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Prediction of quality of life by Helsinki computed tomography scoring system in patients with traumatic brain injury

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ABSTRACT

Purpose: The aim of this study is to assess the association between the Computed Tomography (CT) findings on admission, according to the Helsinki computed tomography CT score, and patient's Quality of Life (QoL) following traumatic brain injury (TBI) in Lebanon.

Methods: A retrospective study was performed on 49 males suffering from war induced TBI. Participants were stratified into two groups based on the date of injury. Helsinki CT score was calculated for CT scans of participants. Outcomes were assessed using QoL scales including the Project for the Epidemiological Analysis of Critical Care Patients scale (PAEEC).

Results: Correlation analysis showed that QoL, up to 4 years post-TBI, was significantly associated with Helsinki CT classification. Group 1 of subjects living with TBI for 1–2 years revealed a correlation coefficient r = 0.536, *p*-value = 0.027, whereas, group 2 including subjects who are injured since 3–4 years, had a correlation coefficient r = 0.565, *p*-value = 0.001.

Conclusion: The present study showed that patients with traumatic brain injury experienced significant quality of life deterioration up to 4 years post-TBI. Our findings propose the important role of Helsinki score in predicting the quality of life among patients with TBI.

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Traumatic brain injury; Helsinki CT score; project for the epidemiological analysis of critical care patients; Lebanon

Introduction

Traumatic brain injury (TBI) is an adjustment in the normal function of the brain due to implemented external forces (1,2). It is identified as the most severe and disabling injury threatening the global public health (2,3).

Patients with TBI often undergo computed tomography (CT) scan upon initial admission to the emergency department in order to facilitate the assessment procedures and have quick access to medical intervention. It is recognized as the "gold standard" diagnostic modality in evaluating cranial and intracranial abnormalities following head trauma (4). In order to quantify and apply systematic measuring for the pathological alterations following TBI, CT classification systems are used (5). One of these classification systems and the most recent one is the Helsinki CT scoring system (6). Several studies assessed the use of Helsinki CT score and demonstrated that it has good specificity and sensitivity in predicting TBI outcomes as it exhibits a "discriminative power" for mortality following TBI (7,8).

TBI severity classification depends on several factors such as anatomical location, duration of the symptoms and clinical presentation which can vary from altered mental status, coma, physical weakness, paralysis and aphasia (1). Permanent deficits can be noted in patients with head trauma leading to persistent physical, cognitive, psychosocial and linguistic problems (9–11). QoL post-TBI is influenced by the severity of injury (12). Some studies indicate that QoL, following TBI, is impaired and deteriorated (12–14). Hence, emphasizing the importance of evaluating QoL in TBI individuals to enhance recovery and life satisfaction.

QoL scales measure the subjective impression of patients regarding their own health, when compared with objective clinical scales of physical functioning (10). Several measures targeting Qol, following TBI, are implemented within research and community services. The Short Form health Survey 36 (SF-36) is one of these scales, that is commonly used and widely spread among patients post-TBI (15). This scale has been validated and adapted to the Lebanese population by Sabbah et al. (16). However, SF-36 is considered a generic instrument for measuring QoL, so, using it in combination with an additional disease-specific scale is recommended (17).

Another QoL scale that is used generally among "critically ill" patients, more specifically among population with brain injury is The Project for the Epidemiological Analysis of Critical Care Patients (PAEEC) QoL scale (18). The PAEEC is a validated tool in Spain and is used among patients with brain injury. It presented high internal consistency (Cronbach's alpha = 0.85), as well as, excellent inter-observer (0.92) and intra-observer (0.92) reproducibility (18). Moreover, the PAEEC exhibited noticeable reproducibility among patients and families (0.92) with high reproducibility when using telephone and face-to-face interviewing (0.96); also, the factorial analysis indicated 3 components of PAEEC reflecting its 3 subscales (18).

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Therefore, the aim of this study is to assess the ability of the cranial CT scan scoring system to predict the quality of life in Lebanese patients with brain injury.

Materials and methods

Study design and participants

This is a retrospective observational study conducted from December 2018 till June 2019 in Lebanon. 49 patients with TBI were recruited from three Specialized Rehabilitation Centers.

Inclusion and exclusion criteria

Eligible subjects were Lebanese participants diagnosed with TBI confirmed by a CT scan on admission. Participants over 18 years of age were included, with TBI sustained for more than 1 year but not exceeding a period of 4 years. Within this Study eligible patients with TBI were recruited despite the cause or severity of the injury. Patients with no confirmatory CT scans were excluded, as well as subjects sustaining old injuries for a period of more than 4 years.

Sample size

Germany software, the G-Power version 3.0.10, was used for the sample size calculation. The required sample size was computed based on the results reported by a previous study (14). The following parameters were used: an effect size (r) of 0.4, an assumed two-sided significance of 5% and a power of 80%. This produced a total minimal sample size of 44 participants. Thus, a convenient sample size of 49 patients with TBI were recruited within this study.

Procedure

Participants were stratified according to the date of injury and divided into 2 different groups the first being 1–2 and the second 3–4 years post-TBI. Upon the recruitment of eligible subjects and after explaining the study objectives, participants were interviewed face-to-face by two specialists in a standardized manner. Participants enrolled in the study signed a written informed consent explaining the aim of the study while emphasizing their right to refuse participation. If the patient was not aware, caregivers signed the consent.

A neurosurgeon reviewed all the CT scans of patients with TBI and the Helsinki CT score was calculated on the spot. Moreover, questionnaires including the socio-demographic information, the Arabic versions of the SF-36 and the PAEEC questionnaires, with a total of 7 pages were filled by the participants. For those who were not able to answer because of language disabilities, a speech and language therapist helped them complete the forms, with the assistance of their caregiver. However, for few numbers of patients with altered awareness and restricted comprehension skills, caregivers were asked to complete the targeted questionnaires. The order of the assessment measures was counterbalanced across participants to ensure the control of order effect.

Assessment measures

The measurement scales included: the socio-demographic questionnaire, the Helsinki Computed Tomography Scoring System, the Short Form Health Survey 36 and The Project for the Epidemiological Analysis of Critical Care Patients.

The socio-demographic questionnaire

The language used in the questionnaire was Arabic. It covered three main categories, defining general personal information, socio-economic level and medical history of the patients, in addition to the measurement scales. The general personal information included the participant's age, gender, marital status, address, and education. As for the socio-economic level, it contained employment status and monthly income. In addition, the medical history was documented to include detailed information concerning date of injury, cause of injury or pathology, site of injury and physical consequence.

Pilot Testing of the Questionnaire.

The questionnaire was pilot-tested on a sample of 20 patients with TBI to determine the clarity, coherence and intelligibility of the generated items. Patients exhibiting good comprehensive and expressive language skills were chosen. Participants completed the questionnaire, time was recorded, and face-to-face interviewing was established after completion. However, participants did not report any problems or ambiguity in understanding the items as they took an average of 3 to 4 minutes for completing the questionnaire.

The Helsinki computed tomography scoring system

The Helsinki CT score was first established in 2014 by Raj R (6). It is a trauma scoring system with enhanced prediction of outcomes in patients with TBI (7). It is calculated based on four main variables that include the lesion type and volume, presence of intraventricular hemorrhage and status of suprasellar cisterns, as shown in Table 1 (6). Regarding the type, a subdural hematoma (SDH) is scored 2, an intracerebral hematoma is scored 2, whereas, an epidural hematoma is scored −3. As for the volume, any hematoma volume greater than 25 cm^3 is scored 2. Moreover, if intraventricular hematoma (IVH) is present a score of 3 is added. Finally, regarding the suprasellar cistern, normal, compressed and obliterated statuses are scored, respectively, by 0, 1 and 5. The obtained scores of the CT are summed up to get a score ranging between −3 and 14. When the score increases, the outcome is worse (6). Figure 1 represents the CT Scan of a patient with TBI with the appropriate Helsinki score calculations.

At a cutoff value of 4.5, the Helsinki CT score showed good psychometric characteristics with a specificity of 74.6%, a sensitivity of 74.1% and an accuracy of 74.5% for mortality (8). For the unfavorable outcomes, the specificity, sensitivity and accuracy were 81.2, 56.8 and 71.5%, respectively (8). In order to use the Helsinki CT score within our study, permission was granted from the initial author.

The Project for the Epidemiological Analysis of Critical Care Patients (PAEEC)

PAEEC is a specific QoL questionnaire developed for patients in need of "critical care" in The Project for the Epidemiological

Table 1. The Helsinki CT scoring system.

Variable	Score
Mass lesion type(s)	
Subdural hematoma	2
Intracerebral hematoma	2
Epidural hematoma	−3
Mass lesion size >25 cm^3	2
Intraventricular hemorrhage	3
Suprasellar cisterns	
Normal	0
Compressed	1
Obliterated	5
Sum score	**−3 to 14**

Table reprinted from Raj et al. Neurosurgery 2014;75:632–46; Permission was obtained from the author.

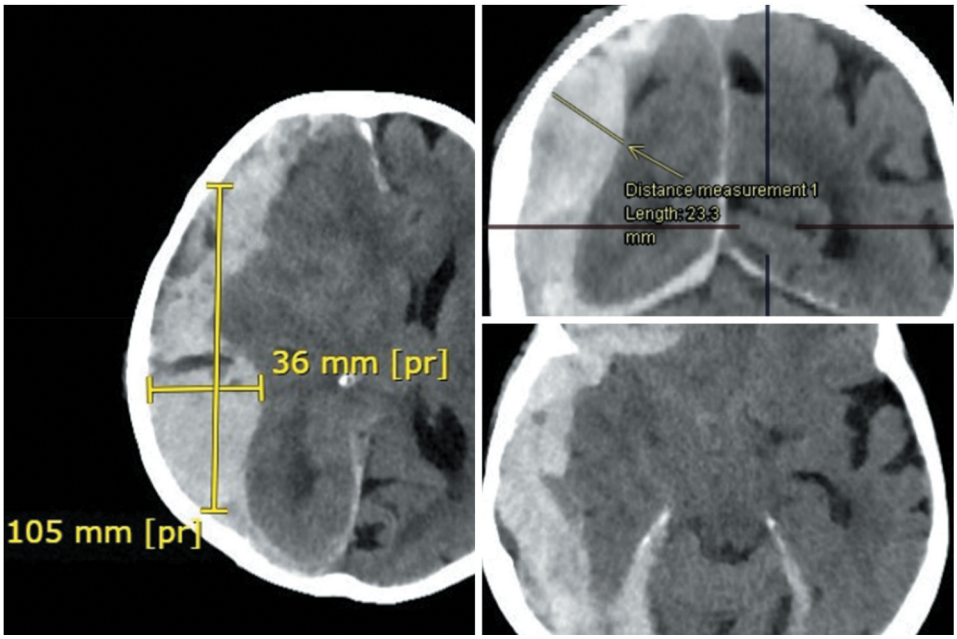

Figure 1. CT Scan of a patient with TBI with the appropriate Helsinki score calculations.
Helsinki score: Mass lesion as SDH: 2 points, Mass lesion size > 25 cc: 2 points, IVH: none, Basal cisterns are compressed: 1 point, Sum: 5.

Analysis of Critical Care Patients (18). It was initially proposed, in 1996, by Fernandez et al. (18). PAEEC is a validated QoL tool among the Spanish population and is used among patients with brain injury (14,19,20). Studies indicated that the results of the PAEEC questionnaire parallel those of the Glasgow Outcome Scale and it is documented to capture changes for follow-up procedures (18).

The PAEEC is composed of three subscales assessing normal physiologic activities, normal daily activities and emotional states, during the 2 months before its administration (18). The first subscale targets the oral communication, feeding process, as well as, bladder and bowel control (18). Moreover, the second subscale evaluates effort capacity, the ability of dressing up, mobility, executing fine movements, fulfilling work or activities and the involvement in social relationships (18). As for the third subscale, it assesses emotions and subjective impression regarding health (18). The total range score of the first, second and third subscales are 0–9, 0–15 and 0–5, respectively; the scoring of the three subscales are added up to establish the baseline QoL score ranging between a minimum of 0 and a maximum of 29, with increasing scores indicating worse QoL (18). Furthermore, permission and approval were taken from the initial author to translate and utilize the PAEEC within our study.

The PAEEC was translated independently by two independent professionals who are Lebanese native speakers. The first was a sworn translator without any medical background and the second one was a speech therapist. The two obtained Arabic versions were discussed and compared in a structural manner in order to resolve discrepancies; a unified Arabic version of the PAEEC was proposed. Two back translations were carried out by two English speakers who were blinded to the original English version. Both of the back-translated versions were compared to the original English version to indicate appropriate reproducibility of the scale items.

In order to assess clarity, comprehensibility and adaptability of the Arabic PAEEC, 20 patients with TBI were asked to complete this scale; the patients chosen for pilot testing presented good comprehensive and acceptability of the scales' items.

Ethical considerations

The study protocol was reviewed and approved by the scientific committee of the Neuroscience Research Center (NRC), Faculty of Medical Sciences at the Lebanese University. Researchers and field worker conducted the study according to the research ethics guidelines laid down in the Declaration of Helsinki of the World Medical Association Assembly (21).

Statistical analysis

Data entry and analysis were performed using the statistical software SPSS version 23.0. Descriptive statistics were reported using means and standard deviations (SD) for continuous variables and frequency with percentages for categorical variables. Normality of data was assessed using Shapiro-Wilk test. Mann–Whitney U test was used to compare means of two categories. Spearman correlation was used to correlate the continuous variables of non-normal distribution. A simple linear regression to study the linear relationship between the dependent variable Y and one independent variable X was performed. It is defined by the equation $Y = a + b \times X$. Thus, we would be able to estimate and predict the PAEEC score (dependent variable) from the Helsinki score (independent variable). All statistical tests were two-sided, and the significant level was set at 0.05.

Results

Sample characteristics

Table 2 represents the socio-demographic characteristics of our sample. The sample included 49 participants of males suffering from TBI due to war and explosions. The mean age of the participants was 31.9 ± 10.24, with a minimum age of 20 years and a maximum age of 59 years. Almost half of the participants were from Mount Lebanon (46.9%), whereas, the other half were distributed across other districts as follows: South (32.7%), Bekaa (16.3%) and Beirut (4.1%). Regarding their marital statuses, 71.4% of our sample were married and 28.6% were single. In addition to that, 65.3% of the participants had 1 to 12 years of education, while 34.7% had studied for more than 12 years. Moreover, concerning the employment status of the participants, the vast majority were unemployed (69.4%). Some (12.2%) were freelancers, 10.2% had a full time job, while 8.2% were part timers.

Outcome scores of participants

Table 3 represents the outcome scores of our participants on the different assessment measures performed. Our participants are stratified into two groups on the basis of the injury date, with groups 1 and 2 representing subjects with TBI for 1–2 and 3–4 years, respectively.

As mentioned before, the cutoff value of the Helsinki CT score is documented to be 4.5 points (8). When compared together, groups 1 and 2 exhibited different levels of severity on the Helsinki CT score; so that, group 1 showed mild brain injury by average (2.53 ± 2.29), while group 2 presented moderate one (4.75 ± 2.02), with p-value < 0.05.

For the QoL assessment, the PAEEC and SF-36 questionnaires were utilized. The mean totals of the PAEEC were 9.76 ± 7.32 and 10.97 ± 7.33 points for groups 1 and 2, respectively, which translates into significant deterioration in QoL among both groups (0 is the best score and 29 the worst score). Concerning the basic physiological activities, both, groups 1 and 2 showed decline, with scores of 1.94 ± 2.46 and 1.75 ± 2.41, respectively. Also, mean scores on normal daily activities revealed reduced performance among both groups. Moreover, the emotional states of both groups are considered impaired, with greater mean score among group 2. As for the SF-36, participants among both groups exhibited severely lowered scores on the physical and mental components, taking into consideration that it is scored from 0 to 100 and higher scores indicate better performance. Comparison

Table 2. Socio-demographic characteristics of participants.

	Frequency (n)	Percentage (%)
Gender	49	100
Male	0	0
Female		
Geographic region	2	4.1
Beirut	23	46.9
Mount Lebanon	16	32.7
South	8	16.3
Bekaa		
Marital status	14	28.6
Single	35	71.4
Married		
Educational level	32	65.3
1 to 12 years	17	34.7
>12 years		
Employment status	34	69.4
Unemployed	6	12.2
Free work	4	8.2
Part-time work	5	10.2
Full-time work		
	Mean ± SD[a]	
Age	31.90 ± 10.24	

[a]Standard deviation

Table 3. Outcome scores of participants.

	Group 1 (1–2 years) N = 17	Group 2 (3–4 years) N = 32	
	Mean ± SD[a]		*p*-value
Helsinki CT score	2.53 ± 2.29	4.75 ± 2.02	0.003*
PAEEC[b] total score	9.76 ± 7.32	10.97 ± 7.33	0.56
Subscale 1 [c]	1.94 ± 2.46	1.75 ± 2.41	0.48
Subscale 2[d]	6.18 ± 4.35	6.94 ± 4.57	0.50
Subscale 3[e]	1.65 ± 1.46	2.28 ± 1.55	0.17

Mann-Whitney U test; * *p*-value < 0.05 is significant
[a]Standard deviation; [b] Project for the Epidemiological Analysis of Critical Care Patients quality-of-life questionnaire; [c] Basic physiological activities; [d] Normal daily activities; [e] Emotional state

between means of groups 1 and 2, across all subtests of PAEEC and SF-36, demonstrated no significant differences with *p*-values > 0.05.

Correlation analysis

Relationship between CT scan findings and QoL

The relationship between the Helsinki CT score, quantifying the CT findings, and the PAEEC QoL questionnaire among group 1 is shown in Table 4. Statistically significant correlation was demonstrated among the total score of the PAEEC and the Helsinki CT score, with r = 0.536 and a *p*-value = 0.027. Moreover, the results indicated a strong relationship between CT findings and basic physiological activities subscale (r = 0.714, *p*-value = 0.001). On the other hand, no correlation was documented among Helsinki CT score, the normal daily activities and emotional state of participants living with TBI for 1–2 years.

Among group 2, the association between the CT findings and QoL is displayed in Table 5. The results showed significant correlation among the Helsinki CT score and the total score of the PAEEC (r = 0.565, *p*-value = 0.001). Also, similar significant results were found between CT score, basic physiological activities and normal daily activities subscales, with r = 0.501, *p*-value = 0.005 and r = 0.625, *p*-value < 0.001, respectively. However, no correlation was found among CT score and emotional state subscale.

Finally, a simple linear regression analysis was conducted to evaluate the prediction of PAEEC score from the Helsinki CT score on admission (Figure 2). Our data showed that there is an important relationship between Helsinki score on admission and QoL of patients with TBI after 4 years (*p*-value<0.001). Helsinki score provides significant information for predicting the QoL of patients with TBI. Patients with higher Helsinki score have worst QOL after 4 years. The coefficient of determination (R-squared) = 0.278 which means 27.8% of the variance in the PAEEC score is due to Helsinki score. The regression equation for predicting the writing score is:

*PAEEC score = 4.05 + 1.63*Helsinki score*

Discussion

The consequences of TBI are well documented in literature. They might include cognitive linguistic impairments (9,22), physical disabilities (23) and psychiatric disorders (24–27). Not only does TBI impose functional limitations on patients, but also it affects their social integration, socio-economic status (28–30) and eventually life satisfaction and QoL (12,31,32). From here comes the importance of considering the prediction of such outcomes. Therefore, the utilization of an early prediction tool is pivotal to promote identification of possible injury consequences; an example of such tool is the Helsinki CT score that is recommended for evaluating the severity and outcomes of brain injury (7,8). Thus, CT scan quantification can aid in the anticipation of long-term QoL.

In the present study, the relationship between CT findings and QoL post-TBI using the Helsinki CT score, the PAEEC and SF-36 QoL questionnaires was investigated. Results provided evidence that QoL outcomes for patients with TBI were related to CT findings on admission. In this study, it was found that QoL up to 4 years post-TBI was associated with abnormalities identified on CT images, with increasing severity of abnormalities reflecting worse QoL. The present study demonstrated that patients living with TBI for 1–2 years (N = 17) experienced QoL deterioration with a total PAEEC score of 9.76 ± 7.32 (0 is the best score and 29 is the worst score). Such results are similarly stated in a Spanish study, published in 2016, assessing the relationship between CT findings, using the Marshall CT

Table 4. Correlation between Helsinki CT score and QoL among group 1.

	Group 1 (1–2 years) N = 17			
Scores Correlation	PAEEC[a] total score	Subscale 1[b]	Subscale 2 [c]	Subscale 3[d]
Helsinki CT score	r = 0.536 *p*-value = 0.027*	r = 0.714 *p*-value = 0.001*	r = 0.429 *p*-value = 0.086	r = 0.209 *p*-value = 0.420

Non-parametric Spearman Correlation; * *p*-value < 0.05 is significant
[a]Project for the Epidemiological Analysis of Critical Care Patients quality-of-life questionnaire; [b] Basic physiological activities; [c] Normal daily activities; [d] Emotional state

Table 5. Correlation between Helsinki CT score and QoL among group 2.

		Group 2 (3–4 years) N = 32		
Scores Correlation	PAEEC[a] total score	Subscale 1[b]	Subscale 2 [c]	Subscale 3[d]
Helsinki CT score	r = 0.565 *p*-value = 0.001*	r = 0.501 *p*-value = 0.005*	r = 0.625 *p*-value < 0.001*	r = 0.075 *p*-value = 0.684

Non-parametric Spearman Correlation; * *p*-value < 0.05 is significant
[a]Project for the Epidemiological Analysis of Critical Care Patients quality-of-life questionnaire; [b] Basic physiological activities; [c] Normal daily activities; [d] Emotional state

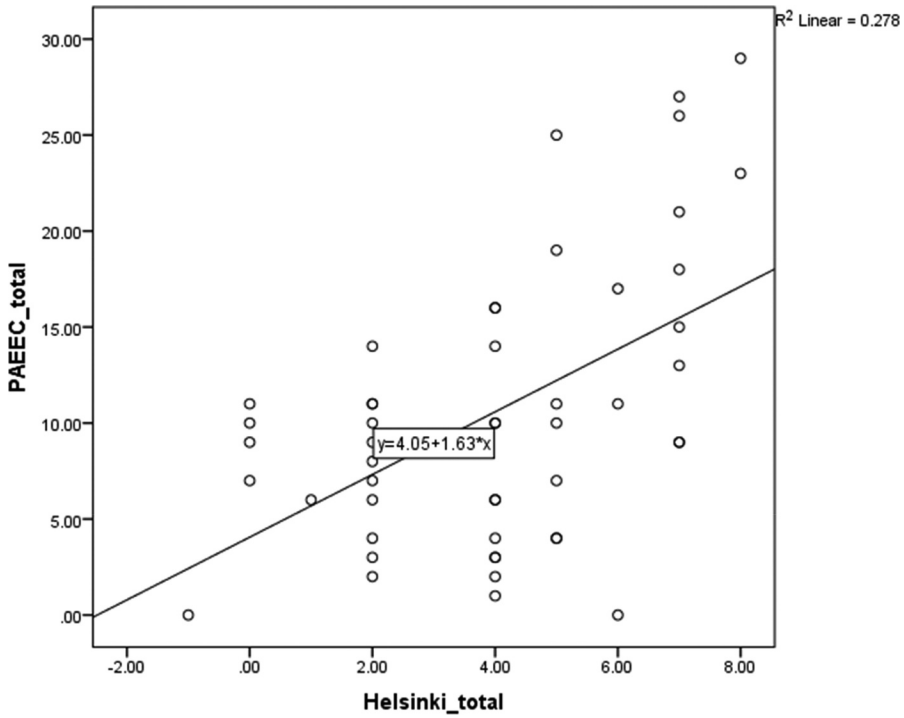

Figure 2. A scatter plot and the corresponding regression line and regression equation for the relationship between the dependent variable PAEEC score and the independent variable Helsinki score. R-squared linear = coefficient of determination.

score, and QoL among a population of 531 patients with TBI; they reported that 1 year post-TBI their sample scored an average of 9.44 on total PAEEC, along significant association with CT abnormalities (14). The current findings replicated the results of several studies indicating QoL decline 1 year post-TBI; however, they used different QoL measuring tools. For instance, a study, conducted on 996 survivors with TBI in Netherlands, stated that patients with 1 year post-injury with moderate and severe injuries exhibited decline in QoL (33). Another study, done in an outpatient rehabilitation setting on 100 patients with mild TBI, demonstrated similarities with our study in terms of lowered QoL; also, they proposed that QoL after 1 year was related to age, unemployment and educational level (34). Moreover, a previous study analyzing QoL after 2 years in 351 patients that are poly-traumatized concluded similar results as ours (35).

The results of the present study indicated that group 2, comprising patients living with TBI for a period of 3 to 4 years (N = 32), showed lowered QoL. A recent study conducted in France mentioned that QoL 4 years post-TBI is deteriorated and influenced strongly by mood and cognition, with no significant association with age, gender or educational level (12). Another study, in Spain, aimed to assess QoL after 4 years of TBI, using PAEEC questionnaire, on a sample of 238 participants and concluded that survivors with TBI experienced moderate deterioration in QoL, with a PAEEC mean score of 6.77 points (20). However, when they stratified their sample according to injury severity, groups with severe injuries scored higher on PAEEC (0 is the best score and 29 is the worst score); according to Marshall CT classification, patients with diffuse injury types III and IV scored 9.05 and 13.71 points on PAEEC mean score (20), which can support our results.

Taken together, such results provide strong evidence in support of the fact that this study provided valuable information regarding the association between CT findings and QoL among population with TBI in Lebanon. Thus, it is highly important to consider QoL following TBI as they can impact life satisfaction and social functioning.

Strengths and limitations

To the best of our knowledge, this is the first study conducted to assess the association between the CT findings on admission, according to the Helsinki CT score, and patient's QoL among

individuals with TBI in Lebanon. Studies targeting this population are null in our country and extremely scarce in the Arab area. Findings of the present study should be considered in light of several limitations. Firstly, the representativeness of the sample size. This is a retrospective observational study from three specialized neuro-rehabilitation centers located in Beirut, South and Bekaa areas; so, the socio-demographics and socio-economic statuses of participants may not necessarily reflect those of all Lebanese subjects with TBI; thus the results may not be generalized. Secondly, the limited number of epidemiological studies and records of population-based data on Lebanese population with TBI, hence, measures of prevalence and incidence of TBI are missing. Another drawback is the fact that hospitals and medical centers do not preserve rigorous medical records for patients with TBI during primary hospitalization and rehabilitation phases and the lack of TBI registry in tertiary hospitals. Altogether, such problems constituted an obstacle in the way of recruiting the targeted number of participants and lengthened the period of data collection. Therefore, for the above-mentioned reasons and in addition to the lack of proper traumatic brain injury centers and lack of adequate follow ups, data could not be extended to include a multi-center collection process. Thirdly, all the participants were men. Lebanon is located in a geographical area of war conflict. This fact reflected the results indicating that all the participants suffering from war induced TBI were males. In addition, women in the Lebanese culture are usually involved in household activities and in relatively non-dangerous jobs leading to lower risks of TBI. Fourth, the participants were not stratified according to the severity level of the injury. Some studies have reported that patients with TBI, mainly severe injuries lacked awareness and thus reflected low QoL; however, patients with milder forms of TBI ranked better on QoL questionnaires with promising functional outcomes, due to enhanced self-awareness and motivation (36). Fifth, the PAEEC questionnaire is not validated among the Lebanese population. Hence. the correlation between the results of PAEEC questionnaire and another validated QoL scale in Lebanon, which is the SF-36, was assessed in order to make sure that the results obtained by PAEEC are reproducible and truly reflected by another reliable scale.

Finally, the CT scans, collected from patients' record files during initial hospital admission, were performed in various hospitals across Lebanon, through different CT machines. However, the results of the Helsinki CT score are documented in literature to be reproducible and reliable (7,8). Although different limitations were apparent, this study delivered promising information regarding QoL of patients with TBI, which can constitute a starting point for several subsequent studies. This novel study is the first to assess the QoL in subjects with TBI and draw associations with a CT scan scoring system in the Arabic society. This manuscript will encourage the different Arab governments to implement a CT score system during initial hospital admission for patients with TBI, implementing appropriate and suitable measurements to reduce the undesired long-term outcomes of the injury.

Conclusion

This study is the first initiative in Lebanon as it evaluates the relationship between CT findings and QoL post-TBI. The results showed promising findings suggesting significant associations among the targeted variables. We concluded that patients with TBI experienced important deterioration in QoL up to 4 years following injury, defined by the severity of injury. One of the key factors in boosting QoL is managing the psychosocial outcomes associated with the injury, such as unemployment and financial status. Therefore, considering measures targeting their inclusion within the occupational fields is vital. The government and organizations should consider employing such individuals in suitable jobs in order to promote their productivity and enhance their socio-economic status which in turn improves their QoL.

Finally, since this is the first study to evaluate such association among Lebanese population with TBI, further investigation is needed on a larger sample size, including both genders, in order to be able to generalize our results.

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Declaration of interest statement

No conflict of interest was declared.

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