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FORENSIC MEDICAL ANALYSIS OF FATAL FALLS FROM HEIGHTS AMONG CHILDREN IN UKRAINE

A. O. Pletenetska

Bogomolets National Medical University, Department of Forensic Medicine and Medical Law Kyiv, Ukraine
ORCID ID: [0000-0002-7029-3377](https://orcid.org/0000-0002-7029-3377), e-mail: fantasylinka@gmail.com

Abstract. Relevance. Child mortality due to falls from heights is a significant public health issue that requires thorough research to identify risk factors and develop effective preventive measures.

The aim of the research was to conduct a forensic medical analysis of the causes of child mortality in Ukraine related to falls from heights, to identify risk factors, and to develop recommendations for improving medical responses, preventing such incidents, and reducing mortality rates.

The materials for the study were annual reports from the Bureau of Forensic Medical Examination of Ukraine for the period from 2019 to 2022. The study focused on cases of violent deaths, specifically those caused by falls from heights. Statistical analysis methods were used, including the calculation of percentage indicators and confidence intervals, utilizing open-source software such as OpenOffice and GNU Octave.

Results. The study revealed that the number of fatal falls among children in Ukraine fluctuated between 2019 and 2022, with a noticeable decrease in 2022. However, this reduction may be partially explained by the evacuation of a large number of children due to the war, which provided them with safer environments. The highest mortality rate from falls occurred among adolescents aged 12–18 years, suggesting increased risky behavior, participation in extreme sports, or possibly suicidal tendencies. In 2020, there was an increase in fatalities among children aged 1–7 years, particularly among girls, which may be attributed to inadequate supervision during the lockdown when children spent more time at home but were not always under proper adult control. Compared to previous years, 2021 saw a slight rise in mortality from falls, especially among adolescents, pointing to increased psychological stress, depression, and social problems in this age group. The impact of the war and the pandemic significantly altered the conditions under which children lived, greatly influencing the structure of mortality. In particular, due to changes in social conditions and reduced outdoor activity, mortality from falls decreased, though this change does not necessarily indicate a reduction in the overall risk of falls in society.

Conclusions. Forensic medical analysis of child mortality from falls in Ukraine highlighted the importance of thoroughly investigating each case to accurately determine the causes of death. The impact of the pandemic and the war on these trends is significant and requires separate consideration. To reduce mortality, it is essential to improve the medical response system and preventive measures, especially in the context of changing social circumstances. The study also emphasizes the importance of considering psychological, social, and demographic factors related to falls from heights among children.

Keywords: child mortality, falls, forensic medical expertise, violent death, Ukraine, war.

Introduction. Falls from height are one of the leading causes of pediatric trauma and fatalities worldwide. According to the Centers for Disease Control and Prevention (CDC), falls are among the primary causes of both fatal and nonfatal injuries in children [1]. The high frequency of such incidents, along with the severity of sustained injuries, necessitates a detailed analysis of their causes, circumstances, and outcomes.

Recent studies indicate that falls from height pose a significant danger to children due to their physiological and anatomical vulnerabilities. For instance, a recent analysis demonstrated that injuries sustained from falls vary depending on the child's age, the height of the fall, and the surface on which the impact occurs [2]. Additionally, the conditions under which falls happen play a crucial role. A study conducted in the United Kingdom found that a substantial proportion of falls occur due to children's accidental access to windows and balconies [3].

A particularly important distinction is observed between low- and high-altitude falls. As shown by retrospective analyses, falls from heights exceeding three meters are more likely to result in severe traumatic brain injuries, which are a major cause of fatalities in such cases [4]. Furthermore, preventive measures aimed at mitigating fall risks play a key role in reducing pediatric injuries. Experts emphasize the necessity of implementing effective strategies, such as installing protective barriers and educating parents [5].

Recent studies also suggest that analyzing the circumstances of falls can be significantly improved using modern methods, particularly machine learning, which allows for a more detailed research of risk factors and the prediction of injury likelihood [6].

In Ukraine, all cases of violent death, including fatal falls from height, are subject to mandatory forensic examination. This process enables the determination of trauma

mechanisms, their consistency with reported circumstances, and the exclusion of potential criminal factors. Forensic examinations of such cases are conducted in accordance with national regulations and involve pathological examination, histological analysis, and, when necessary, additional methods such as toxicological and biochemical testing. However, forensic practice in Ukraine faces limitations in employing modern technologies, such as post-mortem computed tomography, which is a standard procedure in some European countries and the United States.

Thus, research into child mortality due to falls from height remains a pressing issue in modern medicine and forensic science, requiring a comprehensive approach to assess its scale and develop effective preventive measures.

Aim. The aim of the research was to analyze the causes of child mortality in Ukraine related to falls from height, using forensic medical data to identify risk factors and develop recommendations for improving medical response, preventing such incidents, and reducing mortality.

Materials and methods. The material for the research consisted of annual reports from the Bureau of Forensic Medical Expertise of Ukraine for the period 2019–2022, containing data on the causes of death of children whose bodies were examined in forensic institutions. Cases of violent deaths, including those resulting from falls

from height, were selected for analysis.

Forensic and clinical analysis was conducted to identify patterns and potential opportunities for preventing such incidents in the future. Quantitative indicators were evaluated as percentages (P), calculated as the ratio of the number of cases with the studied characteristics (n) to the total number of cases (N). To determine the reliability of the results, the margin of error (mP) and the 95% confidence interval (CI) were calculated.

Statistical data processing was performed using open-source software. In particular, OpenOffice packages (Base, Calc, Writer, Draw, Math) were used for storing and analyzing textual and tabular data, and GNU Octave for mathematical processing. The results of the study were saved in *.doc and *.xls formats, in accordance with the GPL (GNU General Public License).

Results. Forensic medical analysis of child mortality due to falls from height in Ukraine shows certain trends during the period from 2019 to 2022. According to the provided data, the total number of violent deaths across all age groups ranged from 28,690 to 42,773 individuals. The share of child fatalities within this general context fluctuated, but showed certain patterns (Table 1).

Table 1

Distribution of Child Deaths from Falls from Height in Ukraine for 2019–2022 According to Forensic Medical Data

Indicator, Year	Total deaths (0 – Older than 60)	Total child deaths				to 1 Year		1 to 7 Years		7 to 12 Years		12 to 18 Years	
		n	P, %	mp	CI, %	Male	Female	Male	Female	Male	Female	Male	Female
2019 Violent death	823	2,7	0,1	0,2									
Fall from Height	30121	74	4,8	0,5	1,1	61	45	129	55	101	44	273	115
2020 Violent death	770	2,7	0,1	0,2									
Fall from Height	28690	72	4,9	0,6	1,1	39	43	110	66	79	42	270	121
2021 Violent death	827	2,8	0,1	0,2									
Fall from Height	29219	79	4,1	0,5	0,9	49	31	85	66	91	50	328	127
2022 Violent death	712	1,7	0,1	0,1									
Fall from Height	42773	49	3,0	0,4	0,8	47	46	77	54	81	51	246	110
Fall from Height	2286					0	0	7	4	3	8	14	13

In 2019, a total of 823 child deaths were recorded, accounting for 2.7% of all violent deaths. Of these, 74 cases were related to falls from height, making up 4.8% of total child mortality. The highest mortality rate was observed in the 12-18 age group (31 boys and 14 girls), which may be explained by the greater mobility of this group and their potential involvement in risky activities. Children in this age group are more prone to traumatic falls due to their active lifestyle, participation in extreme sports, lack of adult supervision, and possible suicidal intentions.

In 2020, the total number of child deaths decreased to 770 cases, but mortality from falls from height remained almost unchanged (72 cases, 4.9%). The reduction in the number of violent deaths can be explained by the impact of quarantine restrictions, which reduced the number of risky situations outside the home. However, mortality from

falls among girls aged 1-7 years increased almost twofold (from 5 to 9 cases), indicating possible gaps in supervision of children in this age group. This could be linked to young children staying at home during isolation but not always being under proper adult supervision, which may have contributed to tragic falls.

In 2021, there was an overall increase in the number of violent deaths among children (827 cases), as well as a slight rise in mortality from falls from height (79 cases, 4.1%). Although the general trend remained the same, a significant spike in mortality was noted among adolescents aged 12-18 years — 29 boys and 25 girls. This could indicate more significant social and psychological issues in this age group, such as depression, psychological pressure, or reckless behavior. Additionally, this group saw a higher number of accidents related to falls from multi-story build-

ings, bridges, and other high structures. It is possible that some of these deaths were suicidal, which requires further research considering the emotional state of adolescents in modern society.

A sharp decrease in the number of child deaths from violent causes in 2022 (712 cases) compared to previous years can be explained by several factors, including the impact of the war. A large number of children were evacuated or left the country, affecting the overall statistics. Moreover, the number of deaths from falls from height significantly decreased in 2022 — 49 cases (3.0%), the lowest figure during the analyzed period. A notable decrease was observed in the 7-12 and 12-18 age groups. The reduction in mortality from falls in these age groups can be explained by the fact that many children, due to evacuation, were in safer environments, including places with fewer risk factors. Additionally, the wartime situation changed children's recreational activities — outdoor time and exposure to dangerous playgrounds decreased due to the threat of combat operations.

In forensic medical practice, adolescents often had multiple polytraumas typical of falls from great heights, while younger children mostly presented with traumatic brain injuries, which may indicate differences in the mechanisms of falls.

Analyzing the data, it should be noted that changes in child mortality from falls from height may have been caused not only by social and demographic factors but also by external circumstances, such as the COVID-19 pandemic and the start of Russia's full-scale invasion of Ukraine in 2022. The impact of these events significantly influenced the general trends and structure of child mortality. Further research is needed, taking into account psychological, social, and economic factors that may have a significant impact on child mortality rates.

Conclusions.

Forensic medical analysis indicates a decrease in fatal falls among children in 2022; however, this may not solely be due to preventive measures but also a result of the large-scale evacuation of children due to the war. Many children were in safer conditions, which may have contributed to the reduction in mortality, but this does not necessarily indicate a decrease in fall risk in a broader context.

The forensic medical analysis shows that falls could have been caused by both accidental circumstances (accidents due to loss of balance) and intentional actions (suicidal intentions, murders), highlighting the need for thorough investigation of each case to determine the cause of death more accurately.

In adolescents, injuries related to falls from great

heights were most frequently recorded, which may indicate risky behavior (e.g., participation in extreme sports or carelessness) or, potentially, suicidal intentions.

The pandemic and war have altered children's behavioral patterns, which may be reflected in the statistics of falls. However, such changes are difficult to interpret unambiguously, as they may be influenced not only by social or psychological factors but also by changes in children's living conditions.

To clearly identify the causes of child deaths from falls from height, further studies are needed, considering social, psychological, and demographic factors, as well as thorough analysis of each case to identify potential links with external circumstances (war, pandemic, etc.).

Perspectives for future research involve studying the psychological, social, and environmental factors that influence the risk of fatal falls among children, as well as developing effective preventive measures based on forensic medical data. Furthermore, it is necessary to consider the changes caused by external circumstances, such as war and the pandemic.

Ethical standards compliance. The research was conducted in accordance with the key principles and rules of humane treatment of patients as outlined in the Tokyo Declaration of the World Medical Association, the International Recommendations of the Helsinki Declaration on Human Rights, the Council of Europe's Convention on Human Rights and Biomedicine, the Laws of Ukraine, orders of the Ministry of Health of Ukraine, and the requirements of the Ethical Code of the Ukrainian Doctor.

Access to forensic medical data was obtained based on a Cooperation Agreement with the State Institution "Main Bureau of Forensic Medical Examination of the Ministry of Health of Ukraine" and the O.O. Bogomolets National Medical University. During the study, no data was used that could identify the victims or other parties involved in criminal proceedings, and there was no need to obtain approval from an ethics committee, as the research did not include the disclosure of operational investigative data or pre-trial investigations.

No part of this work contains plagiarism or data fabrication. All sources of information have been properly cited and referenced.

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References:

- Centers for Disease Control and Prevention. (n.d.). Web-based injury statistics query and reporting system (WISQARS): Nonfatal Injury. Retrieved January 21, 2025, from <https://www.cdc.gov/injury/wisqars/index.html>
- Kong K Y C, & Tham LP (2024, February 16). Falls from height in children: Epidemiology and outcome. Singapore Medical Journal. Advance online publication. <https://doi.org/10.4103/singaporemedj.SMJ-2021-397>
- Rajagopal M, Kundra M, Mabood N Ali, S, Rankin T. Dow N, & Craig W (2020, August 20). Paediatric injuries due to falls from windows and balconies: An 8-year prospective and retrospective review. Paediatrics & Child Health, 26(5), e222–e228. <https://doi.org/10.1093/pch/pxaa090>

4. Bandte A, Püschel K, & Krajewski K (2018, September). Traumatic brain injury in high versus low falls in young children and adolescents: A retrospective analysis. *Journal of Neurosurgery: Pediatrics*, 22(3), 233–237. <https://doi.org/10.3171/2018.2.PEDS17714>
5. Guirguis-Blake J M, Michael Y L, Perdue L A, Coppola E L, Beil TL, & Thompson JH (2018, April). Interventions to prevent falls in community-dwelling older adults: A systematic review for the U.S. Preventive Services Task Force [Internet]. Agency for Healthcare Research and Quality (US). <https://www.ncbi.nlm.nih.gov/books/NBK507253/>
6. Omaki E, Shields W, Rouhizadeh M, Delgado-Barroso P, Stefanos R, & Gielen A (2023, October). Understanding the circumstances of paediatric fall injuries: A machine learning analysis of NEISS narratives. *Injury Prevention*, 29(5), 384–388. <https://doi.org/10.1136/ip-2023-044858>

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СУДОВО-МЕДИЧНИЙ АНАЛІЗ ЛЕТАЛЬНИХ ПАДІНЬ З ВИСОТИ СЕРЕД ДІТЕЙ В УКРАЇНІ

А. О. Плетенецька

Національний медичний університет імені О.О. Богомольця, кафедра судової медицини та медичного права, м. Київ, Україна

ORCID ID: 0000-0002-7029-3377, e-mail: fantasylinka@gmail.com

Резюме. Актуальність. Дитяча смертність через падіння з висоти є важливою проблемою охорони здоров'я, яка потребує детального дослідження для визначення факторів ризику та розробки ефективних профілактичних заходів.

Метою дослідження було провести судово-медичний аналіз причин дитячої смертності в Україні, пов'язаної з падіннями з висоти, для виявлення факторів ризику та розробки рекомендацій щодо покращення медичного реагування, профілактики таких випадків і зменшення летальності.

Матеріали та методи. Як матеріал для дослідження було використано річні звіти бюро судово-медичної експертизи України за період 2019–2022 років. Для аналізу були виокремлені випадки насильницької смерті, зокрема ті, що трапилися внаслідок падінь з висоти. Застосовано статистичні методи аналізу, включно з розрахунком відсоткових показників і довірчих інтервалів, з використанням програмного забезпечення з відкритим вихідним кодом, зокрема OpenOffice та GNU Octave.

Результати. Дослідження показало, що кількість смертельних падінь серед дітей в Україні змінювалася упродовж 2019–2022 років, причому у 2022 році було зафіксовано зниження загальної кількості смертей. Однак цей результат може бути частково пояснений евакуацією великої кількості дітей через війну, що створило для них безпечніші умови. Найвищий рівень смертності через падіння з висоти був серед підлітків 12–18 років, що може свідчити про підвищену схильність цієї групи до ризикованої поведінки, участі в екстремальних видах спорту або, можливо, суїцидальних намірів. У 2020 році спостерігалось збільшення смертності серед дітей 1–7 років, особливо серед дівчаток, що може бути результатом недостатнього нагляду під час карантину, коли діти більше часу проводили вдома, але не завжди під належним контролем дорослих. Порівняно з попередніми роками, у 2021 році зафіксовано незначне збільшення смертей через падіння, зокрема серед підлітків, що вказує на зростання психологічного стресу, депресії та соціальних проблем у цій віковій групі. Вплив війни та пандемії значно змінив умови, в яких перебували діти, що мало великий вплив на структуру смертності. Зокрема, внаслідок змін у соціальних умовах та зменшення часу проведення на вулиці, смертність від падінь серед дітей знизилася, однак ця зміна не обов'язково свідчить про зменшення загального ризику падінь у суспільстві.

Висновки. Судово-медичний аналіз дитячої смертності через падіння з висоти в Україні показав важливість детального вивчення кожного випадку для точнішого визначення причин смертей. Вплив пандемії і війни на ці показники є суттєвим і потребує окремого розгляду. Для зниження смертності необхідно удосконалити систему медичного реагування та профілактичні заходи, зокрема в умовах зміненої соціальної ситуації. Дослідження також підкреслює важливість урахування психологічних, соціальних і демографічних чинників у контексті падінь з висоти серед дітей.

Ключові слова: дитяча смертність, падіння, судово-медична експертиза, насильницька смерть, Україна, війна.

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