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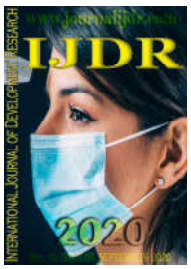

RESEARCH ARTICLE OPEN ACCESS

THE PEDIATRIC TRAUMA SCORE MORE ACCURATELY PREDICTS THE SEVERITY OF INJURY FROM ROAD TRAFFIC ACCIDENTS IN CHILDREN UNDER THE AGE OF 7 YEARS

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ABSTRACT

Background: Road traffic accidents are potentially preventable multifactorial events due to factors such as vehicle fleet growth, human error and inadequate or insufficient laws, being responsible for a significant portion of morbidity and mortality in children. **Objective:** To calculate the Pediatric Trauma Score (PTS) and the Revised Trauma Score (RTS) and compare if there is a relationship between the severity of injury and the age of road traffic victims. **Methods:** This is a descriptive and exploratory study with a quantitative and documentary approach, performed in the city of Sobral, with motorcycle accidents involving children between 2005 and 2013. Data were collected from emergency ambulance service records and analyzed using the Kruskal-Wallis test. **Results:** There were 910 motorcycle accidents involving children between 2005 and 2013, 543 (59.7%) victims were male; 494 (54.3%) were aged 16-18 years old; 377 (41.4%) were victims of motorcycle falls. In the <7 year age group, hit by motorcycle (36.6%) and motorcycle falls (35.9%) were more predominant. PTS showed worse results in the <7 year age group when compared to the other age groups. There were no differences in RTS between the age groups. Among the variables that compose the PTS, musculoskeletal trauma (fractures and skin lesions) is highlighted as a severity factor. **Conclusion:** In motorcycle accidents involving children <7 years, the severity of injury was greater when compared to other age groups. Thus, PTS is a good pre-hospital screening tool to be used in children who have suffered motorcycle accidents.

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INTRODUCTION

In the world, an estimated 1.24 million people are killed in road traffic accidents each year, with a further 20 to 50 million people suffering non-fatal injuries, many of which are temporarily or permanently disabled by these injuries. Traffic accidents are primarily responsible for deaths in the 15 to 29-year age group, and the second, in the range of 5 to 14 years (WHO, 2013). In middle-income countries, WHO forecasts indicate that the situation will become even worse due to an expected increase in motorization rates, with no equivalent investments in road safety (Waiselfisz, 2011). Traffic accidents represent one of the most serious health problems, and a leading cause of morbidity and mortality in most developed and developing countries (Schvartsman *et al*, 2003).

Brazil ranks fifth among countries in traffic deaths behind India, China, the United States and Russia. According to the Brazilian Ministry of Health, in 2015, 37,306 deaths were recorded and 204,000 people were injured (Vias Seguras, 2020). In Brazil, in 2016, according to data from Datasus, the external causes of morbidity and mortality caused 21,573 deaths of children and adolescents, constituting the main cause of death in the age group from 0 to 19 years, and 4,349 (20.2%) of deaths were caused by road traffic accidents (DATASUS, 2020). In almost all countries, accidents are a frequent cause of mortality and disability in childhood. In recent years, medical literature and WHO publications have highlighted the fact that accidents are usually recorded as one of the first five causes of death in the first five years of life, while being the leading cause in those aged over 5 years (WHO, 2013; Waksman & Gikas, 2003; Waksman &Pirito).

Providing assistance at the scene of the accident, the fastest and safest manner, for the victim to be able to receive definitive treatment is the premise to reduce morbidity and mortality of polytrauma patients. In children, about 40% of violent deaths which occur in the period between the accident and their arrival at the hospital have treatable causes. These deaths could be avoided with timely action and with particular emphasis on care of the airways as well as control of hemorrhage at prehospital level (Schvartsman *et al*, 2003). The hospital to which the victim is to be taken depends on the severity of the accident, types of procedure and resources needed for better restoration of health. The magnitude of trauma must be expressed in objective terms. This quantification has fundamental importance, because it allows the screening of the most serious patients, as well as evaluating the quality of the service to be provided (Engum*et al*, 2000). In order for this screening to occur, trauma indices are used, which has the purpose of assessing physiological alterations, severity of anatomical lesions and the probability of survival in polytrauma patients (Júnior *et al*, 1999). Henceforth, this study had as objective to calculate the Pediatric Trauma Score (PTS) and the Revised Trauma Score (RTS) in motorcycle accident victims, and assess if there is a relationship between the severity of injury and age.

METHODS

Study design: This is a cross-sectional retrospective study.The study was conducted at the Mobile Emergency Care Service (SAMU) in the city of Sobral, implemented since August 2005, operating within the city limits and occasionally in neighboring districts. The city of Sobral is located in the northwest region of the state of Ceará, Brazil, with an area of 2,123 km^2 and a population of 199,750 inhabitants: with 86% classified as urban.The study population consisted of motorcycle accident victims, aged 0 to 18 years, attended by SAMU-ambulance service Sobral, between 2005 and 2013.All motorcycle accident victims classified as: motorcycle collisions with other motorcycles, motorcycle collisions with bicycles, motorcycle collisions with cars, motorcycle collisions with other vehicles, hit by motorcycle and motorcycle falls aged 0-18 years were included in the study. Victims with incomplete or unreadable emergency ambulance service records were excluded from the study.

The Mobile Emergency Care Service (SAMU): The Emergency Mobile Assistance Service (SAMU) aims to reach the victim early after any emergency or urgent situation that may lead to suffering, sequelae or even death. Situations of clinical, surgical, traumatic, obstetric, pediatric, psychiatric nature among others are considered emergencies. SAMU is a 24-hour free service, through the provision of guidelines and the sending of manned vehicles by a trained team, accessed by the number “192” and activated by an Emergency Regulation Center.

Variables: Data collected from the emergency ambulance service records consisted of: data of accident (day, month and year); time of accident(7:01 a.m. -1:00 p.m., 1:01 p.m. - 7:00 p.m., 7:01 p.m. 1:00 a.m. and 1:01 a.m. -7:00 a.m.); type of unit victims were transported to (basic or advanced) sent (Advanced Health Unit-USA or Basic Health Unit-USB); age of the victim (in years); neighborhood of the occurrence; sex of the victim; cause of care (motorcycle crash, motorcycle crash, motorbike collision, motorcycle collision, motorbike collision); (weight, airway, systolic blood pressure, skin and presence of fractures); of the RTS (Glasgow coma scale, systolic blood pressure and respiratory rate); type of victim (pedestrian, driver, cyclist).

Trauma scales: The RTS is a physiological scoring system that is used to assess the patient's vital functions consisting of the Glasgow coma scale, systolic blood pressure, and respiratory rate. The parameters are converted to coded scores from 4 (normal) to 0 according to established ranges (Table 1). This scale is widely used for triage in the prehospital setting (denominated the t-RTS), from which the sum of the coded scores (ranging from 0 to 12) the patient is transported to a previously classified trauma center according to the capacity of its diagnostic, therapeutic and human resources). A higher RTS is associated with a better chance of survival (Champion *et al*, 1989). The RTS score was obtained directly from the prehospital care report.

Table 1. The Revised Trauma Score

Glasgow Coma Scale	Systolic Blood Pressure	Respiratory Rate	Coded Score
13-15	>89	10-29	4
9-12	76-89	>29	3
6-8	50-75	6-9	2
4-5	1-49	1-5	1
3	0	0	0

The PTS can be used to evaluate trauma in children, PTS evaluation parameters include patient size, airway patency, system (CNS) status, systolic blood pressure, skeletal trauma and open wounds. Each criterion is assigned a score from +2 to -1 (Table 2), inasmuch that the total score for a patient may range from 12 to -6; the higher the final value, the better the prognosis (Ramenofsky *et al*, 1988). The PTS was calculated retrospectively, using the data collected from the prehospital care report. For approximate weight, the advanced pediatric life support (APLS) formula was used (weight = [age + 4] × 2), the result being expressed in kilograms.

Table 2. The Pediatric Trauma Score.

Component	Coded Score		
	+2	+1	-1
Weight (kg)	>20	10-20	<10
Airway	Normal	Maintainable	Intubated
CNS[a]	Awake	Loss of consciousness	Unresponsive
SBP[b] (mmHg)	>90	50-90	<50
Fractures	None observed or suspected	Closed	Open or multiple
Wounds	None	Minor (< 7 cm), without fascia involvement	Major or penetrating, with fascia involvement

[a] Central nervous system; [b] Systolic blood pressure

Data analysis: A database was prepared using the statistical software package SPSS for Windows, version 22.0, (SPSS Inc., Chicago, IL). The data obtained were submitted to the Kolmogorov-Smirnov test to evaluate their normal distribution. As the data obtained did not follow a normal distribution, the non-parametric Kruskal-Wallis test was used to evaluate the difference between the means found in the PTS and RTS Scales. Values of $p<0.05$ indicated statistical significance. All data was double checked for accuracy by two investigators. To assess the relationship between PTS and the age range, the null hypothesis that the median Pediatric

Trauma Score is the same for all age groups was tested. To assess the relationship of the RTS and the age range, the null hypothesis that the median of the RTS is the same for all age groups was tested.

Ethical considerations: All ethical principles established by the National Health Council in Resolution number 466/2012 were respected and in accordance with the 1964 Helsinki declaration and its later amendments. This study was approved by both the *Comitê de Ética em Pesquisa* (CEP), *Universidade Estadual Vale do Acaraú* (Sobral, CE, Brazil), protocol number 869,057, and the *Universidade Federal do Ceará* (Sobral, CE, Brazil), protocol number 839,236.

RESULTS

A total of 910 reports were assessed from 2005 to 2013, with 59.7% being male. There was an eleven-fold increase in the number of occurrences in 2011(year with the highest number of accidents) compared to 2005. There was no significant difference for the distribution of age (p=.368) and sex (p=.633) between the studied years. The most affected age group was between 16 and 18 years of age, for both sexes, in all the studied years (Table 3). Motorcycle-to-pedestrian collisions and motorcycle falls during the daytime period were the most frequent events in the 0 to 7 and 8 to 11-year-old age groups (p<.001 and .014 for collisions; and p=.012 and .011 for falls,

Table 3. Distribution of motorcycle accidents involving under 18 years olds in the city of Sobral-CE, according to age, year of occurrence and sex

Year	0-7 years		8-11 years		12-15 years		16-18 years	
	Male	Female	Male	Female	Male	Female	Male	Female
2005	1	2	1	3	1	0	6	2
2006	4	0	0	0	2	0	4	4
2007	4	3	2	8	2	9	23	7
2008	10	7	11	3	9	14	28	25
2009	8	6	7	2	11	8	38	23
2010	20	10	9	8	13	16	52	35
2011	20	7	10	10	21	20	54	34
2012	9	6	9	3	20	12	43	32
2013	6	8	6	3	15	15	63	21

All numbers are absolute.

Table 4. Distribution of motorcycle accidents involving under 18 years olds in the city of Sobral-CE, according to age, time and type of accident

Type of accident	0-7 years					8-11 years					12-15 years					16-18 years				
	Time of accident					Time of accident					Time of accident					Time of accident				
	A	B	C	D	p[a]	A	B	C	D	p[a]	A	B	C	D	p[a]	A	B	C	D	p[a]
Motorcycle-to-pedestrian collision	18	18	11	1	.001	12	13	4	4	.014	10	7	10	2	.12	5	7	17	3	.002
Motorcycle fall	16	14	15	2	.012	3	12	5	2	.011	11	28	32	8	<.001	46	62	73	47	.032
Motorcycle-to-motorcycle collision	4	4	3	1	.57	1	3	4	0	.42	2	11	7	0	.30	18	26	23	6	.005
Motorcycle-to-car collision	5	2	5	0	.47	2	2	2	0	1.00	1	5	6	5	.33	19	34	23	10	.003
Motorcycle-to-bicycle collision	3	7	1	0	.08	8	11	3	0	.11	8	11	3	0	.009	13	21	18	1	.001

Table 5. Distribution of median score according to the Revised Trauma Score (RTS) of motorcycle accidents involving under 18 years olds in the city of Sobral-CE, according to the type of accident and age

Typeofaccident	0-7 years		8-11 years		12-15 years		16-18 years		p[a]
	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)	n	Median (IQR)	
Motorcycle fall	47	12 (12.0, 12.0)	2	12 (12.0, 12.0)	78	12 (12.0, 12.0)	227	12 (12.0, 12.0)	.564
Motorcycle-to-pedestrian collision	48	12 (12.0, 12.0)	3	12 (12.0, 12.0)	29	12 (12.0, 12.0)	32	12 (12.0, 12.0)	.295
Motorcycle-to-motorcycle collision	12	12 (12.0, 12.0)	8	12 (12.0, 12.0)	23	12 (12.0, 12.0)	73	12 (12.0, 12.0)	.001
Motorcycle-to-car collision	12	12 (12.0, 12.0)	6	12 (12.0, 12.0)	17	12 (12.0, 12.0)	86	12 (12.0, 12.0)	.939
Motorcycle-to-bicycle collision	11	12 (12.0, 12.0)	2	12 (12.0, 12.0)	35	12 (12.0, 12.0)	53	12 (12.0, 12.0)	.287
Total number of accidents	130	12 (12.0, 12.0)	95	12 (12.0, 12.0)	185	12 (12.0, 12.0)	471	12 (12.0, 12.0)	<.001

All numbers are absolute, unless otherwise stated; IQR interquartile range (25%, 75%); [a] p-value calculated using a Kruskal-Wallis unpaired test.

Table 6. Distribution of median score according to the Pediatric Trauma Scale (PTS) of motorcycle accidents involving under 18 years olds in the city of Sobral-CE, according to the type of accident and age

Type of accident	0-7 years		8-11 years		12-15 years		16-18 years		p[a]
	n	Median (IQR)	n	Median (IQRR	n	Median (IQR)	n	Median (IQR)	
Motorcycle fall	47	10 (8.5, 11.5)	22	11 (10.5, 11.5)	78	11 (11.0, 11.0)	227	11 (11.0, 11.0)	<.001
Motorcycle-to-pedestrian collision	48	10 (8.5, 11.5)	37	11 (10.0, 11.0)	29	11 (11.0, 11.0)	32	11 (11.0, 11.0)	.007
Motorcycle-to-motorcycle collision	12	10 (8.0, 12.0)	8	11 (11.0, 11.0)	23	11 (10.0, 12,0)	73	11 (10.0, 12.0)	.025
Motorcycle-to-car collision	12	10 (8.5, 11.5)	6	11 (10.0, 12.0)	17	11 (11.0, 11.0)	86	11 (10.0, 12.0)	.41
Motorcycle-to-bicycle collision	11	11 (10.0, 12.0)	22	11 (10.0, 12.0)	35	11 (11.0, 11.0)	53	11 (10.0, 12.0)	.09
Total number of accidents	130	10 (9.0, 11.0)	95	11 (10.5, 11.5)	185	11 (11.0, 11.0)	471	11 (10.5, 11.5)	<.001

All numbers are absolute, unless otherwise stated; IQR interquartile range (25%, 75%); [a] p-value calculated using a Kruskal-Wallis unpaired test.

respectively). In the 12 to 15-year-old age, motorcycle falls was the most common type of accident, occurring between 1 p.m. and 7 p.m. and 7 p.m. and 1 a.m. (p<.001). During the same time period, motorcycle falls was also the most common type of accident in the 16 to 18-year-old age group (p=.032), followed by motorcycle to car collisions (p=.003) and motorcycle to motorcycle collisions (p=.005) (Table 4). When the RTS was used, differences in medians were not observed, in relation to age and type of accident, except in motorcycle-to-motorcycle collisions (p=.001) (Table 5). However, there was a significant difference in the median value according to the PTS in patients aged 0 to 7 years when compared to the other age groups, showing greater severity in this age group (Table 6). Involvement of the airways, central nervous system and hemodynamic stability was small (1.0, 3.8 and 1.9% of the victims, respectively) and without differences between the age groups (p=.46, .91 and .24, respectively). Furthermore, there was a higher incidence of fractures and extensive skin lesions in 16 to 18-year-old group (p=.001).Fractures were present in 30.5% of the patients, with a predominance of closed fractures (83.3%) (Data not shown).

DISCUSSION

In this study, 910 cases were attended by the SAMU ambulance service in Sobral between 2005 and 2013. However, it is believed that the actual number of victims was much higher. Passers-by encountering an incident involving young patients tend not to comply with prehospital care standards, placing patients without any immobilization in private vehicles (cars and motorcycles) and taking them to the nearest hospital, not waiting for the arrival of the ambulance service. Such an attitude is taken due to the great emotional appeal caused by seeing a child victim of an accident and also by the ease of removal, since they are often small in size. Sometimes they despise the severity of the trauma and take the child to receive care at home. This approach goes against the prehospital care guideline, which is to not cause additional harm to the patient[3] and is in agreement with the national literature that reports the use of the prehospital service in only 25% of accident victims (Waiselfisz, 2011; Waiselfaisz, 2013). Initiating care at the accident scene and placing the victim as quickly and safely as possible in order to receive the definitive treatment is the premise to reduce morbidity and mortality of the multiple trauma patients. In children, about 40% of violent deaths occurring between the accident and their arrival at the hospital have treatable causes. These deaths could be avoided with a timely performance and with particular emphasis on airway care as well as bleeding control at the prehospital level (Schvartsman*et al*, 2003). The different prehospital assistance services are qualified to perform universal care, but when faced with pediatric patients, the performance is much lower than expected (Schvartsman*et al*, 2003; Fowler *et al*, 2018).

The hospital to which the victim is to be taken depends on the severity of the accident, the types of procedure and the resources needed for better recovery. The magnitude of the trauma must be expressed in objective terms. This quantification is of fundamental importance, since it allows the screening of the most serious patients, besides evaluating the quality of the service provided. The PTS developed solely to measure traumatic lesions in children, has been shown to be effective in grading severity (Schvartsman*et al*, 2003; Tepas *et al*, 1987). In cases involving children, especially in traffic accidents, the trauma is considered multisystemic until proven otherwise. The mechanism of trauma allied with questions on:airway patency; external bleeding and impairment of neurological status provide the regulatory physician subsidies for sending the patient to the most appropriate unit for the case (American Academy of Pediatrics, 2013). The population most involved in motorcycle accidents was that of male adolescents, translating a risk behavior of these, since they considered themselves immune to acts of irresponsibility (Gaspar *et al*, 2004).Rathinam*et al* (2007) identified that in India, and Yeh *et al* (2008) in Taiwan that there were two main predictors for the motorcycle accidents for riders aged between 10 and 16 years - risky behavior and previous encounters with police authorities. In the incidentsin which under 18 year olds were riding motorcycles and suffered accidents, they chose not to trigger prehospital assistance, fearing for repression from the public authorities.

Closed fractures were most common in children under 7 years of age, being the item that scored the most in the PTS in patients with PTS <8. This may have been caused due to the fact that most of the accidents occurred within the urban environment, with an intense traffic, forcing pilots to maintain a low speed (Parreira*et al*, 2012). In addition, the infant skeleton is actively growing and is composed of a large proportion of cartilaginous tissue and metabolically active growth zones. The bony ligaments are strong and resistant. Thus, children with musculoskeletal trauma undergo major forces before having long bone fractures, dislocations or deformities, allowing the significant transmission of force to underlying organs. These findings were compatible with those of previous studies (Allan, 2009; Júnior, 2002).

In this study, the PTS and the RTS in the prehospital setting were studied; the results showed a difference in PTS when compared to RTS in children less than 7 years of age, this may be attributed to motorcycle ejection as a contributing factor to the severity of the trauma (Scheidler*et al*, 2000). PTS has been shown to be a useful tool in the screening of traumatized children and is related to the severity of the trauma (Tepa *et al*, 1987). In our study when comparing RTS as PTS, a difference between the two values was observed; in patients less than 7 years of age median PTS was 10 points, while median PTS was 11 points among the older age groups; this difference was not observed when using RTS. Although Potoka*et al* (2001) mentioned some drawbacks to the use of PTS such as: open wound size not being so precise, placing patients with bleeding and non-bleeding lesions in the same group, and assessing CNS and upper airway patency in a subjective way, the authors believe that in this study that the PTS together with the mechanism of injury (falling from vehicle in movement and pedestrian collisions), increased the sensitivity for the identification of patients with greater severity (Engum*et* al, 2000). In this study, 95% of the patients suffered mild traumatic brain injury (TBI), that is, a Glasgow Coma Scale score of 14-15 points. However, in the 0 to 7-year-old age group, which corresponds to 14.36% of attendance, the children present moderate risk for TBIand, according to DinizGuerra *et al* (2010), the smaller the size of the child the greater the possibility of developing intracranial hypertension. Severe and moderate TBI mostly affected those adolescents who suffered motorcycle fall as the main cause of the accident; these data are in agreement with the literature (Dantas*et al*, 2012). This study has some limitations which have to be pointed out. First, both RTS and PTS are physiologic scoring systems, designed toassess the initial vital signs of a patient,

however, this score may deteriorate especially when the transport time to the hospital is long. Second, the score was made by a single emergency physician. Additionally, the study was conducted in a single city, with a relatively small number of participants. Further studies should be conducted on a wider scale to confirm the usefulness of this scoring system. Nevertheless, the results from this study demonstrated the effectiveness of the PTS when compared to the RTS in the prehospital screening of children. After collecting and analyzing data in this study, the authors conclude that motorcycle accidents involving children under 7 years of age present greater severity of trauma when compared to other age groups, and that such severity is due to musculoskeletal trauma. Furthermore, the PTS proved to be a valuable tool for prehospital screening in children victims of motorcycle accidents. We also recommend further studies to include observation on the use of the RTS and PTS in road traffic injuries in general.

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