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RETROSPECTIVE OBSERVATIONAL STUDY OF INJURIES MANAGED BY EMERGENCY MEDICAL SERVICES IN NOVÉ ZÁMKY REGION, SLOVAKIA

RETROSPEKTÍVNA OBSERVAČNÁ ŠTÚDIA ÚRAZOV RIEŠENÝCH ZÁCHRANNOU
ZDRAVOTNOU SLUŽBOU V REGIÓNE NOVÉ ZÁMKY, SLOVENSKO

Tomáš Dudich¹, Andrea Bratová²

Tomáš Dudich je doktorandom v odbore verejné zdravotníctvo na Vysokej škole zdravotníctva a sociálnej práce sv. Alžbety v Bratislave a študentom Fakulty zdravotníckych vied Univerzity v Pécsi. Vo výskume sa venuje epidemiológii úrazov, prednemocničnej neodkladnej zdravotnej starostlivosti a vzdelávaniu zdravotníckych pracovníkov. Andrea Bratová sa vo svojej odbornej a výskumnej činnosti venuje ošetrovateľstvu, anesteziológii a intenzívnej starostlivosti, prvej pomoci, kvalite a bezpečnosti zdravotnej starostlivosti. Spoločný výskum autorov sa zameriava na epidemiológiu úrazov a prednemocničnú neodkladnú zdravotnú starostlivosť.

Tomáš Dudich is a doctoral student in public health at St. Elizabeth University of Health and Social Work in Bratislava and a student at the Faculty of Health Sciences, University of Pécs. His research focuses on injury epidemiology, prehospital emergency care and the education of healthcare professionals. Andrea Bratová's professional and research activities focus on nursing, anaesthesiology and intensive care, first aid, healthcare quality and patient safety. Their joint research focuses on injury epidemiology and prehospital emergency care.

Abstract

Regional prehospital injury surveillance can identify patterns that are not visible in hospital-only datasets. This retrospective observational study analysed 778 de-identified injury-related records from three emergency medical service units in the Nové Zámky region between 1 January and 31 December 2021. The median estimated age was 60 years (IQR 40–77), 54.9% of patients were male and 44.5% were aged 65 years or older. Head injuries were the most frequent primary diagnostic group (38.8%), followed by hip and thigh injuries (13.4%). An external mechanism was identifiable in 385 records; falls accounted for 54.5% and road traffic

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injuries for 25.5% of these cases. Among patients aged 80 years or older with a documented mechanism, 96.5% were falls. Most patients were transported to a trauma emergency department (86.6%), while 1.3% died at the scene. Age, scene type, documented treatment, analgesia and disposition differed significantly among units. The findings support targeted fall-prevention measures, more consistent external-cause coding, and periodic audit of analgesia and destination decisions. Unit-level differences should be interpreted in relation to geography, dispatch selection and scope of practice rather than as comparative performance measures.

Key words: injury epidemiology, emergency medical services, prehospital care, falls, head injury, road traffic injury, Slovakia

Abstrakt

Regionálne sledovanie úrazov v prednemocničnej zdravotnej starostlivosti umožňuje identifikovať vzorce, ktoré nemusia byť zachytené v nemocničných databázach. Retrospektívna observačná štúdia analyzovala 778 anonymizovaných záznamov o úrazoch riešených tromi posádkami záchrannej zdravotnej služby v regióne Nové Zámky od 1. januára do 31. decembra 2021. Medián odhadovaného veku bol 60 rokov (IQR 40–77), muži tvorili 54,9 % súboru a 44,5 % pacientov malo 65 rokov alebo viac. Najčastejšou skupinou primárnych diagnóz boli poranenia hlavy (38,8 %), nasledované poraneniami bedra a stehna (13,4 %). Mechanizmus úrazu bolo možné určiť v 385 záznamoch; pády predstavovali 54,5 % a dopravné úrazy 25,5 % týchto prípadov. U pacientov vo veku 80 rokov a viac s dokumentovaným mechanizmom tvorili pády 96,5 %. Väčšina pacientov bola transportovaná na traumatologický urgentný príjem (86,6 %), pričom 1,3 % pacientov zomrelo na mieste udalosti. Medzi posádkami sa štatisticky významne líšili vek, typ miesta udalosti, dokumentovaná liečba, analgézia. Výsledky podporujú cieľenú prevenciu pádov, dôslednejšie kódovanie vonkajších príčin a pravidelný audit analgézie a smerovania pacientov.

Kľúčové slová: epidemiológia úrazov, záchranná zdravotná služba, prednemocničná starostlivosť, pády, poranenia hlavy, dopravné úrazy, Slovensko

Introduction

Injuries remain a major public-health and healthcare-system burden. They include road traffic crashes, falls, drowning, poisoning, burns, self-harm and interpersonal violence and account for millions of deaths and a substantial proportion of disability worldwide (World Health Organization, 2024). Emergency medical services (EMS) are frequently the first healthcare contact for injured patients and therefore generate valuable information on injury patterns, geographic demand, patient characteristics and early management.

The epidemiology of prehospital trauma differs from that described by major-trauma registries. Population-based ambulance data include a broad spectrum of cases, ranging from minor soft-tissue injuries and low-energy falls to time-critical polytrauma. A Swedish national registry study reported that trauma represented 14% of primary EMS missions, while only a small subgroup met criteria for severe or potentially severe injury (Larsson et al., 2024). This distinction is relevant to workforce and resource planning because high-volume, lower-acuity injuries may consume substantial capacity even when mortality is low.

Older adults are especially important in regional injury surveillance. The World Health Organization identifies adults older than 60 years as the group with the greatest number of fatal falls, and falls are the second leading cause of unintentional injury death globally (World Health Organization, 2021). Road traffic injury remains a leading cause of death among children and younger adults (World Health Organization, 2023). A regional EMS dataset can therefore reveal a dual burden of low-energy falls in older adults and higher-energy mechanisms among younger patients.

Trauma demand and access to advanced prehospital care are also spatially patterned. Injury events are associated with features of the local environment (Cook et al., 2020), while attendance by prehospital critical-care teams may vary with geographic isolation, time and mechanism of injury (McHenry and Smith, 2023). The Nové Zámky region contains an urban centre, surrounding villages and state-road corridors; consequently, units based in Nové Zámky and Kolta may serve different populations and case mixes.

The aim of this study was to describe injury-related cases managed by three EMS units in the Nové Zámky region during 2021 and to compare patient demographics, scene type, injury patterns, documented treatment, analgesia and disposition among units. A secondary aim was to evaluate the association between age group and documented mechanism of injury.

Methods

Study design, setting and population

This retrospective observational study used routinely collected, de-identified operational data and was reported in accordance with the principles of the STROBE statement (Von Elm et al., 2007). The source spreadsheet contained three consecutive unit-specific sections: RLP Nové Zámky (RLP NZ), RZP Nové Zámky (RZP NZ) and RZP Kolta. RLP denotes a physician-staffed ambulance response, whereas RZP denotes a non-physician ambulance response. All patient rows with a valid numeric date from 1 January to 31 December 2021 were included. Header rows, unit labels and blank separator rows were excluded. The final analytic sample contained 778 cases: 169 from RLP NZ, 409 from RZP NZ and 200 from RZP Kolta.

Variables and data cleaning

The original variables comprised date, time, scene description, year of birth, two diagnosis fields, treatment, analgesia, sex and destination or disposition. Core variables were complete in all 778 patient rows. The secondary diagnosis or external-cause field was empty in 301 records (38.7%). Text values were harmonised without changing the underlying clinical meaning. Slovak variants of positive and negative entries were standardised, scene descriptions were grouped as urban, rural or road/mixed, and destination entries were grouped into clinically interpretable categories.

Age was estimated as 2021 minus year of birth because complete dates of birth were unavailable. Age groups were defined as 0–17, 18–44, 45–64, 65–79 and 80 years or older. Time was grouped into 00:00–05:59, 06:00–11:59, 12:00–17:59 and 18:00–23:59. ICD-10 entries were normalised for spacing and punctuation. The primary diagnosis was grouped by the first valid S- or T-code. External mechanisms were derived from both diagnosis fields and classified as road traffic injury, fall, intentional injury, poisoning or toxic exposure, and other

external causes. Alcohol involvement was defined by the presence of F10 or T51 in either diagnosis field. Treatment and analgesia variables represent documentation in the supplied spreadsheet and not the complete clinical record.

Outcomes and statistical analysis

Primary outcomes were distributions of age, sex, scene type, primary diagnosis group, documented mechanism and destination. Secondary outcomes included documented treatment, analgesia, alcohol-related coding and differences among the three units. Categorical variables are presented as counts and percentages. Age is reported as mean with standard deviation (SD) and median with interquartile range (IQR). Differences among units were assessed using Pearson's chi-square test for categorical variables and the Kruskal–Wallis test for age. Cramér's V was calculated as an effect-size measure for chi-square tests. Significant Kruskal–Wallis results were followed by pairwise Mann–Whitney tests with Holm adjustment. The association between age group and mechanism was evaluated only in records with an identifiable external mechanism (n=385). All tests were two-sided and $p < 0.05$ was considered statistically significant.

Results

Patient and temporal characteristics

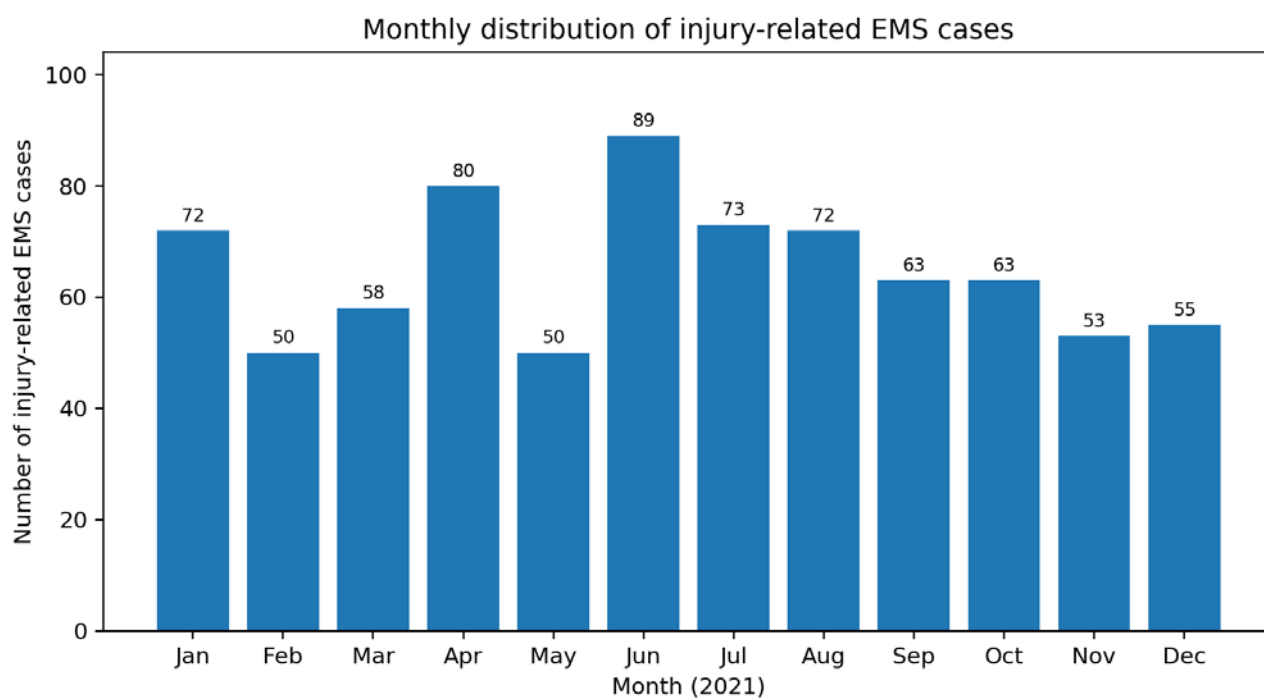
A total of 778 injury-related cases were analysed. The mean estimated age was 57.7 years (SD 23.2), the median was 60 years (IQR 40–77), and the range was 2–99 years. Men represented 427 cases (54.9%) and women 351 (45.1%). Women were older than men (median 71 years, IQR 48–83 vs 53 years, IQR 37–69; Mann–Whitney $U = 50,634$; $p < 0.001$). Overall, 346 patients (44.5%) were aged 65 years or older.

Urban scenes accounted for 416 cases (53.5%), rural scenes for 305 (39.2%) and road/mixed scenes for 57 (7.3%). Activity was highest between 12:00 and 17:59 (276; 35.5%). June had the highest monthly case count (89; 11.4%), whereas February and May had the lowest counts (50 each; 6.4%).

Characteristic	n	%
Male sex	427	54.9
Female sex	351	45.1
Age 0–17 years	38	4.9
Age 18–44 years	199	25.6
Age 45–64 years	195	25.1
Age 65–79 years	176	22.6
Age ≥80 years	170	21.9
Urban scene	416	53.5
Rural scene	305	39.2
Road/mixed scene	57	7.3
00:00–05:59	93	12.0
06:00–11:59	202	26.0
12:00–17:59	276	35.5
18:00–23:59	207	26.6

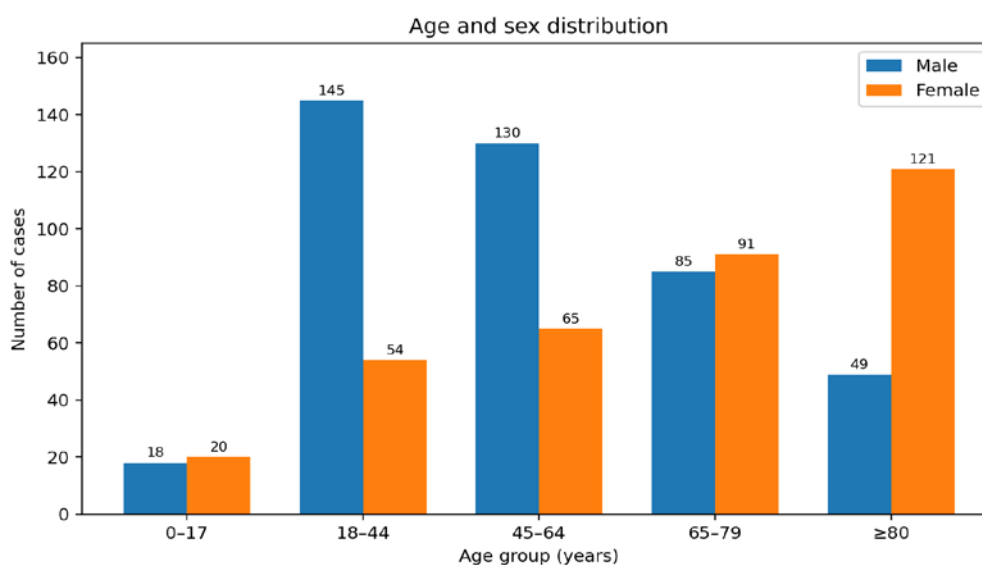
Table 1 – Overall demographic, scene and temporal characteristics

Source: Author's processing based on the analysed dataset



Graph 1 – Monthly distribution of injury-related EMS cases in 2021

Source: Author's processing based on the analysed dataset



Graph 2 – Distribution of cases by age group and sex

Source: Author's processing based on the analysed dataset

Injury patterns and documented mechanisms

Head injuries were the dominant primary diagnosis group (302; 38.8%), followed by hip/thigh injuries (104; 13.4%) and thoracic injuries (48; 6.2%). Frequent code families included superficial head injury (S00), open wound of the head (S01) and femoral fracture (S72). Alcohol-related codes (F10 or T51) were present in 90 records (11.6%).

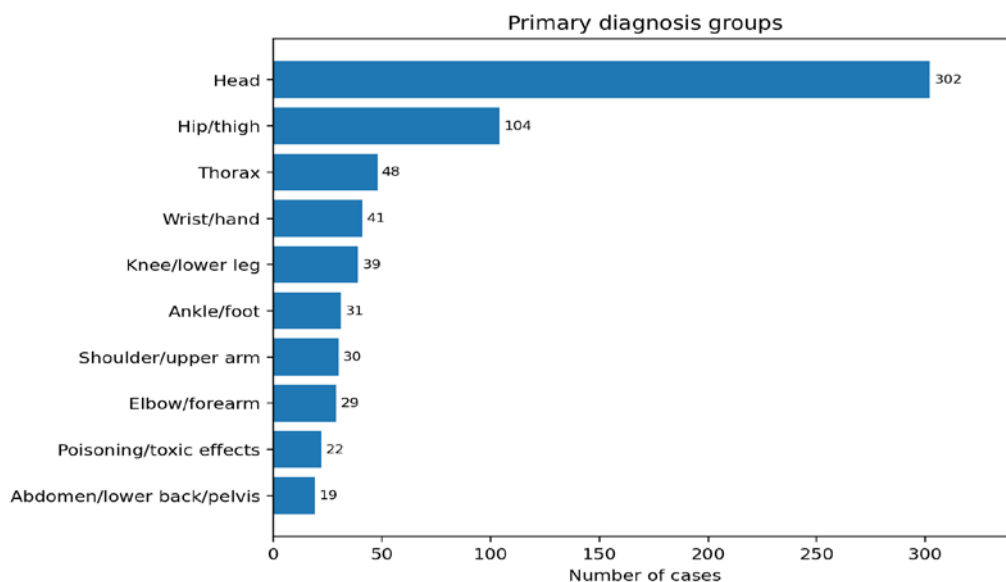
An external mechanism could be identified in 385 records (49.5%); no external cause was recorded in 393 (50.5%). Among records with a documented mechanism, falls accounted

for 210 cases (54.5%), road traffic injuries for 98 (25.5%), intentional injuries for 34 (8.8%), poisoning or toxic exposure for 21 (5.5%) and other external causes for 22 (5.7%). Mechanism differed by age group ($\chi^2=166.40$, $df=16$, $p<0.001$; Cramér's $V=0.314$). Falls constituted 80.5% of documented mechanisms in patients aged 65–79 years and 96.5% in those aged 80 years or older. Road traffic injury represented 47.6% of documented mechanisms in the 18–44-year group.

Primary diagnosis group	n	%
Head	302	38.8
Hip/thigh	104	13.4
Other/non-specific	63	8.1
Thorax	48	6.2
Wrist/hand	41	5.3
Knee/lower leg	39	5.0
Ankle/foot	31	4.0
Shoulder/upper arm	30	3.9
Elbow/forearm	29	3.7
Poisoning/toxic effects	22	2.8
Abdomen/lower back/pelvis	19	2.4
Multiple/unspecified injuries	16	2.1
Other external effects	14	1.8
Foreign body/burn/frostbite	13	1.7
Neck	6	0.8
Other/complications	1	0.1

Table 2 – Primary diagnosis groups

Source: Author's processing based on the analysed dataset



Graph 3 – Most frequent primary diagnosis groups

Source: Author's processing based on the analysed dataset

Differences among EMS units

RLP NZ managed 169 cases (21.7%), RZP NZ 409 (52.6%) and RZP Kolta 200 (25.7%). Age differed among units (Kruskal–Wallis $H=25.42$, $p<0.001$). RLP NZ patients were younger than patients managed by RZP NZ and RZP Kolta (both Holm-adjusted $p<0.001$), whereas no age

difference was observed between the two RZP units (adjusted $p=0.740$). Sex distribution did not differ significantly among units ($p=0.136$).

Scene type showed the largest unit difference ($\chi^2=243.98$, $df=4$, $p<0.001$; Cramér's $V=0.393$). RZP Kolta operated predominantly in rural settings (83.0%), whereas RZP NZ was predominantly urban (71.4%). RLP NZ had the highest proportion of road/mixed scenes (14.2%). Documented treatment differed among units ($\chi^2=50.99$, $df=2$, $p<0.001$; Cramér's $V=0.251$), as did documented analgesia ($\chi^2=10.35$, $df=2$, $p=0.006$; Cramér's $V=0.104$).

Variable	RLP NZ (n=169)	RZP NZ (n=409)	RZP Kolta (n=200)
Age, median (IQR), years	50 (34–66)	64 (42–79)	63 (39.8–81)
Male, n (%)	104 (61.5)	219 (53.5)	104 (52.0)
Urban scene, n (%)	104 (61.5)	292 (71.4)	20 (10.0)
Rural scene, n (%)	41 (24.3)	98 (24.0)	166 (83.0)
Road/mixed, n (%)	24 (14.2)	19 (4.6)	14 (7.0)
Treatment documented, n (%)	75 (44.4)	69 (16.9)	42 (21.0)
Analgesia documented, n (%)	17 (10.1)	17 (4.2)	20 (10.0)
Critical care/death, n (%)	23 (13.6)	3 (0.7)	0 (0.0)

Table 3 – Characteristics by EMS unit

RLP: physician-staffed unit; RZP: non-physician ambulance unit; IQR: interquartile range

Source: Author's processing based on the analysed dataset

Disposition and early outcomes

The trauma emergency department was the recorded destination for 674 patients (86.6%). Thirty-five patients (4.5%) were transported to an internal medicine emergency department, 16 (2.1%) to anaesthesiology/intensive care and six (0.8%) to paediatrics. Eighteen patients (2.3%) refused transport or treatment, 11 (1.4%) were treated at the scene and 10 (1.3%) died at the scene.

Collapsed disposition differed significantly among units ($\chi^2=104.46$, $df=6$, $p<0.001$; Cramér's $V=0.252$). RLP NZ accounted for 14 of 16 intensive-care destinations and nine of 10 on-scene deaths. This pattern is consistent with selective dispatch of a physician-staffed resource to higher-acuity incidents and must not be interpreted as evidence that one unit produced worse outcomes.

Variable	n	%
Any documented treatment	186	23.9
Documented analgesia	54	6.9
Alcohol-related code	90	11.6
Trauma emergency department	674	86.6
Internal medicine emergency department	35	4.5
Anaesthesiology/intensive care	16	2.1
Refused transport/treatment	18	2.3
Treated on scene	11	1.4
Death on scene	10	1.3
Paediatrics	6	0.8
Other/specialist transfer	8	1.0

Table 4 – Treatment and disposition

Source: Author's processing based on the analysed dataset

Comparison	Test statistic	df	p value	Effect size
Age by crew	H=25.42	2	<0.001	—
Sex by crew	$\chi^2=3.99$	2	0.136	V=0.051
Age group by crew	$\chi^2=25.59$	8	0.001	V=0.106
Scene type by crew	$\chi^2=243.98$	4	<0.001	V=0.393
Treatment by crew	$\chi^2=50.99$	2	<0.001	V=0.251
Analgesia by crew	$\chi^2=10.35$	2	0.006	V=0.104
Disposition by crew	$\chi^2=104.46$	6	<0.001	V=0.252
Mechanism by age group*	$\chi^2=166.40$	16	<0.001	V=0.314

Table 5 – Inferential statistical results

*Analysis restricted to records with an identifiable external mechanism (n=385). V: Cramér's V.

Source: Author's processing based on the analysed dataset

Discussion

Principal findings

This regional study identified four clinically and operationally important patterns. First, the injury-related EMS population was old: the median age was 60 years and 44.5% of patients were aged 65 years or older. Second, head injuries were the most common primary diagnosis group. Third, falls dominated among cases with a documented mechanism, particularly in the oldest age groups. Fourth, the three units had distinct geographic and acuity profiles: RZP Kolta was predominantly rural, RZP NZ predominantly urban, and RLP NZ managed younger patients and most critical-care destinations and on-scene deaths.

Age, sex and falls

The age distribution differs from trauma cohorts focused on hospital transport or major trauma. In a Nepalese ambulance study, 59% of patients were male and almost half were aged 18–44 years (Mantyč et al., 2025). The Nové Zámky dataset also showed modest male predominance but contained a much larger older-adult component. This difference probably reflects inclusion criteria, local demography, low-energy falls and the inclusion of all recorded injury-related EMS cases rather than only patients transported by a selected ambulance type to one hospital. The strong association between older age and falls is consistent with established injury epidemiology. The World Health Organization reports that adults older than 60 years experience the greatest number of fatal falls (World Health Organization, 2021). In the present dataset, falls constituted 80.5% of documented mechanisms among patients aged 65–79 years and 96.5% among those aged 80 years or older. Regional prevention should therefore extend beyond road safety and include balance and strength interventions, medication review, vision assessment, home-hazard modification and post-fall referral pathways. In long-lived older adults, these preventive measures should also be linked with home-care services and should reflect the complexity of care needs arising in the domestic environment (Zrubáková et al., 2026). Women were substantially older than men, but this must not be interpreted as a sex-specific incidence difference because age- and sex-specific population denominators were unavailable.

Head injuries and mechanism documentation

Head injuries represented 38.8% of primary diagnoses. This is clinically plausible in a dataset dominated by falls and minor-to-moderate trauma. However, the ICD-10 grouping did not distinguish isolated superficial injury from intracranial injury severity. The term head injury therefore describes anatomical coding and not the severity of traumatic brain injury.

The external mechanism was absent in 50.5% of records. This is the most important data-quality limitation because it prevents a complete estimate of the proportions attributable to falls, road traffic crashes and other external causes. Mechanism documentation also differed by unit and may generate artificial comparisons. Standardised prehospital records should capture both injury diagnosis and external cause in structured fields. At the organizational level, structured risk-analysis methods can support the identification and prioritization of weaknesses in documentation and healthcare processes (Šulcová and Nemčíková, 2025).

Road traffic injury, geography and physician-staffed response

Road traffic injuries represented one quarter of cases with a documented mechanism and were particularly prominent among adults aged 18–44 years. This is consistent with the global importance of road traffic injury among children and young adults (World Health Organization, 2023). RLP NZ had the highest proportion of road/mixed scenes and managed younger patients, supporting the interpretation that it was selectively dispatched to higher-risk road incidents and other potentially critical cases.

The scene-type differences among units demonstrate the importance of local geography. RZP Kolta managed 83.0% of cases in rural locations, whereas the two Nové Zámky units were mainly urban. Previous research has shown that injury events are spatially patterned rather than randomly distributed (Cook et al., 2020), and that geographic isolation, mechanism and time influence advanced prehospital team attendance (McHenry and Smith, 2023). The current dataset lacks coordinates and response intervals, but its unit-level differences are compatible with these broader findings.

Treatment, analgesia and disposition

Any treatment was documented in 23.9% of cases and analgesia in 6.9%. The treatment rate was highest in RLP NZ, consistent with its higher-acuity case mix. The analgesia proportion appears low, but the dataset does not permit a judgement of undertreatment because pain scores, drug names, doses, routes, timing and reassessment were unavailable. Pain management remains an important component of healthcare and should therefore be considered when evaluating the quality of documented prehospital treatment (Zacharová and Haluzíková, 2013). Most patients were transported to a trauma emergency department, while only a small proportion were treated at the scene or refused transport. Linkage of prehospital and hospital records would permit evaluation of diagnosis, admission, surgery, disability and mortality after transport. Evaluation of trauma outcomes should not be limited to immediate disposition, because subsequent quality of life and the satisfaction of patients' needs are also relevant dimensions of care (Gulášová et al., 2009).

Implications for practice and public health

- Establish a structured regional injury dataset with mandatory external-cause coding, pain scores, intervention details, response intervals and linkage to hospital outcomes.
- Develop an EMS-triggered pathway for older adults after falls, including recurrent-fall screening and referral to community prevention services.
- Audit head-injury assessment and destination decisions, particularly in older adults receiving anticoagulant or antiplatelet therapy.
- Review analgesia documentation and clinical practice using pain-score-based indicators rather than a binary summary field.
- Use geocoded data to identify fall, assault and road-traffic clusters and to support targeted prevention and resource planning.

Strengths and limitations

A major strength is the inclusion of a complete calendar year and all available patient rows from three operational units, with no missing values in the core demographic, primary diagnosis, treatment, analgesia and destination fields. The dataset captures a broader spectrum of prehospital injury than a major-trauma registry and therefore provides practical information for local service planning.

Several limitations require emphasis. This was a single-region, single-year study, and 2021 may have been affected by pandemic-related changes in mobility and healthcare use. The source was an operational spreadsheet rather than a validated trauma registry. Diagnosis codes may reflect preliminary field assessment and were not confirmed against hospital records. Vital signs, injury severity scores, response and transport intervals, procedures, medication details, pain scores and post-hospital outcomes were unavailable. Age was estimated from year of birth. An identifiable external mechanism was absent in 50.5% of records. Population denominators were unavailable, so incidence rates and age- or sex-specific risks could not be calculated. Unit comparisons are confounded by dispatch criteria, geography and scope of practice and should not be interpreted causally.

Conclusion

Injury-related EMS cases in the Nové Zámky region during 2021 were characterised by an older patient population, frequent head-injury coding and a strong predominance of falls among records with a documented mechanism. Road traffic injury remained important among younger adults. The three EMS units served different geographic and clinical populations, with the physician-staffed unit managing younger and more critical cases. The most actionable priorities are structured external-cause documentation, fall-prevention pathways for older adults, improved analgesia auditing and linkage of prehospital data with hospital outcomes.

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doc. PhDr. Katarína Zrubáková, PhD.*

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