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Differences in health-related quality of life, neuropsychological functions and emotional state between children and adolescents with mild traumatic brain injury and healthy controls

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Abstract: Little is known about the impact of mild traumatic brain injury (TBI) on the functioning of children in Latin America, especially regarding a broad construct called health-related quality of life (HRQoL). The objective of this study was to analyze the differences in HRQoL, neuropsychological functions and emotional state between a group of children and adolescents with mild TBI and a healthy control group. A case-control study was conducted in which 30 children and adolescents with mild TBI and their parents and a group of 30 healthy subjects participated. The results showed that participants with mild TBI had an HRQoL similar to the one of the general population of the same age and sex. At the cognitive level, the group with mild TBI had a lower processing speed and less work done in selective and sustained attention tasks; at the emotional and behavioral level, they exhibited more symptoms of anxiety, depression, withdrawal and social problems.

Keywords: Traumatic brain injury; health-related quality of life; neuropsychological functions; emotional state.

Diferencias en la calidad de vida relacionada con la salud, las funciones neuropsicológicas y el estado emocional entre niños y adolescentes con daño cerebral traumático leve y controles sanos

Resumen: Se sabe poco sobre el impacto del trauma craneoencefálico (TCE) leve en el funcionamiento de los niños en Latinoamérica, especialmente en un constructo amplio denominado calidad de vida relacionada con la salud (CVRS). El objetivo de este estudio fue analizar las diferencias en la CVRS, las funciones neuropsicológicas y el estado emocional de un grupo de niños y adolescentes con TCE leve y un grupo control sano. Participaron 30 niños y adolescentes con TCE leve y sus padres, y un grupo de 30 sujetos sanos. Los resultados evidenciaron que participantes con TCE leve percibieron una CVRS similar a la población general de la misma edad y sexo. A nivel cognitivo el grupo con TCE leve tuvo una menor velocidad de procesamiento y cantidad de trabajo realizado en tareas de atención selectiva y sostenida; y a nivel emocional y conductual presentó mayor nivel de síntomas de ansiedad, depresión, retraimiento y problemas sociales.

Palabras clave: trauma craneoencefálico; calidad de vida relacionada con la salud; funciones neuropsicológicas; estado emocional.

Introduction

Traumatic brain injury (TBI) is one of the main causes of pediatric morbidity and mortality and is the most common cause of acquired disability in childhood (Arango-Lasprilla et al., 2012; Arango-Lasprilla et al., 2007; Au & Clark, 2017; Petersen et al., 2008). The incidence of TBI has increased in the last 10 years in Colombia; it is often a

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result of automobile accidents and of social factors specific to the country (Quijano et al., 2010).

In general, there is consensus that the consequences of brain damage caused by TBI in childhood are very broad (Au & Clark, 2017) and that those who survive moderate and severe TBI often have to cope with long-term physical and psychological sequelae (Kotch & Allen, 2019; Resch et al., 2019). However, the specific long-term problems that mild TBI can cause have only been addressed recently, and the results of these studies are contradictory (Duhaime et al., 2012; Jones et al., 2019; Shultz et al., 2016; Staab & Powell, 2019).

Studies on patients with mild TBI suggest that some recover quickly and can return to daily activities, while there are people who continue to exhibit problems (Duhaime et al., 2012; Fineblit et al., 2016; Jones et al., 2019; Lambregts et al., 2018; Shultz et al., 2016). In the case of children and adolescents, recovery may take longer than in adults; some experience persistent residual symptoms for more than 1 to 3 months and are diagnosed with postconcussion syndrome (Cancelliere et al., 2014; Hung et al., 2014). The sequelae of TBI can manifest at multiple levels, causing a variety of deficits that are different for each individual and can affect functionality in daily life, academic, social and/or work activities (Au & Clark, 2017; Duhaime et al., 2012; Jones et al., 2019; Shultz et al., 2016).

A systematic review of 30 studies published between 1990 to 2014 of psychological, psychiatric and behavioral outcomes of children following mild TBI compared to a control group conclude that while the evidence is mixed, the vast majority of children recovery quickly with a small proportion of children displaying persistent problems. The problems most commonly described in the reviewed papers after mild TBI were attention problems and behavioral and emotional problems (i.e., hyperactivity, disruptive behaviors, oppositional defiant disorders, depression, anxiety, post-traumatic stress disorder) [Emery et al., 2016].

A cross-sectional study of 73 young persons (aged 6–22 years) with mild TBI revealed 7–15% had cognitive impairments at two years after injury (Lambregts et al., 2018). The cognitive processes affected were visuospatial constructional ability, visuospatial memory and executive functions (i.e., cognitive flexibility, processing speed and inhibitory control). Phillips et al. (2017) also reported deficits in working memory, especially in the central executive component and phonological loop, in pediatric TBI. Longitudinal studies such as the one carried out by Jones et al. (2019) have shown improvements in overall neurocognitive function over the year following injury, but not between 12 and 48 months after injury. They inform persisting behavioral sequelae, most often hyperactivity/inattention, in the 12 months after mild TBI and beyond.

There is a growing concern about neurodegenerative changes that may occur chronically following mild TBI (Barkhoudarian et al., 2016; Mayer et al., 2017). The management of this condition, especially in children, can be challenging due to the lack of validated biomarkers that clinicians can use to objectively diagnose patients and also to predict cases with a worse prognosis (Mannix et al., 2020; Mayer et al., 2018). Computed tomography (CT) scans are not sensitive to the most probable pathological features of mild TBI (e.g., diffuse neural injuries, edema), neither structural magnetic resonance imaging (MRI), which also has a high-cost. Evidence from both routine-care and research-based studies suggest that the incidence of lesions on structural MRI scans is relatively low following pediatric mild TBI (Mayer et al., 2018). Unlike these structural biomarkers, functional magnetic resonance imaging (fMRI), electroencephalogram (EEG), magnetoencephalography (MEG) and functional near-infrared spectroscopy (NIR) offer great promise for directly correlating the neurobehavioral sequelae (e.g., poor attention) of acute/sub-acute mild TBI with perturbed physiology (Mayer et al., 2017). The clinical use of S100B, a protein found in glial cells, has been studied as serum biomarker for pediatric mild TBI. This may be used as a supplementary tool to identify patients at risk for intracerebral lesions (Calcagnile et al., 2012; Oris et al., 2018).

Health-related quality of life (HRQoL) is considered the subjective well-being perceived by individuals relative to different aspects of their lives, such as physical, mental (emotional) and social aspects. It corresponds to the patient's outlook about their disease and its impact on their life (González et al., 2012; Sherer et al., 2020). Little is known about the course of HRQoL and the parameters of functional outcomes in children and adolescents with TBI. Compared to adults, pediatric HRQoL assessment is a more recent field of study; however, the analysis of research conducted in the pediatric population, mainly in English-speaking countries, has shown that the severity of TBI significantly affects quality of life: mild TBIs have been associated with a good prognosis, while moderate and severe TBIs have been associated with low HRQoL (Di Battista et al., 2012; Ryan et al., 2019).

A systematic review of pediatric HRQoL following mild TBI concluded that a small proportion of children continue to experience diminished HRQoL up to a year or longer post injury. This prolonged recovery may have implications on academic performance or psychosocial wellbeing (i.e., social isolation, increased risk of

developing adverse psychiatric outcomes) [Fineblit et al., 2016]. Jones et al (2019) found thar parents of children with mild TBI reported child's HRQoL significantly deteriorated between 12- and 48-months post-injury, particularly in relation to social functioning and school.

Although HRQoL is a very important outcome parameter, there are currently no studies on the HRQoL of Colombian children with TBI, although it has been studied in adults with moderate and severe TBI (Arango-Lasprilla et al., 2012). This is worrisome because patients often face obstacles after the trauma to satisfactorily reintegrate into their social, family and work life, which could affect their quality of life (Howell et al., 2019; Ryan et al., 2019). There are limitations for the study of TBI in Colombia; for example, the variability in the definitions used and the population being studied, the underreporting of information in medical records, which makes it difficult to estimate TBI severity, and the variability of the time of follow-up of patients. All this constitutes obstacles to the real estimation of epidemiological data and to the understanding of the sequelae and complications that TBI can produce over time.

HRQoL is an important outcome parameter in clinical practice and also in research. However, the available measures should be used in conjunction with other measures, integrating the evaluation of cognitive or behavioral problems, to obtain a complete picture of the well-being of an individual. In the population of children with mild TBI, more information is needed regarding the neuropsychological sequelae of the brain damage. Taking into account that the assessment of HRQoL would provide additional information for the optimization of treatment or comprehensive intervention in pediatric TBI, the purpose of this study was to analyze the differences in HRQoL, neuropsychological functions and emotional state between a group of children and adolescents with mild TBI and a healthy control group.

Method

Participants

A nonexperimental case-control cross-sectional study was conducted with a sample of 60 children and adolescents, 16 females (M_{age} = 12.5 years, SD = 2.3 years) and 44 males (M_{age} = 12.5 years, SD = 2.5 years), and their primary caregiver. Thirty children with a history of mild TBI belonged to the clinical group (M_{age} = 12.7 years, SD = 2.6 years), and 30 healthy children comprised the control group (M_{age} = 12.6 years, SD = 2.5 years). Eighty-three percent of children with TBI belonged to socioeconomic strata 1 and 2, that is, the strata to which citizens with fewer resources belong. Regarding the caregivers, 85% were parents of the children, often the mother (88%), and lived with them.

The children of the clinical group were selected through nonprobabilistic convenience sampling, identifying the children and adolescents in the databases of two private health institutions using one of the following ICD-10 codes (World Health Organization, 1993): S06.2 (Diffuse traumatic brain injury), S06.3 (Focal traumatic brain injury), S06.8 (Other specified intracranial injuries) and S06.9 (Unspecified intracranial injury). Additionally, they were required to meet the following inclusion criteria: 1) Age between 8 and 16 years. 2) Have diagnosis of mild TBI at the time of evaluation confirmed by their medical history. 3) Age at time of trauma between 8 and 16 years. 4) Have had the trauma for at least 6 months prior to the study. 5) Have no documented history of TBI, neurological disorders, psychiatric problems, substance and/or alcohol use, autism spectrum disorder, intellectual disability or learning difficulties prior to the TBI. Due to personal data protection guidelines, the authors were not allowed to review the medical records of the minors, and the process was carried out by the staff of the health centers.

The children of the comparison group were selected from the general population using nonprobabilistic convenience sampling that took into account the following inclusion criteria: 1) Age between 8 and 16 years. 2) Have no documented history of TBI, neurological disorders, psychiatric problems, substance and/or alcohol use, autism spectrum disorder, intellectual disability or learning difficulties.

The groups were similar in age, sex and socioeconomic status ($p > .05$). Mild TBI was confirmed through medical records kept by the health centers, taking into account three criteria: altered level of consciousness (0 - 30 minutes), anterograde amnesia (< 24 hours) and a score on the Glasgow coma scale between 13 and 15 points in the first 24 hours. For five of the clinical cases, there was loss of consciousness lasting less than 30 minutes; for the remaining cases, there was no loss of consciousness. In all cases, the initial score on the Glasgow coma scale was between 13 and 15 points.

Instruments

Health Questionnaire for Children and Young People (KIDSCREEN-27; The KIDSCREEN Group, 2004). The KIDSCREEN-27 assesses the health and subjective well-being of children and adolescents aged 8 to 18 years. It is a cross-cultural instrument developed as a measure of self-perceived health applicable to children

and adolescents who are healthy and to those who have chronic diseases. It has five dimensions: physical well-being, psychological well-being, autonomy and parents, peer and social support, and school environment. The instrument requires only 10-15 minutes to complete, there is a version for children and one for parents, and it was validated in the Colombian population with an internal consistency estimated with the Cronbach's alpha greater than 0.7 in all dimensions (Quintero et al., 2011).

Pediatric neuropsychological assessment protocol

Trail Making Test (TMT; Reitan, 1992). Consists of a paper and pencil task that requires the subject to draw lines to connect a series of circles in ascending order. It requires visuospatial skills, motor speed and dexterity; it is also considered a measure of cognitive flexibility and alternating attention. The instrument has normative data for the Colombian population of children between 6 and 17 years of age, with an internal consistency estimated with Cronbach's alpha of 0.96 for TMT-A and 0.98 for TMT-B (Reynolds, 2002 cited in Arango-Lasprilla et al., 2017).

d2 Test of Attention (Brickenkamp, 2002). Consists of a paper and pencil cancellation test. The task requires the subject to cross out as many target letters as possible («d» with two marks), moving from left to right, with a time limit of 20 s/test. The instrument has normative data for a Colombian population of children aged between 6 and 17 years, and the scores obtained in this test are expressed in percentiles (Arango-Lasprilla et al., 2017). According to the Spanish version of the test (Seisdedos, 2002), in most studies, the scores are very reliable ($r > .90$).

Neuropsychological assessment of children battery (Matute et al., 2007). It is a battery of tests designed to characterize cognitive and behavioral skills in Spanish-speaking children between 5 and 16 years of age. The following battery domains were administered: auditory memory and visual memory, both the encoding and delayed recall processes. The scores obtained in these tests are expressed in percentiles. The test-retest reliability of the administered tasks is between 0.59 and 0.68.

Modified Wisconsin Card Sorting Test (M-WCST; Nelson, 1976). It is used for the evaluation of executive functions. The abbreviated version of the test consists of 48 response cards and 4 stimulus cards. This task is used to evaluate perseverance, and conceptualization skills. The instrument has normative data for the Colombian population of children between 6 and 17 years of age, it has a good reliability estimated with the Cronbach's alpha ($a = 0.83$) in the indicators of completed categories and perseverative errors (Arango-Lasprilla et al., 2017).

Rey–Osterrieth complex figure test (Rey-Osterrieth, 1997). It is a test that evaluates perceptual organization and visual memory by reproducing a figure from memory after a period of distraction. This test also allows evaluation of organizational skills and strategic planning for problem solving and visual-constructional ability. The instrument has normative data for a Colombian population of children aged 6 and 17 years, it has a good reliability estimated with the Cronbach's alpha in the copy ($a = 0.77$) and recovery ($a = 0.66$) of the figure (Arango-Lasprilla et al., 2017).

Childs Behavior Checklist (CBCL) for parents (Achenbach & Rescorla, 2001). This questionnaire evaluates the presence of psychological disorders in children and adolescents aged 6 to 18 years. It is completed by the parents or caregivers of the children and is composed of two parts: the first allows us to assess sports, social and academic skills or competencies, and the second evaluates the main behavioral and affective problems of children aged 6 to 18 years. The internal consistency estimated with the Cronbach's alpha is greater than 0.7 in all questionnaire dimensions.

Procedure

Patients who were admitted to the outpatient clinic for TBI in two pediatric care centers in the city of Cartagena, Colombia, between 2012 and 2018 were identified, compliance with the inclusion criteria was determined through the medical records of the health care centers, and the parents of those who met the criteria to participate in the study were contacted by telephone. The control group was recruited from educational centers in the city.

First, medical history data was gathered for the children participating in the experiment and the caregivers completed the parent version KIDSCREEN 27; then, children's version of the instrument was completed. Next, the pediatric neuropsychological evaluation protocol was administered to the children, and the process lasted approximately 2.5 hours. Parents of minors also completed a questionnaire aimed at identifying the behavioral and socioemotional characteristics of their children.

All procedures performed in this study involving human participants were in accordance with ethical standards of institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

The research ethics committee of the Universidad Tecnológica de Bolívar approved the research protocol and assigned the code FCS1602T2002.

Informed consent was given to all participants in order to get their allowance for this study. They were

informed that they could withdraw their participation at any time. Moreover, all subjects were informed that the data would be coded by numbers to avoid identifying the participants and to maintain the confidentiality of the data.

Data analysis

The data corresponding to the qualitative variables such as sociodemographic factors and relevant clinical information were analyzed using measures of absolute and relative frequencies expressed as percentages; those corresponding to the quantitative variables were analyzed using measures of central tendency.

To compare data between the clinical and control groups regarding the different dimensions of HRQoL, the Mann-Whitney U test statistic was used. Additionally, a group comparison analysis was performed using Student's t-statistic based on the scores obtained by the participants in the pediatric neuropsychological assessment protocol. The analyses were performed with the statistical package for social sciences (SPSS) version 24.0 for Windows (IBM, 2016).

Results

Clinical characteristics of the group with mild TBI

The average time elapsed since the TBI was 18 months, with a range of 7–60 months. Twenty-six percent of children suffered TBI due to a motor vehicle accident, 26.6% due to falls, 23.33% due to a traffic accident as a pedestrian, 13.33% as a consequence of a recreational activity, and 3.33% as a result of being hit by an object and 3.33% due to being hit by a person.

Of the patients, 93.33% were not under pharmacological treatment because of the injury, and only 6.66% were given analgesics to treat recurrent headaches. After the injury, 73.33% of the children did not receive any type of therapeutic care, while 26.66% received at least one of the following therapies in order of frequency: psychological care, psychiatric care, neuropsychological rehabilitation, physical therapy, speech-language therapy, occupational therapy and special education.

Among the main sequelae associated with pediatric TBI, there is a prevalence of headaches, followed by dizziness and pain in the extremities. Less commonly, echolalia, loss of vision, psychomotor agitation, sleep disorders, motor deficits, specific learning difficulties, and behavioral and emotional disorders were observed. After the trauma, 43.33% exhibited the following limitations in order of frequency: doing homework, planning and organization, increased time spent performing household tasks, difficulty interacting with family members in different spaces, performing recreational activities outside the home, and interacting with peers in different environments. Caregivers of 30% of children reported that their school performance worsened after TBI.

HRQoL perceived by children and adolescents with mild TBI, controls and caregivers

Children and adolescents with mild TBI, their caregivers and children without TBI report an HRQoL that is similar to that of the general population of the same age and sex in the dimensions of physical well-being, psychological well-being, autonomy and parents, peers and social support, and school environment (see Table 1).

Table 1. Description of the HRQoL dimensions perceived by each subgroup

	Physical well–being *M (SD)*	Psychological well–being *M (SD)*	Autonomy and Parents *M (SD)*	Peers and Social support *M (SD)*	School environment *M (SD)*
Children with TBI	49.6 (7.9)	49.5 (6.9)	46.5 (9.0)	51.5 (8.9)	48.0 (12.4)
Caregivers of children with TBI	55.9 (13.6)	49.4 (11.8)	56.0 (12.1)	59.6 (10.6)	51.4 (14.2)
Controls	52.4 (10.6)	50.6 (8.7)	47.2 (8.1)	46.9 (8.1)	51.1 (9.4)

Note: M = mean; *SD* = standard deviation. The median T–score was taken for each of the HRQoL dimensions of the KIDSCREEN–27 for Children and Adolescents and the one for parents. The scores are standardized with a median of 50 and standard deviation of 10, and ≤ 40 was used as a cut–off point to indicate a low HRQoL.

The HRQoL perceived by children and adolescents with mild TBI was compared to that reported by the caregivers in the different dimensions of the HRQoL evaluated by the KIDSCREEN 27. There were no significant differences between the perception of the children and their caregivers in the majority of the evaluated dimensions of HRQoL. Significant differences were only found in the Autonomy and parents dimension

($U = 60.0$, $p = .029$, $PS_{est} = 0.26$), so that parents had higher HRQoL scores in this dimension compared to children; however, the size of the effect is small.

Finally, the HRQoL perceived by children and adolescents with and without a history of TBI in the different dimensions of the HRQoL was evaluated by the KIDSCREEN 27 and compared, finding that there is no significant difference between the groups in four of the five dimensions of HRQoL evaluated, except the dimension peers and social support ($U = 259.0$, $p = .004$, $PS_{est} = 0.29$). In this dimension, the group with TBI reports a higher HRQoL compared to the group without TBI; however, the size of the effect is small.

Neuropsychological performance and emotional state

Table 2 shows the analysis of the mean difference between subjects with mild TBI and controls on cognitive measures. The results show that there are statistically significant differences between the clinical and control groups in the TR rate (total of elements attempted) and CON (concentration index) of the d2 test of attention. The TR index measures processing speed, amount of work performed and total productivity in the attention task. It is a measure of selective and sustained attention in which the control group showed a significantly higher performance than the clinical group. Additionally, the clinical group did not achieve a good balance between

Table 2. Comparison of cognitive measures between clinical and control groups

	Clinical group	Control group			
	M (SD)	*M (SD)*	*t*	*p*–value	*d*
Graphic skills					
Rey–Osterrieth complex figure test	25.8 (9.4)	24.9 (7.8)	–.275	.785	—
Attention					
TMT part A (time)	60.4 (45.3)	44.5 (23.3)	–1.208	.237	—
d2 TR	52.3 (31.0)	70.5 (27.8)	–1.990	.046*	0.30
d2 TA	38.0 (32.8)	51.3 (30.8)	–1.123	.271	—
d2 O	31.9 (28.7)	31.2 (29.3)	.061	.952	—
d2 C	15.4 (25.7)	11.7 (9.1)	.506	.617	—
d2 TOT	68.2 (94.4)	60.4 (32.2)	.295	.770	—
d2 CON	25.5 (33.1)	43.2 (27.3)	–2.070	.038*	0.30
d2 VAR	51.6 (33.9)	50.1 (36.7)	.111	.912	—
Verbal–auditory memory (encoding)					
List of words	29.4 (22.1)	23.0 (24.7)	–.752	.458	—
Story recall	23.1 (20.1)	25.9 (24.6)	.349	.729	—
Visual memory (encoding)					
List of figures	34.5 (21.4)	42.1 (26.6)	.867	.393	—
Verbal–auditory memory (delayed recall)					
Spontaneous retrieval of word list	30.8 (24.7)	28.1 (19.3)	–.329	.745	—
Retrieval by word list key	25.7 (20.6)	36.7 (25.3)	1.284	.210	—
Verbal–auditory recognition	34.4 (29.5)	44.7 (22.5)	1.084	.288	—
Story recall	18.1 (21.9)	24.1 (26.1)	.679	.503	—
Visual memory (delayed recall)					
Spontaneous retrieval of figure list	43.6 (31.3)	36.6 (29.4)	–.636	.530	—
Retrieval by figure list key	37.7 (32.2)	41.0 (22.9)	.327	.746	—
Visual recognition	33.9 (26.1)	48.3 (20.1)	–2.576	.104	—
Rey-Osterrieth complex figure retrieval	16.2 (9.0)	16.4 (7.4)	.062	.951	—
Executive functions					
Cognitive flexibility					
No. of perseverative responses M–WCST	10.3 (5.7)	9.3 (5.5)	.421	.627	—
Categorization					
No. of categories M–WCST	2.0 (.9)	2.2 (.8)	–.642	.526	—

Note: *$p<.05$; *M* = mean; *SD* = standard deviation.

speed and accuracy in the execution of the test compared to the control group, with a lower concentration index. However, the size of the effect is small.

No significant differences were found between children with mild TBI and controls in graphic skills, auditory-verbal memory (encoding and delayed recall), visual memory (encoding and delayed recall), and executive functioning (cognitive flexibility and conceptualization).

Table 3 shows the comparison between subjects with TBI and controls in the ten behavioral and emotional characteristics of the CBCL questionnaire. Significant differences were found between the clinical and control groups in the anxiety/depression, withdrawal and depression, and social problems subscales, with a medium effect size. In the anxiety/depression subscale, 13.3% of children with mild TBI are within the clinical range, according to the parents' report, and 13.3% are at risk. Similarly, in the withdrawal and depression subscale, 13.3% of children with mild TBI are at risk. On the social problems subscale, 6.6% of children with mild TBI are within the clinical range, while 13.3% are at risk.

Table 3. Comparison of CBCL between clinical and control groups

	Clinical group	Control group			
	M (SD)	*M (SD)*	*t*	*p*–value	*d*
Anxiety/depression	55.1 (15.9)	45.2 (6.7)	–2.23	.038*	0.46
Withdrawal and depression	53.3 (9.6)	46.0 (9.3)	–2.11	.044*	0.37
Somatization	58.9 (12.7)	49.9 (14)	–1.84	.077	–
Social problems	55.7 (12.5)	47.0 (6.8)	–2.37	.027*	0.41
Thought problems	50.0 (10.9)	45.6 (5.0)	–1.37	.185	—
Attention problems	57.3 (12.0)	48.9 (12.6)	–1.89	.070	—
Delinquent behavior	57.3 (16.1)	51.5 (8.9)	–1.21	.240	—
Aggressive behaviors	53.6 (10.7)	47.9 (6.9)	–1.73	.094	—
Internalizing	56.6 (12.8)	46.6 (7.8)	–2.59	.015*	0.44
Externalizing	53.5 (11.2)	49.4 (8.3)	–1.15	.260	—

Note: *$p<.05$; *M* = mean; *SD* = standard deviation.

In the clinical group, there were mainly internalization problems (withdrawal, somatic complaints, anxiety and depression) rather than externalization problems, and these difficulties were significantly greater compared to the control group, with a medium effect size.

Discussion

Mild TBI has been less understood and studied compared to moderate and severe TBI, despite being an issue that generates significant public health concern worldwide since it represents the majority of TBI cases (Yeates et al., 2009). Similarly, the impact of mild TBI in children and adolescents has received less attention than in adults, especially in Latin America. Considering the physical, cognitive and socioemotional difficulties that can arise after TBI, this study explores the effect of mild TBI on HRQoL in the pediatric population.

Regarding the characteristics of the sample, mild TBI is more common in males than in females, which agrees with the findings reported in previous studies (Alted et al., 2009; Denis et al., 2011; De Villegas & Salazar, 2008). In our study, there was a greater number of cases of mild TBI in the lowest socioeconomic levels, with 83% of the subjects evaluated being grouped in levels 1 and 2[1]. In relation to this, it has been found that socioeconomic status constitutes a risk factor that affects the quality of life of children, with families from lower socioeconomic strata being prone to acquire these injuries due to the conditions of their environment, such as the state of their housing, marginalization, violence, among others (Fiorentino et al., 2015; Quintero et al., 2011).

Falls and motor vehicle accidents were the main mechanisms causing TBI, which supports that proposed by Avilés et al. (2016), Fiorentino et al. (2015), García et al. (2009), and Petersen et al. (2008). Previous studies that have explored the sequelae associated with TBI (Folleco, 2015; Gutiérrez-Ruiz et al., 2017; Pacheco, 2014; Peralta et al., 2014) highlight the development

[1] The Colombian government bases the socioeconomic status of individuals on their income and address of residence, and ranges from 1 (low) to 6 (high).

of cognitive, social and behavioral difficulties after the trauma that are related to low school performance. According to the parents or caregivers, 30% of the children in the present study had worse academic performance after the brain injury; in addition, they had more limitations in performing school tasks and activities such as organizing their things and their time, which can have an impact on academic performance.

In this study, 43.33% of children with mild TBI exhibited physical sequelae such as headache and dizziness. There were also, to a lesser extent, cases of pain in the extremities, loss of vision, psychomotor agitation, sleep disorders, specific learning difficulties and behavioral-emotional disorders. However, these sequelae do not negatively impact HRQoL in mild TBI cases.

A large number of children do not require therapeutic care immediately after mild TBI. Authors assert that the majority of cases exhibit good recovery in motor areas and functional independence for daily activities (Soto et al., 2014); however, long-term medical checks are necessary to continue with the evaluation process. This would explain the fact that 73.33% of the participants in our study did not receive any type of therapeutic treatment after medical discharge, and many of them did not continue with the follow-up medical checks, so there was no follow-up of the case progression that would have allowed the determination of possible therapeutic needs.

According to the results of this study, children and adolescents perceive the different dimensions of HRQoL as normal after mild TBI. When comparing the HRQoL of children with mild TBI and children without a history of TBI, there are no significant differences between the groups, which suggests that there is no important association between mild TBI and HRQoL in our sample. These results are associated with the findings of Petersen et al. (2008), who conducted an investigation to describe HRQoL, health status, behavioral problems and neuropsychological functioning in a sample of children and adolescents after mild TBI through a longitudinal study, and found only small differences throughout the study period and no difference in HRQoL compared to the control group. Souza et al. (2007) detected that after four years of having suffered a TBI, most of the children evaluated returned to normal daily activities, and there were no significant differences between the quality of life of these patients and the comparison group. It remains to be determined in this study whether or not the nature of children's HRQoL has returned to pre-injury levels and cannot be definitively answered this issue by the current analyzes given the absence of information about children's HRQoL prior to mild TBI. Further, it has been suggested that younger pediatric mild TBI patients are less likely to accurately self-report symptoms, which leads them to underestimate the impact of mild TBI (Fineblit et al., 2016; Gilbert & Johnson, 2011; Mayer et al., 2018; Van Kampen et al., 2006).

When comparing in our study the perceptions about the HRQoL reported by parents and children with mild TBI, the parents had a tendency to report slightly higher scores in the majority of the dimensions of the HRQoL; however, these differences were only statistically significant for the Autonomy and parents dimension, although the size of the effect is small. The perception that parents had of HRQoL in the study by Souza et al. (2007) did not agree with the HRQoL self-reported by the children, with slightly higher scores by the parents. Similarly, Pieper and Bear (2011) and Fineblit et al. (2016) found a discrepancy between the perception of children and parents of HRQoL after the TBI, parents rated HRQoL higher than their children.

In many cases, after the trauma, children experienced a change in the way they perceived situations and life problems, exhibiting positive coping with life circumstances. Thus, in the dimension of peers and social support, there was an atypical finding because, contrary to expectations, children with mild TBI showed higher HRQoL in this dimension than children without TBI. In comparison to the control group, all children with a history of mild TBI were within the normal category. This finding suggests that after the trauma, the process of socialization was positive for these children, which could be explained by their social and family environment because among the common characteristics of the participants is that they are part of large families and are frequently surrounded by friends, which facilitates interaction and social inclusion. Family environment and social support are important predictors of psychosocial outcomes and overall functioning after a TBI, considering aspects such as severity, time elapsed after the injury and parenting style (Peralta et al., 2014).

In this study, few significant differences were found between children with mild TBI and controls in standardized cognitive and behavioral measures. Of all the cognitive variables analyzed, only the scores for TR and CON of the d2 Test of Attention were significantly associated with mild TBI; however, the size of the effect is small. There are studies in which no lasting cognitive difficulties have been found in children with mild TBI; although they experience headaches, dizziness and fatigue, they do not show cognitive alterations, even one week after the trauma (Arciniegas & Wortzel, 2014; García et al., 2003; Horn et al., 2013; Theeler et al., 2012). It has been documented that persistent problems after mild TBI are more common in children with a past TBI, learning difficulties, neurological or psychiatric problems, or family stressors (Thompson &

Irby, 2003). This suggests that these antecedents make children more vulnerable to the effects of mild TBI or that the information reported by the caregivers is based on the previous deficit. The possible effect of treatment by the clinical group should be considered in explaining these findings and also the neuroplasticity capacity in childhood (Kolb & Gibb, 2011; Taylor et al., 2013).

There have been few studies on the long-term consequences of mild TBI in the emotional state and behavioral adjustment of children, and the findings are often inconsistent (Keightley et al., 2014). Although some studies have not demonstrated persistent effects of mild pediatric TBI on behavior (Anderson et al., 2001), other studies have documented that children suffering from mild TBI have higher indicators of psychiatric disorders (behavioral problems, social problems, internalization and externalization problems) and higher levels of hyperactivity compared to controls (McKinlay et al., 2002; Massagli et al., 2004; Taylor et al., 2015).

When exploring in our study the effect of mild TBI on daily functioning, particularly in the development of social skills and behavioral problems, we found statistically significant differences with a medium effect size in four of the ten subscales of the CBCL questionnaire: the anxiety/depression, withdrawal/depression, social problems and internalization subscales. For the anxiety/depression and withdrawal scales, the scores were within significant clinical levels. Anxiety is part of a wide spectrum of emotional problems after TBI in childhood and is associated with damage to the dorsal frontal lobe and the frontal white-matter systems (Max et al., 2011). It is also possible to develop depressive disorder after TBI, which may or may not be accompanied by anxiety. Depressive disorder has been associated with older age at injury, family history of anxiety disorders, right frontal white matter lesions and left inferior frontal gyrus lesions (Max et al., 2012). Recent findings examining the relationship between mild TBI and psychopathology showed a significant relation between childhood mild TBI and increases in anxiety/depression symptomology later in adolescence (Connolly & McCormick, 2019).

The results of this exploratory study agree with previous studies conducted in other countries and that was found that mild TBI does not produce significant long-term deficits in neuropsychological functioning, whereas behavioral and emotional problems tend to be more persistent over time. Our findings are also consistent with studies conducted in adults (Keightley et al., 2014; Taylor et al., 2015).

Mild TBI has been empirically-linked to a wide array of varying types of psychological symptoms spanning the internalizing-externalizing spectrum (McCormick et al., 2021). Although in this study the clinical group showed externalizing symptoms, no statistically significant differences were found with the comparison group. This finding contradicts previous literature (Connolly & McCormick, 2019; Emery et al., 2016); however, it must be taken into account that Jones et al. (2019) have reported improvements in child behavior informed by parents in the 12 months post-injury. The average age of the participants in this study was 12 years, so they were in the adolescence life period and often in this stage a significant proportion of adolescents (including those without history of brain injury) engage in externalizing behaviors (e.g., aggression, substance use, and delinquency) [Modecki et al., 2017]. It should also be considered that psychological and psychiatric problems in children with a history of mild TBI are more prevalent when mild TBI is associated with hospitalization, when there are multiple previous mild TBIs and in individuals with preexisting psychiatric illness (Emery et al., 2016).

There are limitations of this study. First, it should be clarified that being an exploratory study, these results are based on a small number of participants, which does not exclude the possibility that there are individuals who experience persistent and chronic effects of mild TBI. Second, this study utilized data from a geographically-limited sample of children and adolescents in Cartagena, Colombia and its metropolitan area, therefore limiting the generalizability of the findings. Third, due to the analytic strategy used in the present study, the evolution of HRQoL, neuropsychological functions and the emotional state of children and adolescents with mild TBI were not follow up.

As recommendations for future studies, it is necessary to develop research with larger samples and with participants from different regions of the country in multicenter studies that allow us to better characterize the nature of mild TBI and to monitor the patient progress to accurately determine the progression of the neuropsychological clinical condition to better manage this condition in childhood. Future research should attempt to replicate these findings and further analyze the trajectories of emotional and behavioral symptoms related to mild TBI across the lifespan.

Conflicts of interest

The authors have no conflicts of interest to declare.

References

Achenbach, T.M., & Rescorla, L.A. (2001). *Manual for the ASEBA Age Forms & Profiles.* University of Vermont, Research Center for Children, Youth & Families.

Alted, E., Bermejo, S., & Chico, M. (2009). Actualizaciones en el manejo del traumatismo craneoencefálico grave. *Medicina Intensiva, 33*(1), 16-30. https://doi.org/10.1016/S0210-5691(09)70302-X

Anderson, V., Catroppa, C., Morse, S., Haritou, F., & Rosenfeld, J. (2001). Outcome from mild head injury in young children: A prospective study. *Journal of Clinical and Experimental Neuropsychology*, *23*(6), 705-717. https://doi.org/10.1076/jcen.23.6.705.1015

Arango-Lasprilla, J.C., Krch, D., Drew, A., De los Reyes Aragon, C.J., & Stevens, L.F. (2012). Health-related quality of life of individuals with traumatic brain injury in Barranquilla, Colombia. *Brain injury*, *26*(6), 825-833. https://doi.org/10.3109/02699052.2012.655364

Arango-Lasprilla, J.C., Rivera, D., y Olabarrieta-Landa, L. (Eds.) (2017). *Neuropsicología infantil*. Manual Moderno.

Arango-Lasprilla, J., Rosenthal, M., DeLuca, J., Cifu, D., Hanks, R., & Komaroff, E. (2007). Functional outcomes from inpatient rehabilitation after traumatic brain injury: how do Hispanics fare? *Archives of Physical Medicine and Rehabilitation, 88*, 11-18. https://doi.org/10.1016/j.apmr.2006.10.029

Arciniegas, D.B., & Wortzel, H.S. (2014). Emotional and behavioral dyscontrol after traumatic brain injury. *Psychiatric Clinics*, *37*(1), 31-53. https://doi.org/10.1016/j.psc.2013.12.001

Au, A.K., & Clark, R.S. (2017). Paediatric traumatic brain injury: prognostic insights and outlooks. *Current Opinion in Neurology*, *30*(6),565-572.https://doi.org/10.1097/WCO.0000000000000504

Avilés, K., Cruz, P., García, B., Jiménez, B., López, A., y Montaño, C. (2016). Perspectiva del trauma craneoencefálico en urgencias de pediatría. *Revista Mexicana de Pediatría, 82*(4),129-134.

Barkhoudarian, G., Hovda, D.A., & Giza, C.C. (2016). The Molecular Pathophysiology of Concussive Brain Injury - an Update. *Physical Medicine Rehabilitation Clinics. 27*(2), 373-393. https://doi.org/10.1016/j.pmr.2016.01.003

Brickenkamp, R., y Cubero, N.S. (2002). *D2: test de atención*. TEA Ediciones.

Calcagnile, O., Undén, L., & Undén, J. (2012). Clinical validation of S100B use in management of mild head injury. *BMC Emergency Medicine, 12(1),13*. https://doi.org/10.1186/1471-227X-12-13

Cancelliere, C., Hincapié, C.A., Keightley, M., Godbolt, A.K., Côté, P., Kristman, V.L., Stålnacke, B.M., Carroll, L.J., Hung, R., Borg, J., Boussard, C.N., Coronado, V.G., Donovan, J., & Cassidy, J.D. (2014). Systematic review of prognosis and return to play after sport concussion: results of the International Collaboration on Mild Traumatic Brain Injury Prognosis. *Archives of physical medicine and rehabilitation, 95*(3), S210-S229. https://doi.org/10.1016/j.apmr.2013.06.035

Connolly, E.J., & McCormick, B.F. (2019). Mild traumatic brain injury and psychopathology in adolescence: evidence from the Project on Human Development in Chicago Neighborhoods. *Journal of Adolescent Health, 65*(1), 79-85. https://doi.org/10.1016/j.jadohealth.2018.12.023

De Villegas, C., & Salazar, J. (2008). Traumatic brain injury in children. *Revista de la Sociedad Boliviana de Pediatría, 47*(1), 19-29.

Denis, A., Álvarez, M., Porto, R., y Cabrera , J. (2011). Revisión sobre el manejo del trauma cráneo encefálico en la Unidad de Cuidados Intensivos Emergentes. *Matanzas. Revista Médica Electrónica, 33*(2), 225-234.

Di Battista, A., Soo, C., Catroppa, C., & Anderson, V. (2012). Quality of life in children and adolescents post-TBI: a systematic review and meta-analysis. *Journal of Neurotrauma, 29*(9), 1717-1727. https://doi.org/10.1089/neu.2011.2157

Duhaime, A.C., Beckwith, J.G., Maerlender, A.C., McAllister, T.W., Crisco, J.J., Duma, S.M., Brolinson, P.G., Rowson, E., Flashman, L.A., Chu, J.J., & Greenwald, R.M. (2012). Spectrum of acute clinical characteristics of diagnosed concussions in college athletes wearing instrumented helmets. *Journal of Neurosurgery, 117*(6), 1092-1099. https://doi.org/10.3171/2012.8.JNS112298

Emery, C.A., Barlow, K.M., Brooks, B.L., Max, J.E., Villavicencio-Requis, A., Gnanakumar, V., Robertson, H.L., Schneider, K., & Yeates, K.O. (2016). A systematic review of psychiatric, psychological, and behavioural outcomes following mild traumatic brain injury in children and adolescents. *The Canadian Journal of Psychiatry, 61*(5), 259-269. http://doi.org/10.1177/0706743716643741

Fiorentino, J., Molises, C., Stach, P., Cendrero, P., Solla, M., Hoffman, E., y Fosco, M. (2015). Trauma en pediatría: Estudio epidemiológico en pacientes internados en el hospital de niños «Ricardo Gutiérrez». *Archivos Argentinos de Pediatría, 113*(1), 12-20. http://dx.doi.org/10.5546/aap.2015.12

Folleco, J. (2015). Diagnóstico y rehabilitación neuropsicológica de los traumatismos craneoencefálicos. Una necesidad por atender. *Revista Tesis Psicológica, 10*(2), 86-103.

García, H., Reyes, D., Diegopérez, J., y Mercado, A. (2003). Traumatismo craneal en niños: frecuencia y algunas características epidemiológicas. *Revista Médica del Instituto Mexicano del Seguro Social, 41*(6), 495-502.

Gilbert, F., & Johnson, L.S.M. (2011). The impact of American tackle football-related concussion in youth athletes. *AJOB Neuroscience, 2*(4), 48-59. https://doi.org/10.1080/21507740.2011.611125

González, D., Giraldo, C., Ramírez, D., y Quijano, M. (2012). Cambios en la calidad de vida en pacientes con trauma craneoencefálico severo después de un programa de rehabilitación. *Psychologia, 6*(1), 77-89. doi: http://dx.doi.org/10.21500/19002386.1172

Gutiérrez-Ruiz, K., Audivet, D., y Mosquera, Y. (2017). Revisión sistemática de la calidad de vida relacionada con la salud en niños latinoamericanos con trauma craneoencefálico. *Acta Neurológica Colombiana, 33*(4), 286-298. https://doi.org/10.22379/24224022169

Howell, D.R., Wilson, J.C., Kirkwood, M.W., & Grubenhoff, J. A. (2019). Quality of life and symptom burden 1 month after concussion in children and adolescents. *Clinical Pediatrics, 58*(1), 42-49. http://doi.org/10.1177/0009922818806308.

Hung, R., Carroll, L.J., Cancelliere, C., Côté, P., Rumney, P., Keightley, M., Donovan, J., Stålnacke, B.M., & Cassidy, J.D. (2014). Systematic review of the clinical course, natural history, and prognosis for pediatric mild traumatic brain injury: results of the International Collaboration on Mild Traumatic Brain Injury Prognosis. *Archives of Physical Medicine and Rehabilitation, 95*(3), S174-S191. https://doi.org/10.1016/j.apmr.2013.08.301

IBM Corp. Released (2016). *IBM SPSS Statistics for Windows, Version 24.0*. IBM Corp.

Jones, K.M., Prah, P., Starkey, N., Theadom, A., Barker-Collo, S., Ameratunga, S., Feigin, V.L., & BIONIC Study Group (2019). Longitudinal patterns of behavior, cognition, and quality of life after mild traumatic brain injury in children: BIONIC study findings. *Brain Injury, 33*(7), 884-893. http://doi.org/10.1080/02699052.2019.1606445

The KIDSCREEN Group (2004). *KIDSCREEN-27. Health Questionnaire for Children and Young People*. http://www.kidscreen.org/cms/es/node/111

Fineblit, S., Selci, E., Loewen, H., Ellis, M., & Russell, K. (2016). Health-related quality of life after pediatric mild traumatic brain injury/concussion: a systematic review. *Journal of Neurotrauma, 33*(17), 1561-1568. http://doi.org/ 10.1089/neu.2015.4292

Keightley, M.L., Côté, P., Rumney, P., Hung, R., Carroll, L.J., Cancelliere, C., & Cassidy, J.D. (2014). Psychosocial consequences of mild traumatic brain injury in children: results of a systematic review by the International Collaboration on Mild Traumatic Brain Injury Prognosis. *Archives of Physical Medicine and Rehabilitation*, *95*(3), S192-S200. https://doi.org/10.1016/j.apmr.2013.12.018

Kolb, B., & Gibb, R. (2011). Brain plasticity and behaviour in the developing brain. *Journal of the Canadian Academy of Child and Adolescent Psychiatry, 20*(4), 265.

Kotch, S.R., & Allen, S.R. (2019). Traumatic brain injury. En *Clinical Algorithms in General Surgery* (pp. 619-621). Springer.

Lambregts, S.A., Smetsers, J.E., Verhoeven, I.M., de Kloet, A.J., van de Port, I.G., Ribbers, G.M., & Catsman-Berrevoets, C.E. (2018). Cognitive function and participation in children and youth with mild traumatic brain injury two years after injury. *Brain Injury, 32*(2), 230-241. https://doi.org/10.1080/02699052.2017.1406990

McCormick, B.F., Connolly, E.J., & Nelson, D.V. (2021). Mild traumatic brain injury as a predictor of classes of youth internalizing and externalizing psychopathology. *Child Psychiatry & Human Development, 52*(1), 166-178. https://doi.org/10.1007/s10578-020-00992-9

Mannix, R., Levy, R., Zemek, R., Yeates, K.O., Arbogast, K., Meehan, W.P., Leddy, J., Master, C., Mayer, A.R., Howell, D.R., & Meier, T. B. (2020). Fluid biomarkers of pediatric mild traumatic brain injury: a systematic review. *Journal of Neurotrauma, 37*(19), 2029-2044. https://doi.org/10.1089/neu.2019.6956

Massagli, T.L., Fann, J.R., Burington, B.E., Jaffe, K.M., Katon, W.J., & Thompson, R.S. (2004). Psychiatric illness after mild traumatic brain injury in children. *Archives of Physical Medicine and Rehabilitation*, *85*(9), 1428-1434. https://doi.org/10.1016/j.apmr.2003.12.036

Matute, E., Rosselli, M., Ardila, A., y Ostrosky-Solís, F. (2007). *Evaluación neuropsicológica infantil.* Manual Moderno.

Mayer, A.R., Kaushal, M., Dodd, A.B., Hanlon, F.M., Shaff, N.A., Mannix, R., Master, C., Leddy, J., Stephenson, D., Wertz, C.J., Suelzer, E.M., Arbogast, K.B., & Meier, T.B. (2018). Advanced biomarkers of pediatric mild traumatic brain injury: Progress and perils. *Neuroscience & Biobehavioral Reviews, 94*, 149-165. https://doi.org/10.1016/j.neubiorev.2018.08.002

Mayer, A.R., Quinn, D.K., & Master, C.L. (2017). The spectrum of mild traumatic brain injury: a review. *Neurology, 89*(6), 623-632. https://doi.org/10.1212/WNL.0000000000004214

Max, J.E., Keatley, E., Wilde, E.A., Bigler, E.D., Levin, H.S., Schachar, R.J., Saunders, A., Ewing-Cobs, L., Dennis, M., & Yang, T.T. (2011). Anxiety disorders in children and adolescents in the first six months after traumatic brain injury. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *23*(1), 29-39. https://doi.org/10.1176/appi.neuropsych.23.1.29

Max, J.E., Keatley, E., Wilde, E.A., Bigler, E.D., Schachar, R.J., Saunders, A.E., Ewing-Cobbs, L., Chapman, S.B., Dennis, M., Yang, T.T., & Levin, H.S. (2012). Depression in children and adolescents in the first six months after traumatic brain injury. *International Journal of Developmental Neuroscience*, *30*(3), 239-245. https://doi.org/10.1016/j.ijdevneu.2011.12.005

McKinlay, A., Dalrymple-Alford, J.C., Horwood, L.J., & Fergusson, D.M. (2002). Long term psychosocial outcomes after mild head injury in early childhood. *Journal of Neurology, Neurosurgery & Psychiatry*, *73*(3), 281-288. https://doi.org/10.1136/jnnp.73.3.281

Modecki, K.L., Zimmer-Gembeck, M.J., & Guerra, N. (2017). Emotion regulation, coping, and decision making: Three linked skills for preventing externalizing problems in adolescence. *Child Development, 88*(2), 417-426. https://doi.org/10.1111/cdev.12734

Nelson, H.E. (1976). A modified card-sorting test sensitive to frontal lobe defects. *Cortex, 12*(4), 313–324. https://doi.org/10.1016/s0010-9452(76)80035-4

Oris, C., Pereira, B., Durif, J., Simon-Pimmel, J., Castellani, C., Manzano, S., Sapin, V., & Bouvier, D. (2018). The biomarker S100B and mild traumatic brain injury: a meta-analysis. *Pediatrics*, 141(6). https://doi.org/10.1542/peds.2018-0037

Pacheco, P. (2014). Caracterización y abordaje en rehabilitación de las secuelas de trauma craneoencefálico en la población pediátrica egresada del Hospital Nacional de Niños Dr. Carlos Sáenz Herrera de enero de 2009 a diciembre de 2012 (Tesis de especialización médica). http://repositorio.sibdi.ucr.ac.cr:8080/jspui/bitstream/123456789/5316/1/38297.pdf

Peralta, V., Cuevas, N., y Ramírez, M. (2014). Neuropsicología de los efectos del traumatismo craneoencefálico infantil en las habilidades sociales. *Revista Chilena de Neuropsicología, 9*(1-2), 25-29. https://doi.org/10.5839/rcnp.2014.090102.07

Petersen, C., Scherwath, A., Fink, J., & Koch, U. (2008). Health-related quality of life and psychosocial consequences after mild traumatic brain injury in children and adolescents. *Brain Injury*, *22*(3), 215-221. https://doi.org/10.1080/02699050801935245

Phillips, N.L., Parry, L., Mandalis, A., & Lah, S. (2017). Working memory outcomes following traumatic brain injury in children: A systematic review with meta-analysis. *Child Neuropsychology, 23*(1), 26-66. http://doi.org/10.1080/09297049.2015.1085500

Pieper, P., & Bear, M. (2011). Child and proxy perspectives of the child's health-related quality of life 1 month after a mild traumatic brain injury. *Journal of Trauma Nursing, 18*, 11-17. https://doi.org/10.3109/02699052.2013.847208

Quijano, M.C., Lasprilla, J.C.A., & Cuervo, M.T. (2010). Alteraciones cognitivas, emocionales y comportamentales a largo plazo en pacientes con trauma craneoencefálico en Cali, Colombia. *Revista Colombiana de Psiquiatría, 39*(4), 716-731.

Quintero, C.A., Lugo, L.H., García, H.I., y Sánchez, A. (2011). Validación del cuestionario KIDSCREEN-27 de calidad de

vida relacionada con la salud en niños y adolescentes de Medellín, Colombia. *Revista colombiana de Psiquiatría*, *40*(3), 470-487.

Reitan, R.M. (1992). *Trail Making Test: Manual for administration and scoring*. Reitan Neuropsychology Laboratory.

Resch, C., Anderson, V.A., Beauchamp, M.H., Crossley, L., Hearps, S.J., van Heugten, C.M., Hurks, P.P.M., Ryan, N.P., & Catroppa, C. (2019). Age-dependent differences in the impact of paediatric traumatic brain injury on executive functions: A prospective study using susceptibility-weighted imaging. *Neuropsychologia*, *124*, 236-245. https://doi.org/10.1016/j.neuropsychologia.2018.12.004

Rey-Osterrieth, A. (1997). *Test de copia y de reproducción de memoria de figuras geométricas complejas*. TEA.

Ryan, N.P., Noone, K., Godfrey, C., Botchway, E.N., Catroppa, C., & Anderson, V. (2019). Young adults' perspectives on health-related quality of life after paediatric traumatic brain injury: A prospective cohort study. *Annals of Physical and Rehabilitation Medicine, 62*(5), 342-350. https://doi.org/10.1016/j.rehab.2019.06.014

Seisdedos, N. (2002). *D2, attention test. Spanish adaptation*. TEA Editions.

Sherer, M., Poritz, J.M., Tulsky, D., Kisala, P., Leon-Novelo, L., & Ngan, E. (2020). Conceptual structure of health-related quality of life for persons with traumatic brain injury: confirmatory factor analysis of the TBI-QOL. *Archives of Physical Medicine and Rehabilitation*, *101*(1), 62-71. https://doi.org/10.1016/j.apmr.2017.04.016

Shultz, E.L., Hoskinson, K.R., Keim, M.C., Dennis, M., Taylor, H.G., Bigler, E.D., Rubin, K.H., Vannatta, K., Gerhardt, C.A., Stancin, T., & Yeates, K.O. (2016). Adaptive functioning following pediatric traumatic brain injury: Relationship to executive function and processing speed. *Neuropsychology, 30*(7), 830. https://doi.org/10.1037/neu0000288

Soto, A., Salinas, T., e Hidalgo, G. (2014). Aspectos Fundamentales en la rehabilitación post tec en el paciente adulto y pediátrico. *Revista Médica Clínica Las Condes, 25*(2), 306–313. https://doi.org/10.1016/s0716-8640(14)70042-2

Souza, L., Braga, L., Filho, G., & Dellatolas, G. (2007). Quality-of-life: child and parent perspectives following severe traumatic brain injury. *Developmental Neurorehabilitation, 10*, 35-47. https://doi.org/10.1080/13638490600822239

Staab, J.P., & Powell, M.R. (2019). Neuropsychological and Psychiatric Comorbidities of Mild Traumatic Brain Injury. En *Neurosensory Disorders in Mild Traumatic Brain Injury* (pp. 99-112). Academic Press.

Taylor, H.G., Orchinik, L.J., Minich, N., Dietrich, A., Nuss, K., Wright, M., Bangert, B., Rusin, J., & Yeates, K.O. (2015). Symptoms of persistent behavior problems in children with mild traumatic brain injury. *The Journal of Head Trauma Rehabilitation*, *30*(5), 302. https://doi.org/10.1097/HTR.0000000000000106

Taylor, S.R., Smith, C., Harris, B.T., Costine, B.A., & Duhaime, A.C. (2013). Maturation-dependent response of neurogenesis after traumatic brain injury in children. *Journal of Neurosurgery: Pediatrics, 12*(6), 545-554. http://doi.org/doi:10.3171/2013.8.PEDS13154

Theeler, B.J., Flynn, F.G., & Erickson, J.C. (2012). Chronic daily headache in US soldiers after concussion. *Headache: The Journal of Head and Face Pain*, *52*(5), 732-738. https://doi.org/10.1111/j.1526-4610.2012.02112.x

Thompson, M.D., & Irby Jr., J.W. (2003). Recovery from mild head injury in pediatric populations. *Seminars in Pediatric Neurology*, *10*(2), 130-139. https://doi.org/10.1016/S1071-9091(03)00021-4

Van Kampen, D.A., Lovell, M.R., Pardini, J.E., Collins, M.W., & Fu, F.H. (2006). The «value added» of neurocognitive testing after sports-related concussion. *The American Journal of Sports Medicine, 34*(10), 1630-1635. https://doi.org/10.1177/0363546506288677

World Health Organization (1993). *The ICD-10 classification of mental and behavioural disorders: diagnostic criteria for research* (Vol. 2). World Health Organization.

Yeates, K.O., Taylor, H.G., Rusin, J., Bangert, B., Dietrich, A., Nuss, K., Wrigth, M., Nagin, D.S., & Jones, B.L. (2009). Longitudinal trajectories of postconcussive symptoms in children with mild traumatic brain injuries and their relationship to acute clinical status. *Pediatrics*, *123*(3), 735-743. https://doi.org/10.1542/peds.2008-1056