Predictors of quality of life after moderate to severe traumatic brain injury

Preditores de qualidade de vida após trauma crânio-encefálico moderado a grave

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ABSTRACT

Objective: To verify correlations between age, injury severity, length of stay (LOS), cognition, functional capacity and quality of life (QOL) six months after hospital discharge (HD) of victims of traumatic brain injury (TBI). **Method:** 50 patients consecutively treated in a Brazilian emergency hospital were assessed at admission, HD and six months after HD. The assessment protocol consisted in Abbreviated Injury Scale, Injury Severity Score, Glasgow Coma Scale (GCS), Revised Trauma Score (RTS), Mini Mental Test, Barthel Index and World Health Organization QOL - Brief. **Results:** Strong negative correlation was observed between LOS and GCS and LOS and RTS. An almost maximal correlation was found between RTS and GCS and functional capacity and GCS at HD. Age and LOS were considered independent predictors of QOL. **Conclusion:** Age and LOS are independent predictors of QOL after moderate to severe TBI.

Keywords: brain injuries, epidemiology; quality of life.

RESUMO

Objetivo: Verificar correlações entre idade, gravidade do trauma, tempo de hospitalização (TH), cognição, capacidade funcional e qualidade de vida (QV) seis meses após alta hospitalar (AH) de vítimas de trauma crânio-encefálico (TCE). **Método:** 50 pacientes tratados em um hospital de emergência brasileiro foram avaliados na admissão, AH e seis meses após AH. O protocolo de avaliação consistia em Escala Abreviada de Lesões, Índice de Gravidade de Lesão, Escala de Coma de Glasgow (ECG), Escore de Trauma Revisado (RTS), teste Mini-Mental, Índice de Barthel e Questionário Breve de QV da Organização Mundial de Saúde. **Resultados:** Forte correlação negativa foi observada entre TH e ECG e TH e RTS. Correlação quase máxima foi observada entre RTS e ECG e capacidade funcional e ECG na AH. Idade e TH foram considerados preditores independentes de QV. **Conclusão:** Idade e TH são preditores independentes de QV após TCE moderado e grave.

Palavras-chave: traumatismos encefálicos, epidemiologia; qualidade de vida.

Trauma is considered a disease of varied aetiology and corresponds to the third cause of death worldwide, surpassed only by cardiovascular diseases and neoplasms[1]. In Brazil, it affects about one million people per year, 360,000 of them have some impairment or disability, and 120,000 of them don't survive[2].

Among the types of trauma, traumatic brain injury (TBI) stand out as the most important cause of disability among young people and a common cause of neurologic morbidity. It represents a serious public health problem with high socio-economic costs related to mortality, morbidity and disability[3]. TBI is also considered a "silent epidemic" because the vast majority of long-term disabilities remains underestimated[4].

At present, TBI is an important public health problem worldwide and traffic accidents are among the leading causes of disability and premature death. In 2005, the USA had, due to traffic accidents, a mortality rate of 29.7/100,000 inhabitants, while in European countries, the problem exists to a lesser extent: Germany presents rate of 10.5/100,000 inhabitants and Netherlands, 8.4/100,000 inhabitants[5]. According to the World Health Organization (WHO), in South America countries, increasing annual numbers of traffic accidents contribute an alarming compromise of quality of life (QOL) in those populations[5].

However, there are very few epidemiological studies about TBI in developing countries[6]. Especially in Brazil,

the few studies available have focused on hospital mortality and use of hospital resources. There are very few data about the dysfunction and impact of QOL after a TBI in Brazil[7]. Only a few small studies in Brazil have applied instruments to assess QOL in the population with TBI[8], making it difficult to evaluate which aspects may influence the outcomes of those patients. Moreover, as pointed out by some authors, patient-centred outcome research may increase our ability to translate that information into public policies for prevention, treatment and rehabilitation for TBI[9].

This study was designed to evaluate patients after TBI admitted to a public tertiary trauma centre in Brazil and to identify predictors of functional capacity and QOL six months after their hospital discharge.

METHOD

The Ethics Committee of Clinics Hospital – Faculdade de Medicina de Ribeirão Preto – Universidade de São Paulo approved this study. Written informed consent forms were obtained from all patients or legally authorized representative.

This is a longitudinal and descriptive study conducted at the emergency unit of a public university hospital, which is a tertiary referral centre for the care of TBI at Ribeirão Preto and its metropolitan area.

We evaluated 50 survivals of moderate to severe TBI, aged over 18 years who were consecutively discharged from the neurology ward of a tertiary emergency and agreed to participate in the study. The exclusion criteria were terminal illness with life expectancy less than one year determined by the medical provider; previous neurological disease with significant functional impairment and prognostic impact and cognitive inability to fill out the questionnaire administered.

Clinical evaluation was performed in three distinct stages: admission, hospital discharge and six months after hospital discharge. The data from admission were collected retrospectively from the hospital-based registry. The data from hospital discharge and six months after the hospital discharge were collected prospectively.

At admission, anatomical and physiological trauma scores were used to assess the severity of the injury and to define the extent of injury[2,10]. The physiological scores used were Glasgow Coma Scale (GCS) and Revised Trauma Score (RTS). The anatomical score used was the Injury Severity Score (ISS).

Upon hospital discharge, demographic data, the GCS, Mini Mental Test and Barthel Index were assessed. After six months of hospital discharge, a single home visit was performed to evaluate GCS, Mini Mental Test, Barthel Index and QOL.

The QOL of patients with TBI was evaluated by World Health Organization Quality Of Life – brief (WHOQOL-brief), an instrument recognized worldwide that is easy to use and understand, available and validated in Brazil[11].

It was emphasized that the questionnaire refers to the conditions of life in the last two weeks, regardless of where the individual was living. The interviewer didn't influence the patient's response nor discussed the issues or answers. If there were any questions while filling out the questionnaire administered, the interviewer read back the questions, avoiding synonymous to prevent interference with the response of the patient.

The reliability of the factors was determined by assessing the internal consistency of each one by the Cronbach's alpha technique. A factor was considered accurate if the minimum index of internal consistency was equal to or greater than 0.80[12].

Data and statistical analysis

The data were analysed using Statistical Package for the Social Sciences (SPSS) version 20.0 for Mac. The calculations of the WHOQOL-brief questionnaire were performed according to the official site: http://www.ufrgs.br/psiquiatria/psiq/whoqol4.html.

Categorical variables are described using absolute and relative frequency, and the Chi-square test was used to verify potential associations among the variables. Comparisons between the results of three or more related samples (average posts) were made using a Friedman ANOVA test (paired samples). The Wilcoxon test was used if there were no significant differences between the means. This test also assessed whether there were significant differences between mean positions for two groups while comparisons between mean positions for more than two groups were made using the Kruskal-Wallis test. The Spearman correlation coefficient was used to examine associations between variables. The Cohen's (1988) conventions were used to interpret effect size. A correlation coefficient of 0.10 was considered a weak or small association; a correlation coefficient of 0.30 was considered a moderate correlation, and a correlation coefficient of 0.50 or larger was considered a high correlation. When appropriately related to relevant hypotheses of the present study, the variables with statistically significant correlation were included in linear regression analysis. The level of significance was set at 5% ($p < 0.05$).

RESULTS

50 patients discharged from the neurological ward with moderate to severe TBI in the study period were included. They were in agreement with our inclusion/exclusion criteria. Table 1 describes the demographic and socioeconomic data of the patients.

Table 2 shows the general causes of TBI and according to age groups. Most motor vehicle accidents and cases of interpersonal violence in this study composed by victims of physical abuse (beatings) and injury by firearms occurred in younger age groups, while falls were the most common among the elderly. The presence of falls in younger age groups was small and was associated with the use of alcohol (6%), neurological convulsing diseases (2%), accidents (4%) and eventual fall (4%).

Table 1. The distribution of victims according to demographic and education data.

Variables	Number	%
Gender		
Male	44	88
Female	6	12
Race/ethnicity		
White	44	88
Black	3	6
Mullato	3	6
Age (years)		
18 - 25	14	28
26 - 35	11	22
36 - 45	10	20
45 - 55	4	8
56 - 65	6	12
66 or older	5	10
Education		
Illiterate	3	6
Incompleted primary	8	16
Completed primary	8	16
Incompleted gymnasium	11	22
Completed gymnasium	2	4
Incompleted high school	7	14
Completed high school	10	20
Incompleted college	1	2

Table 2. The distribution of victims according to demographic and etiological data.

Variables	number	%
Causes of TBI		
Automobile	16	32
Fall	12	24
Bike	6	12
Running over	6	12
Motorcycling	3	6
Physical aggression	6	12
Firearm	1	2
Causes of TBI according to age group		
15 – 25 years old		
Traffic accidents of motor vehicles	10	20
Aggressions	1	2
Accidental falls	2	4
Homicide and injuries caused intentionally by others	1	2
26 – 35 years old		
Traffic accidents of motor vehicles	9	18
Aggressions	2	4
Accidental falls	0	0
Homicide and injuries caused intentionally by others	0	0
36 – 45 years old		
Traffic accidents of motor vehicles	5	10
Aggressions	2	4
Accidental falls	3	6
Homicide and injuries caused intentionally by others	0	0
46 – 55 years old		
Traffic accidents of motor vehicles	3	6
Aggressions	1	2
Accidental falls	0	0
Homicide and injuries caused intentionally by others	0	0
56 – 65 years old		
Traffic accidents of motor vehicles	2	4
Aggressions	3	6
Accidental falls	0	0
Homicide and injuries caused intentionally by others	0	0
66 – 85 years old		
Traffic accidents of motor vehicles	2	4
Aggressions	0	0
Accidental falls	4	8
Homicide and injuries caused intentionally by others	0	0
Other lesions		
Head	50	100
Face	15	30
Neck	1	2
Chest	11	22
Column	4	8
Abdomen	7	14
Upper limbs	14	28
Lower limbs	10	20
Pelvis	1	2

TBI: traumatic brain injury.

Regarding the injured body area, it was observed that 100% of the victims showed nonspecific lesions beyond the TBI as abrasions, contusions and generalized lacerations that can't be considered a single piece body.

Concerning primary lesions arising TBI, there were observed skull fractures (22%), contusions (48%), diffuse axonal injury (26%), intraparenchymal hematoma (4%), subdural hematoma (30%), extradural hematoma (16%) and other minor injuries (12%) while in secondary lesions there was observed the brain swelling (38%). Haemorrhage was found in 24% of the victims being the intraparenchymal the most frequent followed by the arachnoid.

The length of hospitalization ranged from 02 to 133 days (median = 18.5 days), 50% of patients required admission to the intensive care unit (ICU) (mean = 15.84 SD 9.78 days) and 60% required mechanical ventilation (MV) (mean = 7.7 SD 4.74 days). In accidents involving private cars and motorcycles, the use of MV was required in 84% of cases, and 72% of these were admitted to the ICU. Of the patients undergoing MV, 16 (64%) underwent tracheotomy procedure and of these, 11 (68.75%) were discharged with tracheotomy.

According ISS, the most frequent injury classification was moderate (48%), followed by mild trauma (38%) and severe trauma (14%). The variation in scoring ISS was 5 to 35, and the mean value of 17.60 ± 8.62. Table 3 shows the results of the anatomical and functional scales according to age groups (group A: 18–85 years old; group B: 18–25 years old; group

C: 26–35 years old; group D: 36–45 years old; group E: 45–55 years old; group F: 56–65 years old; group G: 66–85 years old).

At admission, 52% of the victims had a GCS score ≤ 8 (severe TBI), whereas 80.8% of these were admitted to the ICU, while mild trauma accounted for 36% of the patients studied. In each case, the most common mechanism of injury was the motor vehicle accidents (40%) and falls (18%), respectively.

Strong negative correlation was observed between length of stay (LOS) in hospital and GCS (Spearman correlation, $p < 0.001$, $r = -0.709$). The causal relationship between these variables was confirmed by linear regression analysis ($p < 0.001$, $r2 = 0.32$) (Figure 1).

The mean RTS in the study population was 6.33 ± 1.30 (Min = 4.09; Max = 7.84). There was a strong negative correlation with statistical significance between LOS and RTS (Spearman correlation, $p < 0.001$, $r = -0.701$). A linear regression analysis confirmed the causal relationship and it is shown in Figure 2 (Linear Regression, $p < .001$, $r2 = 0.28$).

A linear regression analysis shown in Figures 1 and 2 demonstrates that the one-point increase in GCS promotes, on average,

Table 3. Results of the anatomical and functional scales according to age groups.

Groups (age range)	Number of subjects	ISS admission mean±SD (min-max)	RTS admission mean±SD (min-max)	Glasgow admission median (min-max)	BI discharge mean±SD median (min-max)	BI 6 months mean±SD median (min-max)	MMSE discharge mean±SD (min-max)	MMSE 6 months mean±SD (min-max)
Group A (18–85 years)	50	17.6 ± 8.6 (4–47)	6.3 ± 1.3 (7.8–4.0)	8 (3–15)	29.8 ± 30.1 25 (0–100)	83 ± 30.2 100 (0–100)	11.4 ± 8.5 (0–27)	23.2 ± 7.2 (0–30)
Group B (18–25 years)	14	19.7 ± 5.6 (10–30)	6.3 ± 1.3 (4.1–7.8)	8 (3–15)	29.2 ± 23.4 30 (0–65)	95.4 ± 10.5 100 (65–100)	15.4 ± 9.3 (0–27)	27.25 ± 3.3 (21–30)
Group C (26–35 years)	8	16.2 ± 9.3 (10–34)	6 ± 1.5 (4–7.8)	8 (3–14)	19.4 ± 30.8 0 (0–85)	64.3 ± 41.6 85 (0–100)	7.6 ± 8.3 (0–17)	18.7 ± 9.7 (0–29)
Group D (36–45 years)	12	21 ± 12 (5–47)	5.9 ± 1.3 (4–7.8)	7.5 (3–14)	33.75 ± 33.5 27.5 (0–100)	88.9 ± 24,6 100 (25–100)	9.9 ± 6.7 (0–17)	22.9 ± 3.9 (17–28)
Group E (45–55 years)	5	17 ± 1.73 (14–18)	5.9 ± 1.2 (4.5–7.8)	6 (5–15)	38 ± 36.8 20 (0–80)	100 ± 0 100 (100–100)	13.2 ± 9.3 (0–24)	27 ± 2.9 (23–30)
Group F (56–65 years)	6	13 ± 6.6 (5–22)	7.2 ± 1 (5.97–7.8)	13.5 (7–15)	40.8 ± 29.1 35 (10–85)	78 ± 30.9 100 (35–100)	13.3 ± 7.4 (0–20)	23 ± 5 (16–28)
Group G (66–85 years)	5	11.6 ± 8.2 (4–24)	7.2 ± 0.6 (6.6–7.8)	12 (9–15)	17 ± 38 0 (0–85)	45 ± 50.7 35 (0–100)	5.2 ± 8.3 (0–19)	14.3 ± 15 (0–30)

MMSE: Mini mental state examination; RTS: Revised trauma score; BI: Barthel index; GCS: Glasgow coma scale; SD: Standard deviation; Min: Minimum; Max: Maximum.
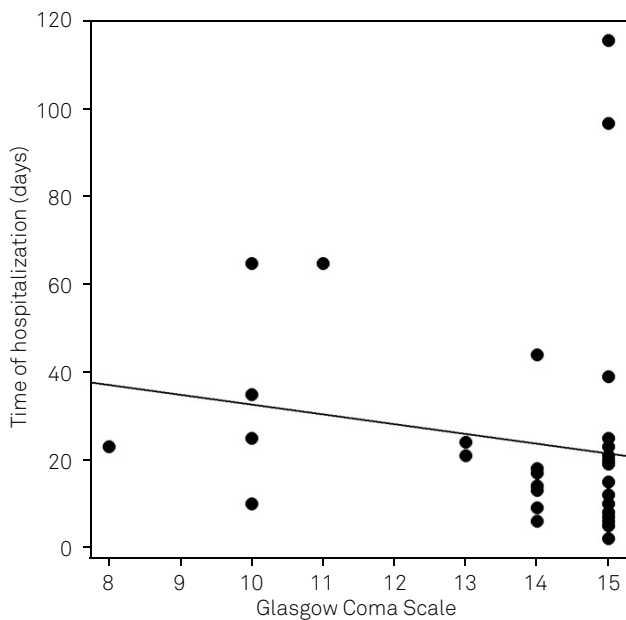
Figure 1. Linear regression analysis between the time of hospitalization and the Glasgow Coma Scale.
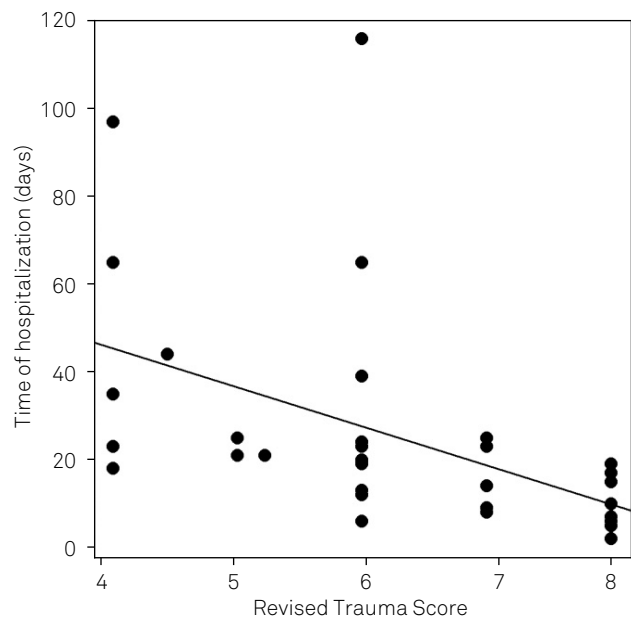
Figure 2. Linear regression analysis between the time of hospitalization and the Revised Trauma Score.

a decrease of 4.11 days in LOS, whereas the decrease of one point in RTS promotes an increase of 11.86 days in LOS.

A correlation was observed almost maximal with strong statistical significance (p < 0.001, r = -0.969) in the analysis of Spearman correlation between the RTS and GCS variables.

As expected, there was a significant improvement in the activities of daily living function (ADL) observed by Barthel Index scores after six months of hospital discharge compared with the hospital discharge scores (mean = 29.8 SD 30.1 and mean = 83.3 SD 30.2, respectively; Wilcoxon Signed Ranks Test, p < 0.001). It was also observed strong statistically significant correlation between functional capacity and GCS at hospital discharge (Spearman correlation, p < 0.001 r = 0.542), as well as a moderate correlation of the ADL function at hospital discharge with both GCS and RTS (Spearman correlation, GCS: p = 0.005, r = 0.45; RTS: p = 0.01, r =0.41).

QOL was assessed after six months of hospital discharge in 37 patients. Among the 13 excluded patients, five died, five were not found for an address change, and three showed no level of consciousness to participate in the interview (GCS <8).

The reliability of the four domains and facets was verified through analysis of internal consistency (Cronbach's alpha technique) and revealed that in all groups presented with a good level of internal consistency (higher than 0.8).

There was a moderate correlation between the cognitive state (Mini Mental test scores) with the physical and environmental domains of the WHOQOL-brief (physical domain: p = 0.03, r = 0.35; environmental domain p = 0.02, r = 0.37).

Table 4 shows the analyses of Spearman Correlation and Linear Regression of the WHOQOL-brief domains with age and length of stay. There was a moderate negative correlation of the psychological and environmental domains of the WHOQOL-brief with age (psychological domain: p = 0.04, r = -0.33; environmental domain: p = 0.02, r = -0.36), and the psychological and physical domains of the WHOQOL-brief with the LOS (psychological domain: p = 0.02, r = -0.37; physical domain: p = 0.01, r = -0.42). Further regression analysis suggested a causal relationship between those variables: psychological domain (age: r2 = 0.11, p = 0.04; LOS: r2 = 0.14, p = 0.02), physical domain (LOS: r2 = 0.11, p = 0.04) and environmental domain (age: r2 = 0.15, p = 0.02).

DISCUSSION

The relevance of this research is that it provides several epidemiological data and represents, to the best of our knowledge, the latest research on QOL with a significant sample size of patients with TBI after six months from hospital discharge developed in a Brazilian institution. Recently, in northern of Brazil, QOL was evaluated six months after the TBI event, but the aim of this study was mainly descriptive[13]. Also, other studies assessed aspects of quality of care and QOL after discharge of overall patients with trauma[1,7]. A further relevance of the present study relies on the analysis of the predictor factors of QOL in this population and on the helpful discussion for designing future studies on QOL after TBI.

In this study, it was found that the characteristics of the victims are related to the mechanisms of trauma, in which young adults engage more frequently in high-speed motor vehicle accidents, while the elderly, in falls, which corroborates the literature[14,15]. Also, the physiological condition on RTS was similar to data from another study that found a score greater than six[16]. These higher scores, i.e. less severe lesions, can be explained by prevention campaigns of the competent bodies as mandatory use of safety equipment and guidelines regarding the risk of accidents caused by the combination of direction and alcohol consumption. However, these data should be weighted, because the determination of respiratory rate, one of the components of the RTS, is influenced by patients' age, mechanism of injury, and mechanical ventilation[9]. Moreover, we observed that the worst RTS' scores (values between three and four) were associated with motor vehicle accidents and the best (values above seven) with falls.

The severity of TBI analysed by both the GCS and the RTS was found as predictive factors for LOS. Although some studies don't consider the values of GCS and RTS as valid predictors of LOS[17], most of the previous studies have observed that the GCS is a useful tool in prediction models of TBI outcomes[18,19]. More recently, it was demonstrated that the motor component of the GCS together with pupillary reactivity provide a simple and feasible score to stratify the severity of patients with TBI, contributing to the early definition of prognosis and most appropriate intervention for neuroprotection[20]. Also, it was noted that the RTS has been assessed as

Table 4. Results of the correlation and linear regression analyses between the domains of WHOQOL-brief with age and length of stay.

Dependent variable	Independent Variable	Spearman Correlation	Linear Regression				
		p-value (r)	95%CI	Alpha	Beta	p-value	R²
Psychological domain	Age	0.04 (0.33)	0.14 to -0.01	15.61	0.33	0.04	0.11
	LOS	0.02 (0.37)	-0.91 to -0.01	17.41	0.80	0.02	0.14
Environmental domain	Age	0.02 (0.36)	0.12 to -0.01	16.30	0.06	0.02	0.15
	LOS	p = 0.17 (-0.23)	NA	NA	NA	NA	NA
Physical domain	Age	p = 0.22 (-0.20)	NA	NA	NA	NA	NA
	LOS	0.01 (0.42)	-0.09 to -0.01	15.81	0.05	0.04	0.11

CI: confidence interval; LOS: length of stay; NA: not analyzed.

a useful scale to predict mortality, trauma severity and LOS in patients with polytrauma[21]. Thus, the results of these assessments can directly determine the LOS.

Nowadays, many tools have been created with the aim of assessing the physical, mental and social-related QOL, and to evaluate the impact of a disease on this[22]. Within this reality, we decided to use the WHOQOL-brief because it is a free access instrument, available in twenty languages and have good psychometric qualities. More recently, a multidisciplinary expert group on TBI recommended the WHOQOL as a good patient-centred outcome measure for this population[23]. Most recently, a systematic review of studies on QOL after TBI reported that WHOQOL-brief showed positive results, but further evidence is limited[24].

Relevant findings of the present study were that age and LOS are predictors of perceived QOL. The relationship observed that the higher the age, the better the QOL perceived by the patient corroborates with other studies that emphasized the impact of normative perceptions while aging on health[25]. According to these authors, older adults with TBI may consider the changes in their health or their symptoms as consequences of the aging process, rather than being caused by their TBI. In contrast, younger adults have a satisfactory health and when compare themselves with their healthy and age-matched peers may be more capable of perceiving changes in their health.

The relationship observed that the higher the LOS, the worse the QOL can be explained by the fact that the LOS reflects the injury severity effects that are not well tapped by GCS or RTS, i.e., the LOS may be the result of several severity-related factors and, thus, directly influence the QOL. The LOS can also be an indicator of the seriousness of other comorbidities and/or concomitant injuries that affects the QOL negatively after the hospital discharge in patients with TBI[26].

In the present study, the functional capacity wasn't correlated with QOL, which is contradictory to the results found previously[27]. It is likely that this difference may have occurred due to the restricted sample studied and may indicate the need to use more sensitive instruments such as Functional Independence Measure (FIM), the Glasgow Outcome Scale Extended (GOSE), and the Disability Rating Scale (DRS) [23,28,29,30].

Limitations of this study must be borne in mind when interpreting these results and for designing future studies on QOL after TBI. Although the population with TBI admitted to our tertiary emergency hospital during the study period was large, analyses were limited to inpatients only from the neurology ward and capable of filling out the questionnaire administered six months after the hospital discharge, which restricted the sample size. Thus, our results may not apply to more cognitively impaired participants. Furthermore, the results found in our sample reflect the characteristics of the population admitted to the neurology ward. Therefore, findings may not generalize to those with mild TBI who do not receive inpatient care in the neurology ward, or to those with very severe TBI who are treated in long-term nursing facilities. Further investigation with a larger sample size and path analysis modelling is required. Besides, the use of sample with a homogeneous severity of TBI will provide better conditions to evaluate the impact of the traumatic event on QOL.

The present study represents a pioneering analysis of the QOL of patients who have suffered TBI in Ribeirao Preto and its administrative area, and shows the importance of trying to optimize assistance to the population victim of trauma not only in order to improve QOL, but also to reduce hospital costs. Consequently, our results and interpretations add one more factor in judging the cost-effectiveness of therapeutic strategies, and will contribute to future studies conducted at tertiary emergency units.

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