

Child and Adolescent Trauma Epidemiology: Insights from a Comprehensive Retrospective Review of 4568 Pediatric Trauma Cases

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Abstract

Objective: The exploration of epidemiological patterns of trauma in underage patients serves as a critical reference for the prevention and treatment of trauma in minors. **Methods:** Data from all cases at the trauma center of the First Hospital of Lanzhou University were collected for the period from November 1, 2020, to October 31, 2023. Cases involving underage trauma patients with complete and quality-controlled data were selected for retrospective analysis. The data analyzed included age, gender, time of trauma, cause of trauma, and major injured body parts. **Results:** A total of 4568 underage trauma patients were identified, comprising 3093 males and 1475 females, resulting in a male-to-female ratio of 2.10:1. Trauma incidents were most prevalent between April and October, with fewer occurrences in November and December. Daily trauma incidents peaked between 18:00 and 22:00, while fewer incidents were recorded from 00:00 to 08:00. Among children aged 0 to 6 years, the highest number of injuries was observed. Falls were the predominant cause of trauma, accounting for 52.78%. In terms of the main injured body parts, the limbs/skin were the most affected (60.22%), followed by the head/neck region (32.03%). A statistically significant disparity was observed in the association between distinct causes of trauma and major injured body parts ($P < 0.001$). **Conclusion:** Trauma among minors occurs more frequently

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in males than in females, with the highest incidence observed among pre-school-aged children. Falls are the primary cause of these injuries. Strengthening fall prevention measures, particularly for preschool-aged children, along with enhancing their self-protective awareness and traffic safety consciousness, can effectively reduce the incidence of injuries among minors, thereby safeguarding their health and well-being.

Keywords

Trauma and Injury, Pediatric Trauma, Trauma Center, Epidemiology, Disease Analysis

1. Introduction

As of 2020, individuals aged 0 - 14 years account for only 17.95% of the total population in China, while those aged 60 and above represent 18.70%. Notably, the segment aged 65 and older constitutes 13.50% of the population [1]. According to United Nations standards [2], China has entered an era of an aging society, and this demographic shift is accelerating. The aging population not only presents challenges for the elderly but also imposes a significant caregiving burden on the younger generation. In the context of the one-child policy, shifts in societal attitudes, and economic factors, the relaxation of birth policies has not succeeded in reversing the decline in birth rates. With a considerable disparity between the populations of minors and the elderly, it is likely that the pressure on today's minors to support the elderly will continue to increase as they transition into adulthood. This trend introduces a range of additional stresses. Ensuring the health and well-being of minors is crucial, not only for their normal development but also for maintaining the overall quality of life for the entire population. In many countries around the world, trauma is recognized as a leading cause of disability and mortality among young individuals. Clearly, trauma significantly affects the health of minors, contributing to adverse health outcomes and fatalities within this demographic [3]-[7]. This article aims to provide a retrospective analysis of trauma cases involving minors, exploring the epidemiological characteristics of trauma incidents among the underage population. In doing so, we intend to offer a literature reference that supports the prevention of trauma incidents in minors and the improvement of corresponding therapeutic capabilities.

2. Methods

2.1. Data Sources

The data utilized in this study were sourced from the trauma database of the First Hospital of Lanzhou University, a recognized Gansu Provincial Level I Trauma Center. For research purposes, access to the trauma database was granted from September 1, 2024, to October 1, 2024. Stringent quality control measures were

implemented to ensure the integrity and accuracy of the dataset, which encompassed comprehensive information on all trauma patients admitted to the hospital from November 1, 2020, to October 31, 2023, totaling 18,235 individuals. All patients provided informed consent for the collection of their data upon admission. The exported dataset primarily included essential demographic factors such as age, gender, cause of trauma, and major injured body parts. The dataset underwent careful screening to exclude patients with incomplete data. Following the data cleaning process, a total of 4,568 pediatric patients with complete information were retained for analysis.

2.2. Study Methods

The identification of trauma causes adhered to the classification method prescribed by the Medical Priority Dispatch System. Simultaneously, the allocation of trauma sites followed the methodology outlined in the Trauma Index [8]. A categorization strategy was employed, whereby the total occurrences of trauma with unspecified causes or sites were collectively designated as “other trauma.” This comprehensive category encompasses a diverse range of trauma types for which specific details regarding either the cause or the site were indeterminable.

2.3. Statistical Methods

Descriptive statistical analysis was performed using Excel 16.0 and SPSS 27.0 software. Various parameters were systematically documented, including the month of trauma occurrence, temporal distribution, composition of trauma causes, distribution of major injured body parts, and patient age. Inter-group comparisons were conducted using Chi-square analysis, with statistical significance established at $P < 0.05$.

3. Results

3.1. Basic Information

Between November 1, 2020, and October 31, 2023, a total of 4568 pediatric trauma patients with complete data were admitted to our trauma center. Among these patients, 3093 were male and 1475 were female, resulting in a male-to-female ratio of 2.10:1. The ages of the patients ranged from 1 month to 18 years. The mean age for males was 9.3 ± 5.1 years, while females had an average age of 7.9 ± 5.1 years.

3.2. Temporal Distribution

The distribution of trauma incidents exhibited a diurnal pattern, with the lowest incidence recorded during the early morning hours. A notable increase in trauma cases was observed during two distinct periods: between 6 am and 12 pm, and again between 2 pm and 8 pm. Seasonally, the period from April to October experienced a significant rise in trauma cases, peaking in September. In contrast, the winter months from November to February demonstrated a marked decrease in the number of trauma cases, as detailed in **Table 1**.

Table 1. Time distribution of trauma.

Months/Hours	0 - 2	2 - 4	4 - 6	6 - 8	8 - 10	10 - 12	12 - 14	14 - 16	16 - 18	18 - 20	20 - 22	22 - 24	Total
Jan	8	1	1	1	4	7	9	18	26	19	22	20	136
Feb	7	2	5	2	15	13	18	20	29	40	42	34	227
Mar	13	2	2	7	13	34	35	39	46	79	73	30	373
Apr	11	5	1	6	22	49	46	37	47	95	80	37	436
May	17	8	3	3	33	57	57	55	64	109	86	49	541
Jun	11	9	4	4	31	39	54	45	55	113	99	50	514
Jul	14	4	4	6	30	53	39	34	46	74	108	50	462
Aug	22	5	7	4	29	56	43	44	36	69	117	62	494
Sep	14	4	10	13	62	69	83	61	88	142	135	89	770
Oct	10	8	2	4	24	51	57	53	56	110	81	45	501
Nov	2	2	0	1	2	10	5	6	13	18	9	3	71
Dec	3	0	2	0	2	4	4	4	8	7	5	4	43
Total	132	50	41	51	267	442	450	416	514	875	857	473	4568

3.3. Distribution of Causes of Trauma

The ranking of trauma causes, in order of prevalence, includes falls, other trauma, road traffic accidents, violence, cutting/stabbing, mechanical injuries, winter sports injuries, animal bites, and burns. The age distribution reveals 1681 cases in the age group of 6 years and below, 1590 cases in the 7 - 12 age group, 696 cases in the 13 - 15 age group, and 601 cases in the 16 - 18 age group. Among these age groups, the highest proportion of cases is observed among preschool children, with notable variations across different age brackets. The gender distribution indicates that, for all causes of trauma, the number of male patients exceeds that of female patients. This suggests the presence of gender differences in the distribution of trauma causes, with most causes being more prevalent in males. Further details can be found in **Table 2**.

3.4. Distribution of Major Injured Body Parts

The data regarding the frequency of major injured body parts indicates that injuries to the limbs and skin were the most prevalent, followed by injuries to the head and neck. Chest and abdominal traumas occurred less frequently than head and neck injuries, while back traumas were the least common. This pattern of injury incidence can be summarized as follows: limbs/skin > head/neck > chest/abdomen > back. Moreover, there was a statistically significant distribution of different major injured body parts in relation to the cause of trauma ($P < 0.001$). Detailed information on the incidence of each major injured body part is presented in **Table 3**.

Table 2. Distribution of causes of trauma.

Cause of Trauma	≤6 (age)		7 - 12 (age)		13 - 15 (age)		16 - 18 (age)		Total		Component ratio (%)	Rank
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female		
Falls	612	398	559	259	237	92	185	69	1593	818	52.78	1
Other trauma	191	143	198	77	109	25	77	30	575	275	18.61	2
Road Traffic Accidents	59	44	128	56	50	20	48	21	285	141	9.33	3
Violence	57	39	119	32	67	17	77	14	320	102	9.24	4
Cutting/stabbing	61	24	81	33	44	12	45	12	231	81	6.83	5
Mechanical injuries	25	22	21	14	13	6	10	6	69	48	2.56	6
Winter sports injuries	0	0	3	1	2	2	3	2	8	5	0.28	7
Animal bite	3	2	5	1	0	0	0	2	8	5	0.28	8
Burns	1	0	3	0	0	0	0	0	4	0	0.09	9
Total	1009	672	1117	473	522	174	445	156	3093	1475	100.00	10

Table 3. Distribution of trauma sites in patients with different causes of trauma (%).

Cause of Trauma	Limbs/skin	Head/neck	Chest/abdomen	Back	Total
Falls	1415 (58.69)	857 (35.55)	97 (4.02)	42 (1.74)	2411 (100.00%)
Other trauma	582 (68.47)	214 (25.18)	42 (4.94)	12 (1.41)	850 (100.00%)
Road Traffic Accidents	241 (56.57)	143 (33.57)	38 (8.92)	4 (0.94)	426 (100.00%)
Violence	163 (38.63)	168 (39.81)	86 (20.38)	5 (1.18)	422 (100.00%)
Cutting/stabbing	250 (80.13)	46 (14.74)	13 (4.17)	3 (0.96)	312 (100.00%)
Mechanical injuries	79 (67.52)	32 (27.35)	3 (2.56)	3 (2.56)	117 (100.00%)
Winter sports injury	7 (53.85)	0 (0.00)	2 (15.38)	4 (30.77)	13 (100.00%)
Animal bite	10 (76.92)	3 (23.08)	0 (0.00)	0 (0.00)	13 (100.00%)
Burns	4 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	4 (100.00%)
Total	2751 (60.22)	1463 (32.03)	281 (6.15)	73 (1.60)	4568 (100.00%)

4. Discussion

4.1. Age and Gender Characteristics of Pediatric Trauma Patients

During the reporting period from November 1, 2020, to October 31, 2023, a cohort of 4568 pediatric trauma patients was analyzed, with preschool children (ages 0 - 6 years) identified as the primary demographic at risk for injuries. This finding aligns with results from various studies conducted worldwide [9]-[11]. Preschool children, due to their limited perception of the external environment and under-developed motor and cognitive abilities, exhibit weaker emergency response capabilities, which places them at a higher risk of injury compared to other age

groups of minors. Research indicates that within the 0 to 6 years age range, the trauma incidence rate is 1.50:1 for males compared to females. Beyond the age of 7, males experience trauma at a rate more than twice that of females. This suggests that significant shifts in trauma patterns occur among children before and after the school-age period, resulting in a markedly higher incidence of trauma in males relative to females. As children aged 0 to 6 have not yet developed distinct gender awareness, behavioral differences between boys and girls are not pronounced. The relatively higher incidence of trauma in local male patients compared to females may be primarily attributed to the greater population of males within this age group in the local context [12], rather than a substantial discrepancy in trauma rates between genders. However, as children age and behavioral tendencies between genders evolve, there is a noticeable increase in the incidence of trauma among males relative to females.

4.2. Temporal Distribution Characteristics

The temporal distribution of injuries indicates that the fewest traumas occur from midnight until dawn, while the highest incidence is observed between 18:00 and 22:00. This peak coincides with the time when minors finish classes and school, resulting in a significant surge in their activities. Consequently, this heightened engagement may contribute to the increased occurrence of trauma during this period. Conversely, from midnight until dawn, a time typically reserved for rest, minors are predominantly at home, engaging in fewer activities, which leads to a lower frequency of injuries. Similar patterns have been identified in research conducted by Cintean [5]. Upon examining the data by month, it was noted that trauma cases were least frequent in November and December, while they peaked between April and October. This pattern is likely attributable to favorable weather conditions during the latter months, which promote increased outdoor activities among minors and subsequently lead to a rise in events that could cause trauma, such as falls and traffic accidents. Although July and August also experienced good weather, the prevalence of end-of-term exams during these months tends to reduce the likelihood of injuries, resulting in fewer trauma cases compared to other months. In contrast, September marks the conclusion of end-of-term exams and the onset of holidays, alleviating academic pressures and contributing to an increase in outdoor activities among minors, which in turn leads to a rise in the number of trauma patients. Furthermore, excessively hot weather in July and August may discourage outdoor activities among minors, serving as an additional factor contributing to the lower incidence of trauma during these months.

4.3. Causes and Major Injury Body Parts Distribution Characteristics

In examining the causes of patient injuries, the predominant factor identified was falls from heights, which is consistent with findings from several other studies [13]-[17]. Children, known for their exuberant playfulness and limited awareness

of the dangers in their surroundings, are at an increased risk of injuries, particularly with the ongoing expansion of infrastructure and urbanization. As the prevalence of steel, reinforced concrete, and cement structures grows in our environment due to continuous development, children engaging in playful activities are especially vulnerable to harm, primarily through falls. Upon analyzing the major injury locations, the predominant sites for various types of trauma were found to be the limbs and skin. A significant relationship was observed between the distribution of major injury body parts and the causes of trauma ($P < 0.001$). Investigating the distribution patterns of major injury body parts in minors is essential, as it lays the groundwork for the early stages of trauma care.

4.4. Recommendations for Prevention and Treatment of Pediatric Trauma

In addressing the epidemiological characteristics of trauma in minors, we propose several improvements: 1) Implementing enhanced safety measures in areas frequented by minors to mitigate risks; 2) Strengthening educational initiatives regarding traffic regulations for minors to increase awareness and reduce traffic-related accidents; 3) Intensifying parental education by utilizing relevant trauma cases to emphasize the necessity for heightened vigilance and protection; and 4) In the domain of trauma care, prioritizing early detection, timely intervention, and prompt rehabilitation is essential to mitigate potential adverse effects on minors. Furthermore, refining trauma registry systems based on identified patterns and characteristics is critical for advancing tailored trauma management for the pediatric population [18]-[21]. In summary, the prevention and treatment of trauma play a vital role in alleviating pressures on families and society, necessitating collective efforts from national, societal, hospital, and individual levels. Conducting trauma epidemiological analyses aids in summarizing the patterns of occurrence and progression of trauma, thereby providing a foundation for the formulation of relevant trauma laws and regulations. Additionally, it serves as a reference for enhancing the quality of trauma care in hospitals.

4.5. Limitations

While our study encompassed two years of patient data from a trauma center in Lanzhou, Gansu Province, China, capturing a substantial number of cases, it is important to acknowledge the potential limitations arising from the diverse socioeconomic conditions across different countries and regions. These disparities can result in significant variations in trauma incidence patterns, thereby constraining the generalizability of our findings beyond this specific context. Consequently, larger multicenter studies are necessary to elucidate universal patterns of trauma occurrence.

5. Conclusion

In the epidemiology of pediatric trauma, there is a notably higher incidence

among males compared to females. Within this demographic, pre-school children experience the highest number of injuries, with falls identified as the predominant cause. It is crucial to strengthen fall prevention measures, particularly for pre-school children, by enhancing their self-protection awareness and traffic safety consciousness. This research aims to reduce the incidence of pediatric trauma, thereby safeguarding the lives and health of minors. Additionally, pediatric trauma exhibits distinct epidemiological characteristics, which warrant further investigation. Refining theories related to the occurrence and development of pediatric trauma is essential for improving preventative measures and healthcare strategies for minors, ultimately ensuring their healthy development.

Author Contributions

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All authors contributed to the article and approved the submitted version.

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Ethics and Dissemination

This study received approval from the Ethics Committee of the First Hospital of Lanzhou University. Patient data were anonymized throughout the research. The findings of this study will be published in a globally influential, open-access academic journal.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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