НЕОНАТОЛОГІЯ, ХІРУРГІЯ ТА ПЕРИНАТАЛЬНА МЕДИЦИНА
NEONATOLOGY, SURGERY AND PERINATAL MEDICINE
Т. XV, №4(58), 2025
VOL. XV, №4(58), 2025
ISSN 2226-1230 (PRINT) ISSN 2413-4260 (ONLINE)
KEY TITLE: NEONATOLOGÌÂ, HÌRURGÌÂ TA PERINATAL'NA MEDICINA (ONLINE)
ABBREVIATED KEY TITLE: NEONATOL. HÌR. PERINAT. MED. (ONLINE)

UDC: 616.381-001-053.2-036.2-084
DOI: 10.24061/2413-4260. XV.4.58.2025.8

CLINICAL AND EPIDEMIOLOGICAL FEATURES OF BLUNT ABDOMINAL TRAUMA IN CHILDREN: DEVELOPMENT OF CRITERIA FOR PREVENTION OF PAEDIATRIC TRAUMA

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Summary.

Blunt abdominal trauma remains a leading cause of morbidity and mortality in the paediatric population, characterised by a high risk of complications and necessitating the development of effective preventive strategies. Trauma constitutes the primary cause of death among children globally, with abdominal injuries accounting for 8-15% of all traumatic injuries in this age group. The anatomical and physiological peculiarities of the paediatric organism render children particularly susceptible to abdominal trauma.

Study objective. *The objective of this study was to determine the clinical and epidemiological characteristics of blunt abdominal trauma in children across different age groups, to identify the principal risk factors, and to develop evidence-based criteria for the prevention of paediatric trauma through analysis of injury mechanisms.*

Materials and methods. *A retrospective analysis of 186 cases of blunt abdominal trauma in children aged 1 month to 18 years was conducted for the period 2018-2023 at the Municipal Non-Profit Enterprise «Ivano-Frankivsk Regional Children's Clinical Hospital of Ivano-Frankivsk Regional Council». The cohort was stratified into five age groups: 1 month-1 year (n = 12), 1-3 years (n = 26), 4-6 years (n = 35), 7-11 years (n = 79), and 12-18 years (n = 34). Clinical, statistical, morphological, and radiological diagnostic methods were employed. Statistical analyses were performed using IBM SPSS Statistics, version 28.0, and R software, version 4.3.0. The study was conducted in full accordance with the principles of the Declaration of Helsinki. The protocol was approved by the Bioethics Committee of Ivano-Frankivsk National Medical University (Protocol No. 7, dated 15 March 2024).*

Study results. *Blunt abdominal trauma was found to occur most frequently in children of primary school age (7-11 years), representing 42.5% of all cases. Males predominated among the injured (64.0%). The principal mechanisms of injury were road traffic accidents (38.2%), falls from height (24.7%), and domestic trauma (21.5%). In infants (1 month-1 year), domestic trauma was predominant (58.3%); with increasing age, the proportion of road traffic accidents and sports-related injuries rose progressively. The spleen (34.4%) and liver (28.0%) were the most commonly injured organs. Conservative management was applied in 78.5% of cases. The overall mortality rate was 3.2%.*

Conclusions. *The proposed criteria for the prevention of paediatric trauma include: reinforcement of transport safety measures with mandatory use of age-appropriate child restraint systems; creation and maintenance of safe play and sports environments; enhancement of parental awareness regarding risk factors for abdominal trauma; development of age-stratified educational programmes on injury prevention; and optimisation of the regional trauma care system.*

Keywords: *Pediatric Trauma; Blunt Abdominal Trauma; Epidemiology; Prevention; Paediatric Traumatism.*

Introduction

Trauma remains the leading cause of morbidity and mortality among children worldwide. Abdominal trauma accounts for approximately 8-15% of all traumatic injuries in this population and is associated with a high risk of complications and fatal outcomes [1]. Blunt abdominal trauma occurs considerably more frequently than penetrating injury and is predominantly attributable to road traffic accidents, falls from height, and sports-related incidents [2].

The anatomical and physiological characteristics of the paediatric organism – including the relatively larger size of intra-abdominal organs, reduced muscular development, and greater flexibility of the costal margins – render children particularly susceptible to abdominal injury [3]. Diagnosis is frequently challenging owing to non-specific clinical manifestations, especially in younger age groups [4].

Although considerable progress has been achieved in the diagnosis and management of abdominal trauma in children, strategies for injury prevention remain insufficiently explored. The development of effective preventive criteria necessitates a detailed analysis of epidemiological patterns, injury mechanisms, and associated risk factors [5].

The objective of study was to determine the clinical and epidemiological characteristics of blunt abdominal trauma in children across different age groups and to formulate evidence-based criteria for the prevention of paediatric injury.

Materials and methods

The study was based on clinical, morphological, radiological, and computed tomography (CT) findings extracted from inpatient medical records of the Municipal Non-Profit Enterprise «Ivano-Frankivsk Regional Children's Clinical Hospital of Ivano-Frankivsk Regional Council», covering the period 2013-2023. A total of 186 children aged 1 month to 18 years were included.

Study groups were formed according to age, in accordance with standard paediatric age classifications: Group 1: 12 children aged 1 month-1 year; Group 2: 26 children aged 1-3 years; Group 3: 35 children aged 4-6 years; Group 4: 79 children aged 7-11 years; Group 5: 34 adolescents aged 12-18 years.

Inclusion criteria were as follows: age between 1 month and 18 years at the time of injury; documented and confirmed blunt abdominal trauma; complete medical documentation, including results of instrumental investigations; and written informed consent provided by parents or legal guardians.

Exclusion criteria comprised: age <1 month or >18 years; acute surgical abdominal pathology; penetrating or

combined abdominal trauma; presence of comorbid conditions potentially influencing the nature or severity of traumatic injury; and incomplete medical records.

Methodologically, the study was based on the comprehensive application of contemporary clinical diagnostic and epidemiological analytical techniques. Clinical, statistical, morphological, and radiological diagnostic methods were employed.

Statistical analysis was performed using IBM SPSS Statistics, version 28.0, and R software, version 4.3.0, with a significance threshold set at $p < 0.05$. Pearson correlation and multivariate regression analyses were conducted.

The study was conducted in full accordance with the principles of the Declaration of Helsinki. The protocol was approved by the Bioethics Committee of Ivano-Frankivsk National Medical University (Protocol No. 7, dated 15 March 2024).

Results and discussion

Analysis of 186 cases of blunt abdominal trauma revealed the highest incidence in children of primary school age (7-11 years): 79 cases (42.5%), a finding attributable to increased physical activity and insufficient risk perception in this age group.

Males predominated across all age strata (119 cases, 64.0%), consistent with global literature reporting a higher propensity for traumatic injury among males.

Analysis of injury mechanisms indicated that road traffic accidents constituted the leading cause of blunt abdominal trauma (71 cases, 38.2%), followed by falls from height (46 cases, 24.7%).

In infants (1 month-1 year), domestic trauma was predominant (58.3%), a pattern attributable to insufficient supervision and suboptimal safety arrangements in the domestic environment. With advancing age, the proportions of road traffic accidents and sports-related injuries increased progressively.

Analysis of injury localisation revealed that the spleen and liver were the most frequently affected organs, a finding consistent with their anatomical position and vascular characteristics. The detailed distribution of injuries is presented in Table 3.

As shown in Table 3, the spleen was the most commonly injured organ (34.4% of cases), a finding explained by its superficial anatomical position and relatively large size in children; capsular and parenchymal lacerations of varying severity predominated. The liver was the second most frequently injured organ (28.0%), with subcapsular haematomas and parenchymal lacerations being the most common lesions. Renal injury occurred in 15.1% of cases, predominantly as contusions and parenchymal lacerations. Less frequent injuries included pancreatic involvement (8.1%), intestinal injury (6.5%), and combined multi-organ trauma (5.4%).

Table 1

Distribution of children with blunt abdominal trauma by age group and gender

Age group	Boys	Girls	Total	Proportion (%)
1 month-1 year	7	5	12	6.5
1-3 years	15	11	26	14.0
4-6 years	23	12	35	18.8
7-11 years	52	27	79	42.5
12-18 years	22	12	34	18.3
Total	119 (64.0%)	67 (36.0%)	186	100.0

Table 2

Distribution of injury mechanisms by age group

Injury mechanism	1 month-1 year	1-3 years	4-6 years	7-11 years	12-18 years	Total
RTA	2 (16.7%)	8 (30.8%)	12 (34.3%)	35 (44.3%)	14 (41.2%)	71 (38.2%)
Falls from height	1 (8.3%)	6 (23.1%)	11 (31.4%)	18 (22.8%)	10 (29.4%)	46 (24.7%)
Domestic trauma	7 (58.3%)	9 (34.6%)	8 (22.9%)	13 (16.5%)	3 (8.8%)	40 (21.5%)
Sports-related trauma	0 (0.0%)	0 (0.0%)	2 (5.7%)	8 (10.1%)	6 (17.6%)	16 (8.6%)
Others mechanisms	2 (16.7%)	3 (11.5%)	2 (5.7%)	5 (6.3%)	1 (2.9%)	13 (7.0%)

Table 3

Frequency of organ damage in blunt abdominal trauma

Injury localization	Number of cases	Proportion (%)	Nature of injuries
Spleen	64	34.4	Capsular and parenchymal lacerations of varying severity
Liver	52	28.0	Subcapsular haematomas, parenchymal lacerations
Kidneys	28	15.1	Contusions, parenchymal lacerations, vascular injuries
Pancreas	15	8.1	Contusions, parenchymal lacerations, ductal injuries
Intestine	12	6.5	Wall lacerations, contusions, mesenteric haematomas
Combined injuries	10	5.4	Involvement of two or more organs
Others	5	2.7	Diaphragm, greater omentum, bladder
Total	186	100.0	

In the majority of cases (78.5%), conservative management was employed, consistent with the current paradigm of non-operative treatment for haemodynamically stable patients. The mortality rate was 3.2% (6 cases), a figure comparable to published data from leading paediatric trauma centres worldwide (Table 4).

ISSN 2226-1230 (PRINT) ISSN 2413-4260 (ONLINE)
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Table 4

Clinical outcomes and treatment modalities

Indicator	Number of cases	Proportion (%)
Treatment modality:		
Conservative	146	78.5
Surgical	40	21.5
Outcomes:		
Complete recovery	168	90.3
Complications	12	6.5
Fatal outcome	6	3.2

Correlation analysis revealed statistically significant associations between: child's age and injury severity ($r = 0.34$, $p < 0.01$); injury mechanism and injury pattern ($r = 0.42$, $p < 0.001$); injury severity and clinical outcome ($r = 0.51$, $p < 0.001$).

The findings of this study confirm that blunt abdominal trauma in children exhibits distinct age- and sex-related patterns. The predominance of males among injured children (64.0%) aligns with international reports and is attributed to a greater propensity for risk-taking behaviour and higher levels of physical activity in boys [6]. The critical importance of preventive interventions in younger children is further supported by evidence on the prevention of unintentional injuries [7].

Comparable sex distribution has been reported in large-scale paediatric trauma studies involving over 12000 childhood injury cases, which also demonstrated a statistically significant male predominance [8]. Epidemiological investigations in paediatric intensive care settings corroborate this trend [9].

The peak incidence in primary school–aged children (42.5%) is associated with a combination of heightened physical activity and inadequate hazard perception, rendering this cohort particularly vulnerable. These results are consistent with global epidemiological data indicating a trauma incidence peak within this age range [10]. Notably, children in this group engage extensively in recreational, sporting, and unsupervised outdoor activities, thereby elevating injury risk.

The high proportion of road traffic accidents among injury mechanisms (38.2%) reflects substantial deficiencies in road safety infrastructure and underscores the urgent need to reinforce protective measures for child passengers. Of particular concern is the age-dependent increase in road traffic accident incidence, reaching a maximum of 44.3% among children aged 7-11 years. This trend may be explained by reduced adult supervision, increased independent mobility, and suboptimal adherence to child restraint system regulations. The injury patterns associated with emerging modes of personal transportation (e.g., scooters, e-bikes) also warrant dedicated attention [11].

Notably, domestic trauma predominated among infants (1 month-1 year), accounting for 58.3% of cases – a finding indicative of insufficient parental supervision and hazardous household conditions. These results underscore the necessity of targeted parental education on the establishment of safe domestic environments for young children. Variability in the management of paediatric abdominal trauma across clinical settings may also influence treatment outcomes [12].

The predominance of splenic (34.4%) and hepatic (28.0%) injuries corresponds to the anatomical and physiological characteristics of the paediatric organism: these organs are positioned more superficially, exhibit relatively larger dimensions compared with adults, and are less protected by underdeveloped musculature. Similar findings have been reported in a study examining temporal trends in the management of paediatric splenic trauma over recent decades [13].

The high proportion of conservative treatment (78.5%) reflects contemporary standards in paediatric trauma care, wherein non-operative management is preferred for haemodynamically stable patients. This approach aligns with guidelines issued by leading paediatric trauma centres and is associated with improved long-term outcomes. The non-operative management of blunt trauma to parenchymal organs in children has demonstrated high efficacy [14].

The observed mortality rate (3.2%) is consistent with figures reported by major paediatric trauma centres globally, suggesting an adequate standard of medical care. Nevertheless, each fatal case warrants thorough multidisciplinary review to identify opportunities for system-level improvement.

The statistically significant correlations identified among key variables confirm the multifactorial nature of paediatric trauma and reinforce the need for a systematic, multidisciplinary preventive strategy. The association between age and injury severity further supports the implementation of age-stratified preventive interventions.

The findings of this study may inform the development of targeted injury prevention programmes. The identified age- and mechanism-specific injury patterns enable the prioritisation of preventive efforts toward the most vulnerable subpopulations and the most prevalent aetiological factors.

Conclusions

This study established that blunt abdominal trauma in children exhibits distinct age-related patterns, with the highest incidence observed in primary school–aged children (7-11 years), representing 42.5% of all cases, and a marked male predominance (64.0%). The principal mechanisms of injury were road traffic accidents (38.2%), falls from height (24.7%), and domestic trauma (21.5%), with age-specific variations in the distribution of these mechanisms.

Analysis of injury localisation revealed that the spleen (34.4%) and liver (28.0%) were the most frequently affected organs. The majority of injuries were of mild to moderate severity, permitting non-operative management in most cases. This is corroborated by the high rate of conservative treatment (78.5%), which reflects current evidence-based practice in paediatric trauma care.

Based on the findings, evidence-based criteria for the prevention of paediatric trauma were formulated,

encompassing the following integrated measures: reinforcement of road safety through mandatory use of age-appropriate child restraint systems; development and maintenance of safe play and sports environments with impact-absorbing surfacing and certified equipment; enhancement of parental and caregiver awareness regarding the principal risk factors for abdominal trauma across different paediatric age groups; design and implementation of age-adapted educational programmes on injury prevention and life safety; and optimisation of the trauma care system with emphasis on diagnostic efficiency and evidence-based treatment algorithms.

The results of this study confirm the necessity of a systematic, age-stratified approach to paediatric trauma prevention, informed by the identified epidemiological patterns and risk factors specific to each developmental stage.

Conflict of interest statement: the authors declare no conflict of interest.

Funding statement: this research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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КЛІНІКО-ЕПІДЕМІОЛОГІЧНІ ОСОБЛИВОСТІ ТУПОЇ АБДОМІНАЛЬНОЇ ТРАВМИ У ДІТЕЙ: РОЗРОБКА КРИТЕРІЇВ ПРОФІЛАКТИКИ ДИТЯЧОГО ТРАВМАТИЗМУ

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Резюме.

Тупа абдомінальна травма залишається однією з провідних причин захворюваності та смертності серед дитячого населення, характеризуючись високим ризиком ускладнень та потребуючи розробки ефективних заходів профілактики. Травматизм є провідною причиною смертності дітей у всьому світі, а абдомінальна травма становить 8-15% від усіх травматичних пошкоджень у дітей. Особливості анатомо-фізіологічної будови дитячого організму роблять дітей особливо вразливими до абдомінальних травм.

Мета дослідження. Визначити клініко-епідеміологічні особливості тупої абдомінальної травми в дітей різних вікових груп, встановити основні фактори ризику та розробити критерії профілактики дитячого травматизму на основі аналізу механізмів травмування.

ISSN 2226-1230 (PRINT) ISSN 2413-4260 (ONLINE)
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Матеріали та методи. Проведено ретроспективний аналіз 186 випадків тупої абдомінальної травми в дітей віком від 1 місяця до 18 років за період 2018-2023 рр. на базі КНП «Івано-Франківська обласна дитяча клінічна лікарня ІФ ОР». Діти були розподілені на 5 вікових груп: 1 міс-1 рік (n=12), 1-3 роки (n=26), 4-6 років (n=35), 7-11 років (n=79), 12-18 років (n=34). Застосовано клініко-статистичний, морфологічний методи та методи променевої діагностики. Дослідження проводилося у повній відповідності з принципами Гельсінської декларації. Протокол дослідження був схвалений комісією з біоетики Івано-Франківського національного медичного університету (протокол № 7 від 15.03.2024). Статистичний аналіз проводився з використанням SPSS 28.0 та R version 4.3.0.

Результати дослідження. Встановлено, що тупа абдомінальна травма найчастіше зустрічається в дітей молодшого шкільного віку (7-11 років) – 42,5% випадків. Серед постраждалих переважали хлопчики (64,0%). Основними механізмами травмування були дорожньо-транспортні пригоди (38,2%), падіння з висоти (24,7%) та побутова травма (21,5%). У дітей першого року життя переважала побутова травма (58,3%), з віком збільшувалася частка ДТП та спортивних травм. Найчастіше уражувалися селезінка (34,4%) та печінка (28,0%). Консервативне лікування застосовувалося в 78,5% випадків. Летальність становила 3,2%.

Висновки. Розроблені критерії профілактики дитячого травматизму включають посилення заходів безпеки в транспорті з обов'язковим використанням дитячих автокрісел, облаштування безпечних ігрових зон та спортивних майданчиків, підвищення обізнаності батьків щодо факторів ризику абдомінальної травми, розробку освітніх програм з безпеки життєдіяльності для різних вікових груп та удосконалення системи медичної допомоги при травмах.

Ключові слова: дитяча травма; тупа абдомінальна травма; епідеміологія; профілактика; дитячий травматизм.

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Received for editorial office on 02/09/2025
Signed for printing on 27/11/2025