group, 1998). The WHOQOL group defines a facet as a behavior (e.g., walking), a state of being (e.g., vitality), a capacity or potential (e.g., the ability to move around), or a subjective perception or experience (e.g., feeling pain). Specific facet definitions are specified in other WHOQOL publications (WHO, 1995). The 24 facets or items are further categorized into four domains: physical capacity (7 items), psychological well-being (6 items), social relationships (3 items), and environment (8 items). Specifically, Q3, Q4, Q10, and Q15 ~ Q18 are grouped into the physical domain; Q5 ~ Q7, Q11, Q19, and Q26 are grouped into the psychological domain; Q20 ~ Q22 are grouped into the social do-

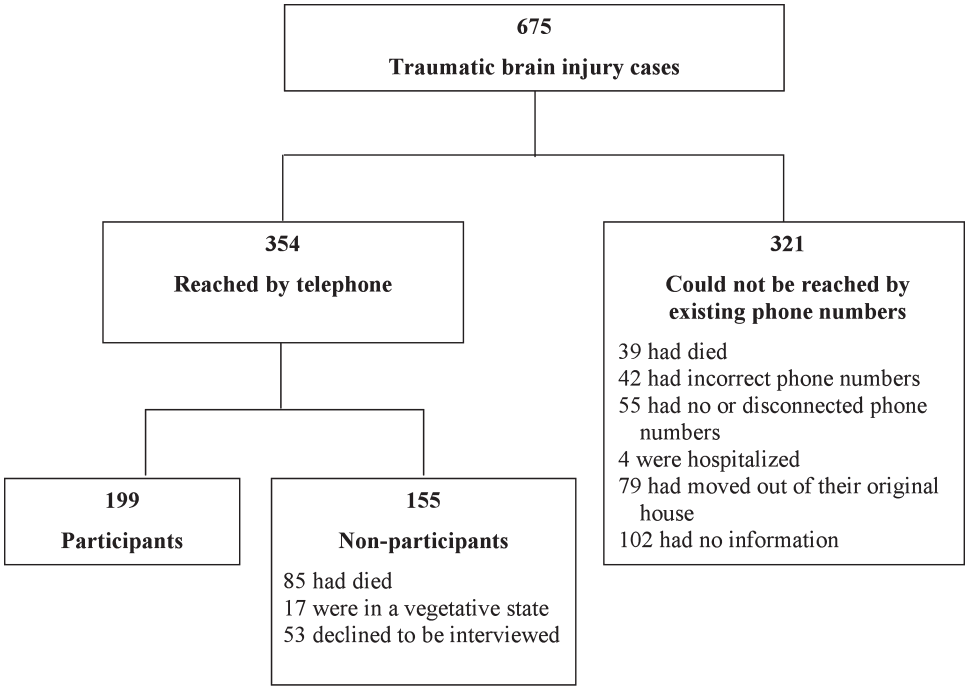

FIG. 1. Flow diagram of traumatic brain injury patients in this study.

main; and Q8, Q9, Q12 ~ Q14, and Q23 ~ Q25 are grouped into the environmental domain. Each item uses a scale from 1 to 5, with a higher score indicating a higher quality of life. Domain scores are calculated by multiplying the mean of all facet scores included in each domain by a factor of 4, and potential scores for each domain vary from 4 to 20 (e.g., score of social relationships = ((Q20 + Q21 + Q22)/3) × 4). The Taiwan version of the WHOQOL-BREF was developed in compliance with WHO guidelines on procedures of translation, as well as design and selection of appropriate items (WHO, 1994). The Taiwan version includes 26 items translated from the standard WHOQOL-BREF and two additional items of local importance (i.e., being respected and food availability); it showed very good reliabilities (including internal consistencies of 0.70 ~ 0.77 and test-retest reliabilities of 0.76 ~ 0.80) and validities (including content, criterion, discriminant, predictive, and construct validities) (Yao et al., 2002). In this study, the two local items were excluded from the analysis to facilitate potential future international comparisons; responses from the two items of the overall quality of life and general health facet were calculated as a single score with a range from 4 to 20, as each domain score.

Instruments for Cognition, ADL, Social Support, and Depression

To evaluate subjects' cognitive status over the telephone, the Telephone Interview of Cognitive Status (TICS) (Brandt et al., 1988; Breitner et al., 1990), a modified version of the traditional Mini-Mental State Examination items, was administered. This 13-item instrument includes the four domains of orientation, registration, calculation, and comprehension. TICS scores range from 0 to 50, with scores of 38 or lower indicating impaired cognition (de Jager et al., 2003).

The Barthel Index [Mahoney and Barthel, 1965] was used to assess functional independence in ADLs. The 10-item instrument includes self-feeding, getting in/out of bed, grooming, performing one toileting, bathing, walking, climbing stairs, self-dressing, and controlling the bowels and bladder. Items have different weights with two items rated on a 2-point scale (0 and 5), six items on a 3-point scale (0, 5, and 10), and two items on a 4-point scale (0, 5, 10, and 15). Scores of the instrument range from 0 to 100, with scores of 0 ~ 60, 61 ~ 90, and 91 ~ 100 indicating severe, moderate, and slight or no dependency, respectively (Shah et al., 1989).

The Social Support Survey (Sherbourne and Stewart, 1991), including the six domains of social network, tangible support, affection, positive social interaction, informational support, and emotional support, was used to evaluate social support. The open-ended item for social networks is not included in the calculation of the scale score, while the other 19 items are scored on 5-point scales. Scores of the instrument were rescaled to a 0–100 range, with scores of 0 ~ 80 indicating a lack of social support.

The Center for Epidemiologic Studies Depression Scale (CES-D) consists of 20 items, emphasizing six affective components of a depressed mood, feelings of guilt and worthlessness, feelings of helplessness and hopelessness, psychomotor retardation, loss of appetite, and sleep disorders (Radolff, 1977). All items refer to the frequency of symptoms during the past week and are scored on 4-point scales. CES-D scores range from 0 to 60, with scores of 16 or more indicating depression (Weissman et al., 1977).

Score Distribution

The mean scores of the 26 items in the WHOQOL-BREF were calculated. The percentage of participants with missing values for each item and the distributions of minimum and maximum possible domain or facet scores (i.e., floor and ceiling values) were used to evaluate the difficulty of completion and the problematic score distribution, respectively.

Internal Consistency and Test-Retest Reliability

Cronbach alpha (Cronbach, 1951) was used to examine the internal consistency of the four WHOQOL-BREF domains. Furthermore, a randomly stratified sample of 30 subjects by a 3-level severity of GCS (i.e., scores of 3 ~ 8, 9 ~ 13, and 14 ~ 15) was selected from the participants to assess the test-retest reliability over approximately 2 weeks. Intraclass correlation coefficients (Shrout and Fleiss, 1979) were calculated for the four domains.

Convergent Validity

To examine the convergence, correlations of certain WHOQOL-BREF domains with the GOS, Barthel Index, CES-D, and Social Support Survey were tested using Spearman's correlation coefficient. It was assumed that those domains that are conceptually related would be relatively strongly correlated, whereas those domains with less in common would show weaker correlations. Accordingly, we hypothesized positive and moderate or high correlations ($r \geq 0.4$) between the following items: the WHOQOL-BREF's physical capacity with the GOS and Barthel Index; the WHOQOL-BREF's psychological well-being with the CES-D; and the WHOQOL-BREF's psychological well-being and social relationships with the Social Support Survey.

Table 1. Sociodemographic and Injury Characteristics Among the 199 Subjects

Characteristic	*Mean ± SD*	*Percent (%)*
Age (y)	45.4 ± 20.3	
Time since injury (y)	1.0 ± 0.7	
Gender		
Male		64.3
Female		35.7
Education		
Elementary or below		26.8
High school		39.9
College or above		33.3
Marital status		
Single		40.2
Spouse present		42.8
Widowed/divorced		17.0
Employment status		
No		42.9
Yes		57.1
Cause of injury		
Motor vehicle crashes		58.1
Falls		26.3
Violence		7.1
Others		8.6
Alcohol consumption prior to injury		
No		70.7
Yes		19.3
Glasgow Coma Scale (GCS)		
3–8		7.5
9–13		22.6
14–15		69.9
Abbreviated Injury Scale to the Head (AIS-H)		
1–2		52.0
3–4		35.7
5		12.2
Glasgow Outcome Scale (GOS) at discharge		
Severe disability		5.4
Moderate disability		9.7
Good recovery		84.9
TICS score[a]		
0–38		25.6
39–50		74.4
Barthel Index score		
0–90		40.6
91–100		59.5
Social Support Survey score		
0–80		39.2
81–100		60.8
CES-D score[b]		
0–16		76.1
17–60		23.9

[a]Telephone interview of cognitive status.
[b]Center for Epidemiologic Studies Despression Scale.

Known-Groups Validity

The known-groups validity of the WHOQOL-BREF was also tested using Student *t* test or one-way analysis of variance (ANOVA) based on four characteristics, including employment, independence in ADLs, social support, and level of depression, known to influence health profiles among people with TBI (Johnston and Miklos, 2002; Webb et al., 1995; Zasler, 1997). For these characteristics, effect sizes were also calculated by the difference in each domain score between subgroups divided by the standard deviation of scores among all persons with TBI. Using Cohen's criteria (Cohen, 1998), a clinically meaningful effect size of $0.2 \sim 0.5$ was considered to be small, $0.5 \sim 0.8$ moderate, and ≥ 0.8 large.

Responsiveness

Six months after the initial assessment, the WHOQOL-BREF was readministered to a random sample of 52 subjects selected from those who reported no employment at the time of the initial assessment. During the 6-month period, 10 out of these subjects had become employed. The responsive statistics for the four domains and the overall quality of life and general health facet were calculated by the difference in the mean change in scores for that domain from the initial to the follow-up assessment between subjects who had become employed and those who remained unemployed during the 6-month period divided by the standard deviation of score changes for the latter group (Guyatt et al., 1989). A similar clinically meaningful level of responsiveness was considered as with the criteria for discriminant validity.

Relation between TBI Severity and the WHOQOL-BREF

A linear regression model was applied to determine the relations between each indicator of TBI severity and domain scores of the WHOQOL-BREF, with and without adjustment for confounders. There were three indicators of TBI severity in the study: the GCS, AIS-H, and posttraumatic amnesia. Domain or facet scores were also calculated and compared within levels for each of the TBI severity indicators.

Statistical Analysis Software, version 8.02 (SAS) was used to perform all statistical analyses.

RESULTS

The distributions of sociodemographic and injury characteristics are shown in Table 1. Of the 199 subjects, the means of age at injury and time since the injury were 45 and 1 year, respectively; 64.3% were male; and 19.3% had consumed alcohol consumption prior to being injured. For severity of TBI, 7.5% of these subjects had GCS scores of ≤ 8, 22.6% had scores of $9 \sim 13$, and 69.6% had scores of 14 or 15. Approximately, 48.0% of subjects had AIS-H scores of $3 \sim 5$, and 15.3% had GOS results indicating moderate-to-severe disability. Moreover, 25.6% of these subjects were cognitively impaired, 40.6% were dependent in ADLs, and 23.9% indicated depression.

As shown in Figure 2, scores of the 26 items of the WHOOL-BREF varied from 3.19 points for Q5 to 4.3 points for Q4.

As shown in Table 2, for each domain score in the WHOQOL-BREF, the median was close to the mean, in-

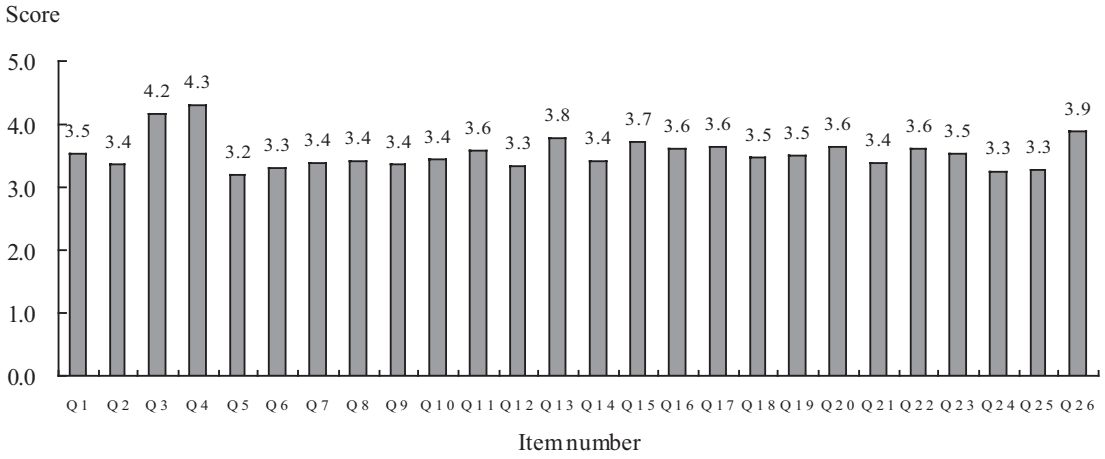

FIG. 2. Item scores of the WHOQOL-BREF.

Table 2. Score Distributions, Internal Consistency, and Test-retest Reliabilities of the WHOQOL-BREF Domains

Domain/facet	*No. of items*	*Mean ± SD*	*Median*	*Min. (%)*	*Max. (%)*	*Missing range (%)*	*Cronbach's α*	*Intraclass correlation*
OQL	2	13.8 ± 2.8	14.0	0.5	2.0	0.0–0.0	0.75	0.87
PC	7	15.1 ± 2.7	15.4	0.0	2.5	0.0–0.5	0.88	0.86
PW	6	13.9 ± 2.5	14.0	0.0	0.0	0.0–0.5	0.89	0.95
SR	3	14.2 ± 2.5	14.7	0.5	3.0	0.0–43.2	0.79	0.74
EN	8	13.7 ± 2.1	13.5	0.0	0.0	0.0–0.5	0.82	0.90

OQL, overall quality of life and general health; PC, physical capacity; PW, psychological well-being; SR, social relationships; EN, environment.

dicating that the distributions of these domain scores were nearly symmetrical. Percentages of ceiling and floor values for each domain score were very low and varied from 0 to 3.0%. While the missing percentage for most items was 0, it was 43.2% for the sexual activity facet (Q21). Cronbach's alpha coefficients varied from 0.75 to 0.89, and the intraclass correlation coefficients varied from 0.74 to 0.95.

For convergent validity, Spearman's correlation coefficients were 0.53 and 0.31 between physical capacity and the GOS and the Barthel Index, respectively, −0.64 between psychological well-being and the CES-D, 0.52 between psychological well-being and the Social Support Survey, and 0.37 between social relationships and the Social Support Survey.

Table 3 shows the results of the known-groups validity. Scores in all four domains and the overall quality of life and general health facet among subjects who were unemployed were dependent for daily activities, had weak social support, and indicated having depression were lower than those of their contrasting counterparts. Results other than those of the environmental domain of the Barthel Index were statistically significant. All effect sizes for discriminant ability were >0.2, and most of them were >0.5.

As shown in Table 4, the effect size of the responsiveness in reference to employment status in the over-

Table 3. Discriminant Ability Analysis for the WHOQOL-BREF Domains

Characteristic	*Statistic*	*OQL*	*PC*	*PW*	*SR*	*EN*
Employment status						
No	Mean	13.0	14.1	13.0	13.6	13.2
Yes	Mean	14.5	15.8	14.6	14.6	14.1
	p value	<0.001	<0.001	<0.001	<0.001	0.006
	Effect size	−0.53	−0.65	−0.62	−0.40	−0.70
Barthel Index						
0–90	Mean	12.9	13.9	13.1	13.5	13.4
91–100	Mean	14.5	15.8	14.4	14.6	13.9
	p value	<0.001	<0.001	<0.001	0.003	0.090
	Effect size	−0.57	−0.70	−0.52	−0.44	−0.24
Social Support Survey						
0–80	Mean	13.3	14.7	13.5	13.8	13.2
81–100	Mean	15.4	16.1	15.4	15.4	15.1
	p value	<0.001	<0.001	<0.001	<0.001	<0.001
	Effect size	−0.75	−0.52	−0.76	−0.64	−0.90
CES-D						
0–16	Mean	14.2	15.7	14.4	14.3	14.0
17–60	Mean	11.9	12.5	11.5	13.3	12.0
	p value	<0.001	<0.001	<0.001	0.034	<0.001
	Effect size	0.81	1.17	1.20	0.42	0.95

OQL, overall quality of life and general health; PC, physical capacity; PW, psychological well-being; SR, social relationships; EN, environment.

Table 4. Responsiveness of each Domain of the WHOQOL-BREF with Respect to Employment Status

Domain/facet	*Employed score change ± SD*	*Unemployed score change ± SD*	*Effect size*
OQL	1.60 ± 2.87	0.12 ± 3.00	0.49
PC	1.03 ± 2.61	0.38 ± 2.98	0.22
PW	0.27 ± 2.27	−0.93 ± 2.71	0.44
SR	0.07 ± 2.78	−0.30 ± 2.64	0.14
EN	1.00 ± 2.48	−0.55 ± 2.35	0.66

OQL, overall quality of life and general health; PC, physical capacity; PW, psychological well-being; SR, social relationships; EN, environment.

all quality of life and general health facet was 0.49. The effect sizes of physical capacity, psychological well-being, social relationships, and environment were 0.22, 0.44, 0.14, and 0.66, respectively.

As shown in Table 5, the unadjusted scores of the overall quality of life and general health facet and each domain of the WHOQOL-BREF did not significantly differ in severity levels as indicated by the GCS, AIS-H, and post-traumatic amnesia. After adjustment for confounders, although the mean scores of the WHOQOL-BREF domains with regard to each indicator changed to some extent, the relationships between the three severity indicators and the four domains and the overall quality of life and general health facet of the WHOQOL-BREF remained similar.

DISCUSSION

Results of this study indicate that the WHOQOL-BREF is an appropriate HRQL instrument for persons with TBI, considering the nearly symmetrical score distribution, low proportions of floor and ceiling values, excellent known-groups validity, very good internal consistency and test-retest reliabilities, and good convergent validity and responsiveness. Minor modification of the

Table 5. Results of Linear Regression Models for the Relation Between TBI Severity and the WHOQOL-BREF with and without Adjustment for Other Variables

		Unadjusted					*Adjusted*				
Severity of TBI	*Statistic*	*OQL*	*PC*	*PW*	*SR*	*EN*	*OQL*[a]	*PC*[b]	*PW*[c]	*SR*[d]	*EN*[e]
GCS											
3–8	Mean	12.9	14.1	13.1	13.1	13.8	12.9	14.3	13.3	12.9	13.8
9–13	Mean	14.0	15.3	14.1	14.1	13.8	14.3	16.0	14.7	14.2	13.9
14–15	Mean	13.9	15.0	13.9	14.3	13.6	13.7	15.6	14.3	14.2	13.5
	p value	0.445	0.282	0.365	0.214	0.904	0.423	0.208	0.344	0.210	0.909
AIS-H											
1–2	Mean	13.8	15.2	14.0	14.5	13.7	13.5	15.7	14.4	14.3	13.6
3–4	Mean	14.0	15.0	13.9	14.1	13.8	14.1	15.7	14.4	14.2	13.9
5	Mean	13.4	14.9	13.8	13.1	13.5	13.6	15.2	14.2	13.1	13.6
	p value	0.713	0.829	0.901	0.051	0.855	0.676	0.844	0.923	0.050	0.849
Post-traumatic amnesia											
No	Mean	14.2	15.2	14.1	14.2	13.8	14.2	15.7	14.5	14.2	13.8
Yes	Mean	13.5	15.0	13.8	14.2	13.6	13.3	15.5	14.1	14.0	13.5
	p value	0.113	0.678	0.383	0.862	0.391	0.065	0.576	0.329	0.774	0.395

[a]Adjusted for education level.
[b]Adjusted for age, gender, education level, and alcohol consumption prior to injury.
[c]Adjusted for education and alcohol consumption prior to injury.
[d]Adjusted for education level.
[e]Adjusted for education level.

statement in Q21 might make it more appropriate for this patient population.

The high missing rates for Q21 reflects its sensitive nature, as well as problems related to sexual activities among persons with TBI; thus, statements for the item ("How satisfied are you with your sex life?") may need to be modified in order to improve the applicability of the WHOQOL-BREF for persons with TBI. To avoid a misunderstanding or an incorrect perception by subjects, the statement for Q21 could be revised to explicitly reflect its definition concerning a person urges and desires for sex. For instance, "How satisfied are you with your sex life, including intimate behavior other than sexual intercourse?" However, a substantial proportion of cancer patients in the United Kingdom (19%) and patients with chronic liver disease in The Netherlands ($12 \sim 21.9\%$) did not answer questions about sexuality as well, while the missing value rates in the remaining items were $<5\%$ (Curran et al., 1998; Ünal et al., 2001). Hence, due to its sensitive nature, Q21 could possibly be replaced by another item in the social relationships domain of the full version of the 100-item WHOQOL questionnaire.

Spearman correlation coefficients of ≤ 0.4 between physical capacity and the Barthel Index and between social relationship and the Social Support Survey indicate that more-vigorous studies are needed to validate the convergent validity of the WHOQOL-BREF. The Barthel Index originally developed for severely ill patients may be insensitive for persons with TBI because of its limitation in scope and its inability to detect low levels of disability (McDowell and Newell, 1996), given that 54.8% of the subjects had maximum possible (100) points for the measure. The convergence of the three-item social relationships domain with the Social Support Survey may have been reduced by the high missing rates for Q21.

Only a few existing generic quality-of-life measures explicitly include the environment as an HRQL domain. However, the importance of the environment where people live has become recognized as relevant to a variety of health outcomes (Jackson, 2003). More recently, transportation, the surroundings, government policies, attitudes, and natural environments have been identified as environmental barriers, with the greatest impact on persons with TBI (Whiteneck et al., 2004). Nevertheless, addressing interactions among critical environmental variables and areas of deficits, such as cognitive impairment, can enhance adequate environmental modifications for maximizing the HRQL and reducing levels of handicap in persons with TBI.

Several investigators have considered adding a cognitive domain or related items to the existing HRQL measures such as the SIP and SF-36 to reflect neuropsychological impairment often evident in persons with TBI, which would improve the known-groups or discriminant validity and responsiveness of the generic HRQL (Berger et al., 1999; Mackenzie et al., 2002; Temkin et al., 1988). However, a modified version of the SIP, produced by adding 118 new items, did not show significant improvement in discrimination (Temkin et al., 1988), and the modification of the SF-36, by the addition of four new items relevant to cognitive functioning, remained poorly discriminative in the two summary scores for physical and mental health, despite the cognitive domain exhibiting very good discriminant ability (Mackenzie et al., 2002). Since the HRQL aspires to evaluate a person subjective feelings about different aspects of health associated with TBI and its sequelae, such as cognitive impairment impact, an independent cognitive domain for persons with TBI might not be necessary for a generic HRQL measure.

Some comments are required about the relationship of the HRQL with TBI severity. First, it should be noted that relations between the HRQL and TBI severity can be influenced by such factors as the nature of the severity indicator of TBI, sensitivity of the HRQL instruments, and the study sample. The nature of the severity indicators of TBI somewhat differs and may evaluate different aspects of TBI severity (e.g., the GCS assesses a subject's level of consciousness, while the AIS-H characterizes anatomic damage). Differences in sensitivity (e.g., discrimination and responsiveness) among HRQL measures, such as the SIP, SF-36, LSI-A, and WHOQOL-BREF, may also affect the relationship between TBI severity and HRQL scores. A more-sensitive HRQL measure often has a stronger association with TBI severity. Also, the relation can be reduced because of lack of the full spectrum of TBI severity from the study sample (e.g., people who cannot communicate over the telephone are rarely included in HRQL studies). Second, the initial severity of TBI, often assessed at hospital admission, might not be appropriate for predicting levels of HRQL among persons with TBI, partly because the assessment can be confounded by some personal attributes such as alcohol consumption (Waller, 1988). Finally, the effect of the magnitude of these factors in the relation of the HRQL with TBI severity may differ in different domains of the HRQL.

Three limitations to this study need to be highlighted. First, it may be less valid to generalize these results to all people with TBI. Fewer people with severe TBI were available or willing to give information for the WHOQOL-BREF over the telephone, and their domain scores may have differed (e.g., people with severe disabilities are usually more dependent on environmental compensation and may be more sensitive to environmental barriers). Nevertheless, the internal consistency, test-retest

reliability, and convergent and discriminant validities did not significantly differ between subjects who had GCS scores of ≤13 and those with GCS scores of ≥14 (data not shown). Second, differences in the domain scores of the WHOQOL-BREF regarding injury severity, employment status, independence in ADLs, social support, and so on can be confounded by one's preinjury psychosocial status. In other words, people who are unemployed, dependent on others for ADLs, lacking social support, and depressed might tend to have more-severe TBI and vice versa. Finally, for the WHOQOL-BREF, the impact of the telephone-administered mode has not been validated by other modes of administration, even though the telephone interviews for other HRQL measures were reported to be comparable to personal interviews and self-administration (Leidy et al., 1999; Revicki et al., 1997).

Based on subjective evaluations of one position in life, the WHOQOL-BREF is one of the very few well-constructed generic HRQL instruments, and it can enhance our ability to examine the multiple consequences of TBI, monitor short- and long-term alterations in multiple dimensions of perceived health (particularly in environmental well-being), and prioritize interventions according to their impacts on the health dimensions of these patients. Furthermore, the cross-cultural WHOQOL-BREF may facilitate international comparisons of the HRQL in persons with TBI.

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APPENDIX: WHOQOL-BREF

Q1. How would you rate your quality of life?
Q2. How satisfied are you with your health?
Q3. To what extent do you feel that physical pain prevents you from doing what you need to do?
Q4. How much do you need any medical treatment to function in your daily life?
Q5. How much do you enjoy life?
Q6. To what extent do you feel your life to be meaningful?
Q7. How well are you able to concentrate?
Q8. How safe do you feel in your daily life?
Q9. How healthy is your physical environment?
Q10. Do you have enough energy for everyday life?
Q11. Are you able to accept your bodily appearance?
Q12. Have you enough money to meet your needs?
Q13. How available to you is the information that you need in your day-to-day life?
Q14. To what extent do you have the opportunity for leisure activities?
Q15. How well are you able to get around?
Q16. How satisfied are you with your sleep?
Q17. How satisfied are you with your ability to perform your daily living activities?
Q18. How satisfied are you with your capacity for work?
Q19. How satisfied are you with yourself?
Q20. How satisfied are you with your personal relationships?
Q21. How satisfied are you with your sex life?
Q22. How satisfied are you with the support you get from your friends?
Q23. How satisfied are you with the conditions of your living place?
Q24. How satisfied are you with your access to health services?
Q25. How satisfied are you with your transport?
Q26. How often do you have negative feelings such as blue mood, despair, anxiety, depression?

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