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SPECIFICS OF PEDIATRIC INJURIES ASSOCIATED WITH THE USE OF PERSONAL ELECTRIC MOBILITY DEVICES

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Summary

Injuries among children resulting from the use of personal electric mobility devices are common and contribute to a range of adverse societal outcomes, including increased financial strain on healthcare systems, instances of disability, pediatric mortality, and other related consequences. Consequently, investigating the characteristics of pediatric injuries associated with this type of trauma is of paramount importance, as the findings may serve as a foundation for the development and implementation of preventive strategies.

Objective. *To delineate the structure of pediatric trauma and injury mechanisms associated with personal electric mobility devices across different age groups; to compare injury patterns resulting from electric scooters, hoverboards, and electric bicycles; and to examine the correlation between the use of basic protective equipment and the manifestation of trauma.*

Materials and Methods. *The study utilized forensic medical data, including radiographic and computed tomography (CT) imaging, sourced from inpatient records at the Ivano-Frankivsk Regional Children's Clinical Hospital and forensic medical examinations conducted at the Ivano-Frankivsk Regional Bureau of Forensic Medicine. The sample comprised 50 children aged 4-18 years who sustained injuries while using personal electric mobility devices.*

Results. *Traumatic brain injuries accounted for 72% of cases involving electric scooters, 24% for hoverboards, and 3% for electric bicycles. Neck trauma was observed in 75% of electric scooter cases, 25% for hoverboards, and none for electric bicycles. Upper limb injuries were reported in 45% of electric scooter cases, 48% for hoverboards, and 6% for electric bicycles. Lower limb injuries were documented in 56% of electric scooter cases, 37% for hoverboards, and 5% for electric bicycles. Chest trauma was most prevalent in electric bicycle cases (75%), followed by hoverboards (20%) and electric scooters (5%). The absence of basic protective equipment was found to significantly influence the frequency of injuries among children.*

Conclusions. *The study elucidated the structure of pediatric trauma associated with the use of personal electric mobility devices. The findings demonstrated that the lack of basic protective equipment significantly impacts the incidence of injuries among children across various age groups.*

Keywords: *Traffic Injury; Childhood; Personal Electric Mobility Device Injury; Injury Mechanism; Traumatic Brain Injury.*

Introduction

The 21st century marks a period of significant advancement in micromobility, characterized by the rapid proliferation of light electric vehicles, such as e-scooters and e-bikes, in urban centers and metropolitan areas. In Ukraine, the development of personal light transport has been particularly notable, encompassing over 12 types of devices, including Segways, electric unicycles, rollerblades, electric rollerblades, hoverboards, and others. Concurrent with the increasing prevalence of personal electric micromobility devices on roadways, there has been a consistent rise in traffic-related accidents and associated injuries [1-4].

Annually, thousands of individuals, including children, sustain injuries or disabilities due to accidents involving personal electric mobility devices, leading to profound impacts on family life and broader societal well-being [5-7].

The anatomical and physiological characteristics of children render them more susceptible to distinct injury mechanisms and higher injury rates compared to adults, potentially exerting detrimental effects on their development [8-9]. Consequently, investigating the structure, mechanisms, and consequences of pediatric injuries resulting from the use of personal electric mobility devices is of considerable relevance. Such research can inform the development of preventive measures, including age restrictions and mandatory use of basic safety equipment, to mitigate the risk of injuries among children utilizing these devices.

Objective. To determine the structure of pediatric trauma and injury mechanisms associated with personal electric mobility devices across different age groups, and to compare injury patterns resulting from electric scooters, hoverboards, and electric bicycles.

Materials and Methods

The study utilized forensic medical data, including radiographic and computed tomography (CT) imaging, obtained from inpatient records at the Ivano-Frankivsk Regional Children's Clinical Hospital and forensic examinations conducted at the Ivano-Frankivsk Regional Bureau of Forensic Medicine. The study cohort comprised 50 children aged 4-18 years who sustained injuries while using personal electric mobility devices. Injuries were categorized by age group: Group 1 – males and females aged 4-6 years (10 individuals); Group 2 – aged 7-9 years (10 individuals); Group 3 – aged 10-13 years (10 individuals); Group 4 – aged 14-18 years (10 individuals).

Inclusion criteria consisted of voluntary consent from parents or guardians and an age range of 4-18 years for individuals injured while using personal electric mobility devices. For cases involving forensic examinations, additional consent was obtained from the relevant investigative authority (police investigator). The scope and methods of the comply with Helsinki Declaration principles on biomedical research (1974), as amended at the 41st International Assembly in Hong Kong (1989),

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involving human subjects. The study ensured adherence to core principles: respect for persons, informed consent, and risk-benefit assessment.

Results and Discussion

Analysis of morphological injury characteristics across different age groups and device types (electric scooter, self-balancing hoverboard (hereafter hoverboard), electric bicycle) revealed characteristic neck, upper and lower limb, chest, and traumatic brain injuries (Fig. 1).

Traumatic brain injuries were most frequently associated with electric scooters (72% of total cases), followed by hoverboards (24%) and electric bicycles (3%). Neck injuries were observed in 75% of electric scooter cases, 25% of hoverboard cases, and none in electric bicycle cases. Upper limb injuries were reported in 45% of electric scooter cases, 48% of hoverboard cases, and 6% of electric bicycle cases. Lower limb injuries were documented in 56% of electric scooter cases, 37% of hoverboard cases, and 5% of electric bicycle cases. Chest trauma was most prevalent in electric bicycle cases (75%), followed by hoverboards (20%) and electric scooters (5%).

These findings are consistent with those reported by McKay W, et al. 2023 [10], confirming that e-scooter and hoverboard users predominantly experience traumatic brain and limb injuries, whereas e-bike users are more likely to sustain chest injuries, with fewer instances of limb and brain injuries.

The absence of basic protective equipment was found to significantly influence the frequency of injuries among children. The correlation between injury frequency and the presence or absence of basic protective equipment (e.g., helmets, knee pads) is illustrated in Fig. 2. These findings are corroborated by other studies examining the impact of helmet use on the occurrence and severity of injuries among electric scooter users [11,12].

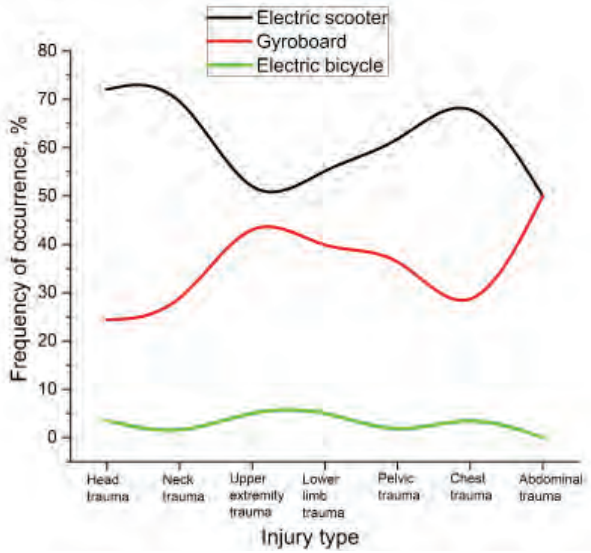

Fig. 1. Structure of pediatric injuries associated with personal electric mobility devices.

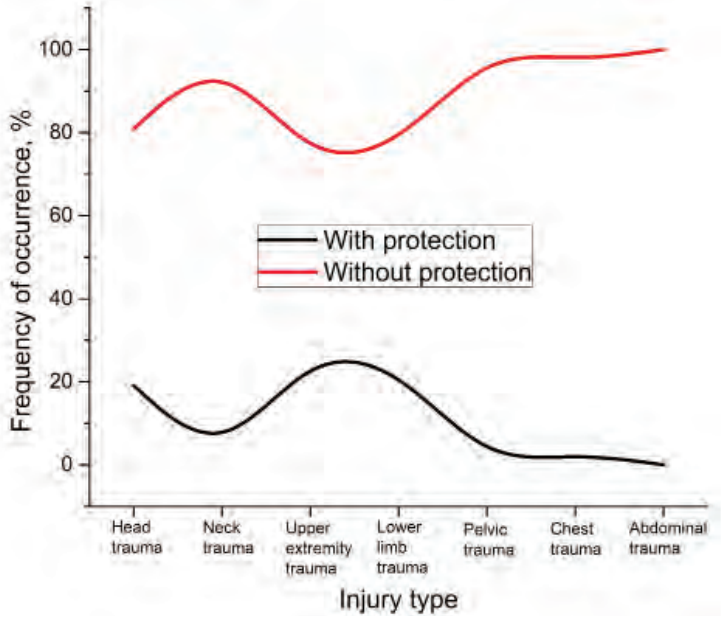

Fig. 2. Relationship between injury frequency and the presence or absence of basic protective equipment.

The study revealed that for children aged 4-6 years, the most prevalent injury mechanism was falling from an electric scooter, with no reported collisions between scooters and motor vehicles. A similar trend was observed in the 7-9 age group, though a new mechanism emerged – scooter-vehicle collisions – accounting for 2% of total injuries (Fig. 3).

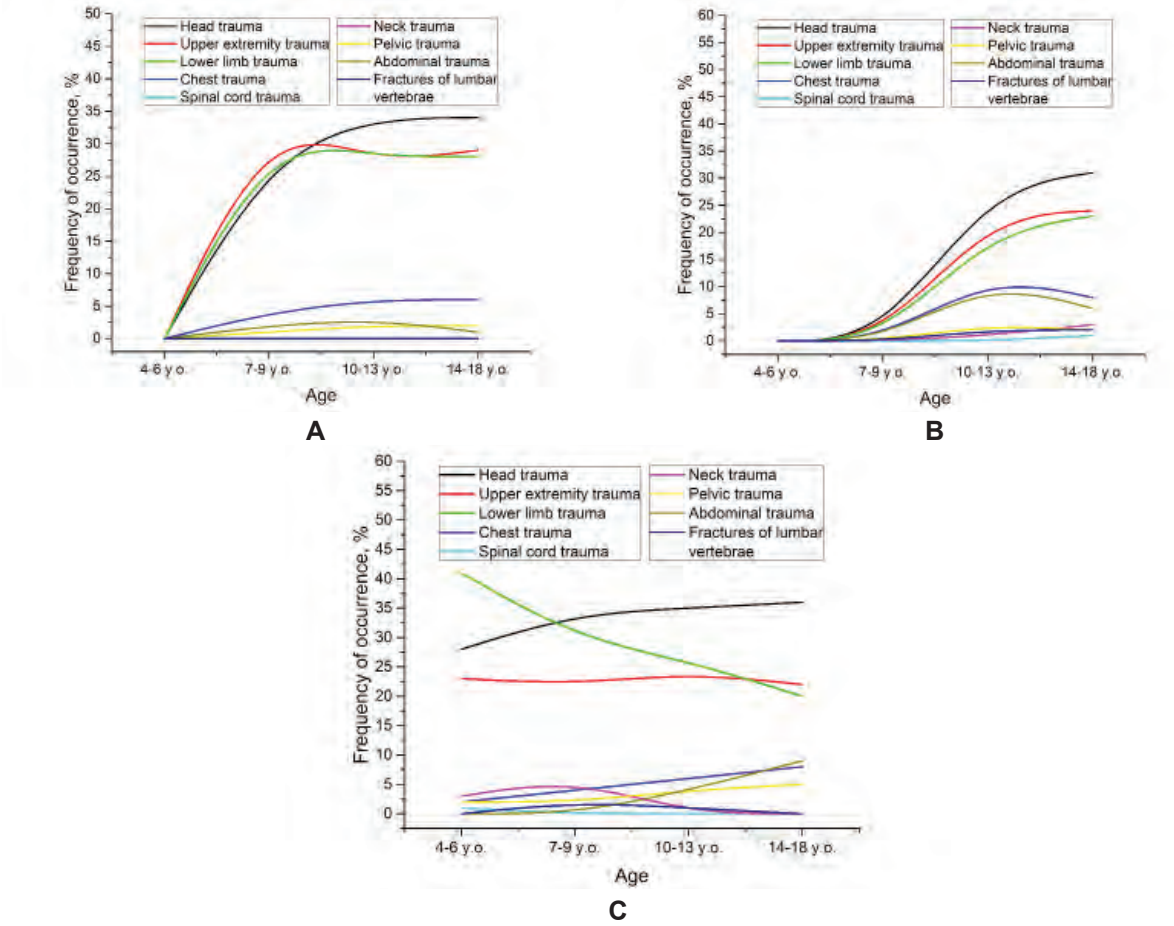

Fig. 3. Injury mechanisms: A – electric scooter and vehicle collision, B – electric scooter and pedestrian collision, C – falling from a moving electric scooter.

In the 10-13 and 14-18 age groups, falling from electric scooters remained the predominant injury mechanism (57% and 55%, respectively). These older age groups also exhibited an increased frequency of scooter-vehicle collisions (Fig. 3).

Analysis of the results demonstrated that falling from a scooter was a characteristic injury mechanism across all age groups, consistent with findings from prior studies [13-14]. No scooter-vehicle collisions were reported among children aged 4-6 years. Isolated instances of such collisions were observed in the 7-9 age group. Notably, a clear trend emerged: as the age of the children increased, so did the frequency of scooter-vehicle collisions.

Conclusion

The study delineated the structure of pediatric injuries associated with personal electric mobility devices: users of e-scooters and hoverboards predominantly sustained traumatic brain and limb injuries, whereas e-bike users were more likely to experience chest injuries, with fewer instances of limb and brain injuries. The research demonstrated that the lack of basic protective equipment significantly influenced injury frequency across all age groups. Analysis identified three primary injury mechanisms for e-scooters: falling from a moving scooter, collisions with pedestrians, and collisions with motor vehicles. Age-specific patterns were observed: falling was common across all age groups; no scooter-vehicle collisions occurred among children aged 4-6 years; and the frequency of scooter-vehicle collisions increased with age.

Conflict of interest: The authors declare no conflict of interest.

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ОСОБЛИВОСТІ ТРАВМУВАННЯ ДІТЕЙ ПРИ ЕКСПЛУАТАЦІЇ ЕЛЕКТРИЧНИХ ЗАСОБІВ ПЕРСОНАЛЬНОЇ МОБІЛЬНОСТІ

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Резюме.

Травмування дітей під час експлуатації електричних засобів персональної мобільності є поширеним явищем і тягне за собою ряд соціально-негативних наслідків, таких як фінансове навантаження на лікувальні заклади, інвалідизація, смерть осіб дитячого віку та інші. Тому вивчення особливостей ушкоджень дітей при даному виді травми є дуже важливим, адже отримані результати можуть лягти в основу розробки та впровадження превентивних заходів.

Мета. Встановити структуру дитячої травми та механізм утворення тілесних ушкоджень, отриманих внаслідок травми на електричних засобах персональної мобільності, у дітей різних вікових груп; порівняти особливості травмування дітей внаслідок експлуатації електросамокатів, гіроскутерів та електровелосипедів; встановити зв'язок між наявністю базових засобів захисту та проявом травми.

Матеріали і методи дослідження. У дослідженні використовувались судово-медичні дані, у тому числі, фоторентгенограми та результати комп'ютерної томографії, отримані з карт стаціонарних хворих із КНП «Івано-Франківська Обласна дитяча клінічна лікарня ІФ ОР» та під час проведення судово-медичної експертизи дітей, котрі травмувалися внаслідок експлуатації електричних засобів персональної мобільності, Івано-Франківського обласного бюро судово-медичної експертизи стосовно 50-ти осіб віком від 4 до 18 років.

Результати дослідження. Встановлено, що черепно-мозкова травма у 72,0% від загальної кількості випадків травмування, зустрічалася при експлуатації електричного самокату. У випадку травмування на гіроборді частота прояву черепно-мозкової травми становила 24,0%, а для травмування на електричному велосипеді – 3,0%; травма шиї: у випадках травмування на електричному самокаті частота її прояву становила 75,0%, у випадку травмування на гіроборді – 25,0% та зовсім не зустрічалася при травмуванні на електричному велосипеді; травма верхніх кінцівок: 45,0% випадків зустрічалося у випадку травмування на електросамокаті, 48,0%, у випадку травмування на гіроборді та 6,0% на електровелосипеді; травма нижніх кінцівок: 56,0% випадків зустрічалося у випадку травмування на електросамокаті; 37,0%, у випадку травмування на гіроборді та 5% на електровелосипеді; травма грудної клітки: 75,0% випадків зустрічалося у випадку травмування на електровелосипеді; 20,0%, у випадку травмування на гіроборді та 5,0% електросамокаті. Істотно на частоту виникнення тілесних ушкоджень у дітей впливало відсутність базових засобів захисту.

Висновки. Результатом проведеної робити стало встановлення структури дитячої травми, пов'язаної із експлуатацією електричних засобів персональної мобільності. Досліджено, що відсутність базових засобів захисту істотно впливає на частоту травмування дітей різних вікових груп.

Ключові слова: транспортна травма; дитячий вік; травма на електричних засобах персональної мобільності; механізм травмування; черепно-мозкова травма.

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