MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2024; 30: e944448
DOI: 10.12659/MSM.944448

Received: 2024.03.11
Accepted: 2024.04.24
Available online: 2024.06.03
Published: 2024.07.05

Burden and Patterns of Electric Scooter-Related Injuries: Insights From 2 Polish Emergency Departments

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABCDEF 1 Tomasz Kłosiewicz
ABCG 2 Patryk Konieczka
ABCDEG 3 Dorota Rutkowska
ABCDEG 4 Daniel Piotr Duchań-Ogrodnik
BCDEF 1 Wiktoria Zasada
BCDEF 1 Hanna Cholerzyńska
ABCE 1 Monika Rozmarynowska
ABCDE 5 Mateusz Bednorz
ABCDE 5 Łukasz Jodłowski

1 Department of Medical Rescue, Faculty of Health Sciences, Poznań University of Medical Sciences, Poznań, Poland
2 Department of Emergency Medicine, Faculty of Health Sciences, Poznań University of Medical Sciences, Poznań, Poland
3 Laboratory for Medical Education, Faculty of Medicine, Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University in Toruń, Bydgoszcz, Poland
4 Department of Emergency Medicine, Faculty of Health Sciences, Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University in Toruń, Bydgoszcz, Poland
5 College of Emergency Physicians in Poland, Dopiewiec, Poland

Corresponding Author: Hanna Cholerzyńska, e-mail: hanna.cholerzynska@usk.edu.pl
Financial support: None declared
Conflict of interest: None declared

Background: The widespread adoption of electric scooters (e-scooters) as a mode of urban transportation has led to a notable upsurge in e-scooter-related injuries globally. Variations in e-scooter regulations across countries contribute to differences in injury patterns. This study sought to investigate the healthcare burden posed by e-scooter-related injuries on emergency departments (EDs) in Poland, and to delineate the epidemiological and clinical features of these injuries.

Material/Methods: Medical records of patients who presented to 2 distinct EDs – in Poznań and Bydgoszcz, Poland – with injuries directly linked to e-scooter use were collected and retrospectively analyzed.

Results: A total of 633 patients were admitted to the EDs due to e-scooter injuries during the study period, and 413 of these patients were further analyzed. The majority were males (64.65%), with a median age of 27 years. Most admissions occurred in the afternoon and nighttime (71.94%), with a higher incidence in the summer (46.73%). Falls were the most frequent mechanism of injury (74.09%), with the head and upper and lower extremities being the most frequently affected locations (36.08%, 29.78%, and 21.07%, respectively). Twelve patients (2.91%) confirmed recent alcohol consumption. Hospitalization costs were higher in cases involving alcohol use and among males.

Conclusion: The findings of this study underscore the significant strain exerted by e-scooter-related injuries on EDs in Poland. Injuries, notably to the head and limbs, carry significant long-term implications and strain healthcare resources. Collaboration with policymakers is crucial to ensure the safety of e-scooter users and appropriate healthcare resource allocation.

Keywords: Autonomous Vehicles • Emergency Service, Hospital • Epidemiology • Stakeholder Participation • Wounds and Injuries

Full-text PDF: https://www.medscimonit.com/abstract/index/idArt/944448

3514 3 1 58

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Introduction

Electric scooters, or e-scooters, have rapidly gained popularity worldwide as a sustainable urban transportation option since their introduction in 2017 [1,2]. The COVID-19 pandemic has influenced transportation choices, with some individuals shifting from public transport to single-person modes such as e-scooters [3-5]. E-scooters offer a potentially more sustainable alternative, particularly in cities with developing cycling infrastructure, like Poland [6]. The presence of e-scooters on the Polish market has increased and there are government subsidies and co-financing programs [7]. The Polish Road Traffic Act specifies a 20 km/h maximum speed limit for e-scooters in Poland [8].

Although they are convenient, the rise in e-scooter use has led to an increase in associated injuries, with hospitalizations rising from 0.06% in 2010 to 10.2% in 2020 [9,10]. Notably, the absolute number of accident-injury admissions, including those related to bicycles, had only a slight increase over this time, suggesting a consistent pattern that necessitates further investigation [11-15]. E-scooter-related injuries span a spectrum of severity, ranging from minor lacerations and contusions to more severe injuries such as fractures, head injuries, and spinal cord injuries [16]. The inherent risks associated with e-scooters, including high speeds and insufficient protection, render riders vulnerable to falls, as well as collisions with pedestrians, motor vehicles, and stationary objects. It has been posited by multiple authors that the current regulatory measures may prove insufficient in mitigating these risks [17-19]. Furthermore, e-scooter-related injuries have exerted a substantial financial impact on regional healthcare systems [20].

The divergent regulations governing the use of e-scooters in different countries affect the incidence and severity of injuries related to their use. Countries with comprehensive traffic regulations, including mandatory helmet use, speed limits for personal transport devices, and designated lanes for e-scooters, have been found to offer a safer environment for e-scooter riders [21]. Additionally, risk factors associated with e-scooter-related injuries have been identified, including incautious riding behavior and vehicle and road characteristics [22]. Thus, there is a pressing need for country-specific studies to better understand the epidemiology and features of e-scooter-related injuries in different settings. In most investigations carried out in individual countries, the sample size ranged from 100 to 200 patients, and these studies were predominantly conducted at single centers. This concentration of research efforts notably restricts the scope of research [2,19,23-29]. Moreover, describing epidemiological patterns frequently requires a thorough analysis spanning a longer period. Regrettably, the literature mainly consists of investigations with study durations limited to just over 2 years, and a substantial majority of these studies lasted just 1 year or less [23,24,29,30]. Despite the growing popularity of e-scooters in Polish urban areas, there is a lack of research on e-scooter-related injuries in the country.

This study aimed to investigate the epidemiology and characteristics of e-scooter-related injuries in Poland and to evaluate the impact of such injuries on emergency department (ED) visits. This retrospective study evaluated data on 413 patients with e-scooter-related injuries admitted to EDs in Poznań and Bydgoszcz, Poland between 2020 and 2023.

Material and Methods

Ethical Statement

According to Polish Law, retrospective analysis of medical records is not medical experimentation, and consent of a bioethics committee is not required (confirmation of Institutional Review Board of Poznań University of Medical Sciences no. KB 699/22).

Study Protocol

The study was conducted in 2 EDs located in the cities of Poznań and Bydgoszcz, Poland. Both hospitals are located in major cities in Poland, they are not trauma centers, and they serve diverse populations, urban and suburban, each with around 35 000 patient visits every year. We retrospectively analyzed deidentified data from visits between March 1st, 2020 and March 1st, 2023 (3 full years of data collection). Relevant data were extracted from the hospitals' medical records databases. The authors manually checked all of the records for possible data entry errors, inconsistencies, missing data, and duplicates to ensure data validation and integrity.

Inclusion Criteria

Our inclusion criteria were: 1) age 18 years or more, 2) confirmed in patient's history presentation related to an e-scooter use, and 3) type of e-scooter involved in the accident: standup electronic kick scooters. Pediatric patients were excluded from the study as both EDs primarily serve adults, with designated pediatric EDs available in both urban centers. Two supervising authors independently oversaw the record's inclusion by the rest of the team, and any uncertainties were resolved through consultation. This collaborative approach ensured thorough oversight and consistency in inclusion of records. The study flowchart is presented in **Figure 1**.

Data Collection

First, after obtaining permission from the authorities, the research teams extracted data from the hospital's information

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

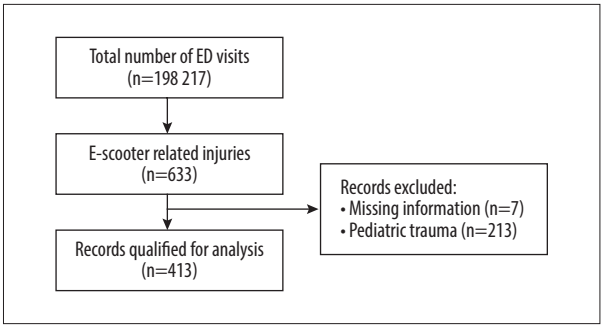

Figure 1. The study flowchart (*prepared using the free online tool: https://app.diagrams.net/*). ED – Emergency Department.

system (HIS). In the HIS we utilize, a physician delineates the reason for admission, medical history, treatment administered, and recommendations for the patient within designated fields. The description of the mechanism of an accident is recorded in the 'medical history' field. This database was exported from the HIS as an editable table. Subsequently, we conducted a search within the medical history cells. We used keywords to search for records (scooter, electric scooter, city-scooter, kick-scooter). All records found were related to electric powered scooters. The collected data included: sex and age, time and date of visit, triage category, time of registration, time of first assessment by a physician, and time of discharge/transfer. Based on these data, length of stay was defined as the time between registration in the hospital information system and discharge or transfer to another ward). The triage system used in both EDs was the Manchester Triage System, which categorizes patients into 5 priority levels based on the urgency of their conditions, using color-coded assessments ranging from immediate attention (red), through orange, yellow, and green, to non-urgent cases (blue).

Time and Seasonal Categories

Visits were divided into 3 time categories – morning (6 AM to 1: 59 PM), afternoon (2 PM to 9: 59 PM), and night (10 PM to 5: 59 AM). The seasons of the year were defined as Spring (March 21st to June 20th), Summer (June 21st to September 22nd), Autumn (September 23rd to December 20th), and Winter (December 21st to March 20th).

Other Variables Determination

From the patient's history, we determined the mechanism of injury (divided into 3 categories: fall, collision, and other) and if the patient wore a helmet (yes, no, or not defined). A fall was defined as an unintentional incident in which a person riding an e-scooter loses balance or control, leading to their descent to the ground or another lower level, and it was not related to a collision with another object, person, or animal. Information on pre-hospital care was not available. The use of alcohol (assessed using blood–alcohol concentration results) was also determined. All patients were routinely asked whether they were drinking alcohol before their accident. Patients who confirmed this or those in which markers of alcohol use were noted, such as an alcohol odor in the breath or clinical features of alcohol intoxication (eg, impaired coordination, slurred speech) were screened using blood–alcohol concentration.

Medical Procedures and Injury Classification

Data were filtered in search of performed procedures, such as imaging, suturing, cast application, monitoring, analgosedation, intubation, blood transfusions, and medication administration. Using the International Classification of Diseases 10th Revision, we also determined the location of the injury (head, upper extremities, lower extremities, abdomen, thorax, neck) and type (divided into categories: contusion, fracture, wound and laceration, sprain and dislocation, and traumatic brain injury). Costs of hospitalization were counted and reported in United States Dollars (USD). All collected data were meticulously organized into spreadsheets, systematically filtered, and examined for any inconsistencies or inaccuracies.

Cost Analysis

We used the actual cost of performed procedures, according to the pricelist used by hospitals whenever a patient is uninsured. Every patient had several procedures performed (eg, triage, physician evaluation). Next, we assessed the radiology, medications, and any other procedures that may have been performed during the ED stay. Polish ED care charges are generally lower than in the United States.

Statistical Analysis

Data were then prepared in a database created in Microsoft Excel (Microsoft Corporation, Redmond, WA, USA). Descriptive statistics of measurable variables were analyzed. Categorical variables are expressed as numbers (n) with percentages (%), whereas quantitative data are expressed as medians with interquartile ranges, as they did not have normal distribution (as confirmed by the Wilk-Shapiro W test). For statistical analysis, the Mann-Whitney U test was used, as appropriate. To evaluate the relationship between age, cost, and length of stay (LOS), linear regression with Pearson's linear correlation coefficient was used, as appropriate. A P value <0.05 was considered significant. Analysis was performed using Statistica 12 software (Tibco Inc., Tulsa, OK, USA).

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 1. Patient and incident characteristics at initial presentation to the ED.

Variable		n	%
Triage category	Red	0	0.00
	Orange	12	2.91
	Yellow	141	34.14
	Green	243	58.83
	Blue	17	4.12
Time of day	Morning (6 AM-1: 59 PM)	116	28.09
	Afternoon (2 PM-9: 59 PM)	139	33.66
	Night (10 PM-5: 59 AM)	158	38.25
Season of the year	Winter	34	8.23
	Spring	68	16.46
	Summer	193	46.73
	Autumn	118	28.58
Mechanism of injury	Fall	306	74.09
	Collision	43	10.42
	Unknown	64	15.49
Alcohol consumption	No	399	96.61
	Yes	12	2.91
	Not defined	2	0.48

Results

Demographic and Incident Characteristics

The total number of analyzed records was 189 217. Inclusion criteria were met in 633 cases. We excluded 220 records (pediatric patients, n=213; missing information, n=7).

Demographic and Incident Characteristics

A total of 413 patients presented to the emergency departments (EDs) with injuries associated with standup e-scooter use during the study period. Of these, 267 (64.65%) were males and 146 (35.35%) were females. The median age was 27 years old [23-36], with the youngest patient being 18 and the oldest 78 years old. None of the patients included in this study died during their ED stay. The demographic and incident characteristics of these patients are shown in **Table 1**.

Timing and Seasonal Variation

Most patients were admitted during the afternoon and nighttime hours (72.94%, n=297), with admissions in the morning being less common. The estimated time of injury was around 1 h before the presentation. The season with the highest number of accidents was summer (47.73%, n=193).

Mechanism of Injury and Alcohol Consumption

The most common mechanism of injury was falling (74%, n=306). Twelve patients (3%) confirmed consumption of alcohol before the injury. In most cases (98%, n=404) there was a lack of information regarding whether the patient had been wearing a helmet.

Injury Distribution and Types

The most common sites of injury were the extremities (51% n=210) and the head, predominantly the face (36%, n=149). Multiple parts of the body were injured in 5% of cases (n=22). Patients experiencing "multiple location" injuries were not included in other categories. The most frequent type of injury was contusion (39%, n=160). Traumatic brain injury was diagnosed in 6 cases (1%). Details of distribution and types of injury are presented in **Table 2**.

Length of Stay and Resources

The median LOS was 95 min (range, 60-160 min). The shortest LOS was 9 min and the longest was 1048 min. The total admission rate was 14% (n=56). An overview of patient outcomes is provided in **Table 3**. Patients were admitted if they required a procedure not available in ED or needed prolonged observation.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 2. Types and distribution of injuries.

Variable		n	%
Location of injury	Head (including face)	149	36.08
	Upper extremity	123	29.78
	Lower extremity	87	21.07
	Thorax	17	4.12
	Abdomen	13	3.15
	Neck	2	0.48
	Multiple locations	22	5.32
Type of injury	Contusion	160	38.74
	Fracture	119	28.81
	Wounds and lacerations	94	22.76
	Dislocations and sprains	34	8.24
	Traumatic brain injury	6	1.45

Table 3. Admissions and discharge details following Emergency Department presentation.

Variable	n	%
Discharged home	357	86.44
Orthopaedic	33	7.99
OMFS	9	2.18
Surgery	12	2.91
Neurosurgery	2	0.48

OMFS – oral and maxillofacial burgery.

Alcohol-related incidents were associated with longer LOS (316 min [165-508] vs 93 min [60-153], p<0.05). No statistically significant associations were found between LOS and age (p=0.1742, r^2=0.0045) or between LOS and sex (M=97 [60-168] vs 94 [65-147], p=0.6963).

Almost all patients (98%, n=406) underwent imaging with computed tomography (CT) or X-ray, depending on the type of injury. One-quarter of patients were administered medication (24%, n=100). Suturing was required in 17% of patients (n=71) and a cast was needed in 15% (n=61). Basic vital signs were monitored during the stay in 63 patients (15%). Procedural analgosedation was used in 8 patients (2%). Intubation and blood transfusion were not performed in any patients.

The Median Cost of Hospitalization

The median cost of hospitalization in ED was $291 (212-452). The minimum cost was estimated to be $156 and the maximum was $3282. Higher hospital costs were associated with alcohol-related incidents ($836 [526-2697] vs $291 [208-451], p<0.05) and male sex (M=306 [232-508] vs 285 [174-414], p<0.05). No statistically significant associations were found between cost and age (p=0.22, r^2=0.00).

Discussion

This study presents the first comprehensive analysis of e-scooter-related injuries and ED visits in Poland, aiming to address factors contributing to ED overuse and overcrowding [31,32]. The longitudinal design of this 3-year study provides a more in-depth exploration of visit patterns, an imperative element for formulating substantive policy recommendations, although we did not analyze annual variations in incidences. With more and more concerns being raised about the safety of e-scooter use, it is crucial to continue this research [33,34].

The median age of patients in our study was lower than that reported in most previous investigations (27 vs 26, 29, 30, 31, 33, 34, or 40 years) [18,25,28,35-39]. This finding is particularly noteworthy since none of the patients included in our study were under 18 years of age, as both EDs in the studied cities exclusively serve adults, with separate pediatric EDs available, in contrast to other studies [18,28,29]. A study by Bryniarska et al on e-scooter rental services in Poland reported that 52.8% of respondents were aged 20-25, and 11.1% were 16-19 years old, with the primary goal for use being recreation. This report highlights the predominance of young people among e-scooter users, rendering the lower age of patients in our study unsurprising [40]. Interestingly, hospital admissions following e-scooter accidents are increasing more in young adults than in children [41]. Our findings concerning

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

admission times in the summer months and other demographic characteristics are comparable to previous studies and are in line with previously discussed data (young people using e-scooters for recreation) [18].

Surprisingly, we observed a low level of alcohol consumption before presentations, contrary to the existing literature [24,25,30,42-44]. This finding is particularly noteworthy given the well-established and substantial burden of alcohol-related ED visits in Poland [45]. A possible explanation for this finding may be the timing of visits – approximately one-third of the presentations occurred in the morning, while another one-third took place in the afternoon. This pattern suggests that e-scooters were potentially used as a mode of commuting to workplaces or educational institutions, serving as an integral component of daily life activities. This finding stands in opposition to the available literature, which characterizes e-scooter users as young adults involved in accidents during nighttime hours [18,29,46]. Moreover, we found that alcohol consumption increased hospitalization costs, a predictable outcome not previously reported [47]. This finding may be related to the longer LOS in this group, which can result in a need for more attention from the ED team or increased use of various resources. This draws attention to an urgent need for stricter regulations regarding e-scooter use after drinking alcohol. We acknowledge the potential bias for underreporting alcohol consumption in EDs. Patients may hesitate to disclose alcohol use due to social stigma or impaired memory, especially after traumatic events like traffic accidents. Documentation practices in the ED may prioritize immediate treatment over comprehensive recording of alcohol history, leading to incomplete or inaccurate information. Legal implications and cultural norms may further discourage patients from admitting alcohol consumption.

Head injuries accounted for over one-third of the injuries in our study, reinforcing the notion that wearing a helmet could mitigate this burden [2,33,41,48]. Nonetheless, in the absence of regulatory mandates requiring e-scooter riders to use helmets in Poland, coupled with a potential lack of awareness regarding the importance of head protection, the finding that only 3 patients reported wearing a helmet is unsurprising, as the substantial majority of participants did not make any reference to this safety measure. While there are no definitive conclusions about the benefits of helmet use in the context of e-scooter use, sufficient data about other two-wheeled modes of transportation, such as skateboarding, may be informative [49]. A study conducted by Fournier et al found that in 44% of simulations of e-scooter accidents, the forehead hit the ground first and the rate of concussion was almost 100% [50]. This recent finding is a baseline for protective gear design. Moreover, face injuries are commonly reported in two-wheeled vehicle accidents [51]. Interestingly, according to Schiffler et al, the risk of craniofacial injuries is related to the level of intoxication, due to a decrease in protective reflexes [52]. Admissions to the Oral and Maxillofacial Surgery (OMFS) ward constituted a small portion of our study population, but the low number of intoxicated patients is noteworthy.

The burden associated with electric scooter-related ED visits also includes a high prevalence of other injuries in patients [41,44,53]. According to a study by Siang Koh et al, trauma related to electric mobility devices, such as e-scooters, tends to be more severe, resulting in prolonged hospitalization and more severe socioeconomic costs than with bicycle use [26]. The predominance of falls (single-user accidents) over collisions (involving 2 or more individuals) with high-speed accidents is a common finding also reported by other studies [18,19,27,34,54,55]. This suggests that e-scooters are mainly a danger to their users and thus the need for stricter regulations about their use, such as wearing helmets or implementing speed limits. With most of our patients triaged green and yellow, their injuries can be considered non-life-threatening, similar to the results described by Sheikh et al [28]. Interestingly, a study from Australia reported that 20% of their patients were triaged as high-priority, which implies imminently life-threatening conditions [27,28]. This may be due to much higher blood–alcohol concentration in those patients (28%). A similar pattern was found by Sheikh et al – more people triaged as higher-priority (The Canadian Triage and Acuity Scale (CTAS) 2-40%) and much higher blood–alcohol concentration (37%). The locations and types of injuries we found were comparable to other such studies, with a predominance of contusions and fractures, to the head and extremities, even in studies with noticeable differences in distribution of triage categories [17,27,28,53]. Moreover, Rix et al reported that the e-scooter injury rate was significantly higher than injury rates for motor vehicles, which raises concerns about necessary surveillance and prevention activities [56].

Although most of their injuries were not life-threatening, patients presenting due to e-scooter-related trauma require thorough medical evaluation and careful management, including imaging studies (X-rays, CT scans) and wound and fracture care. Mitchell et al, similarly to our study, reported high utilization of imaging studies [27]. Admission rates vary in different studies, from 6% to 30.5% [20,27,54]. Our results are at the lower end of the spectrum, with some similarities to the study by Trivedi et al (2019), in which there were few intoxicated patients and the vast majority were triaged as category 4/green [48]. Moreover, Bekhit et al reported significantly more patients with alcohol as a contributing factor [20].

In agreement with White et al and the recognition of safety concerns raised by various stakeholders, we acknowledge the importance of cautious and collaborative integration of e-scooters into transportation planning [57], which, with due

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

care, responsibility, and active collaboration among key stakeholders, holds substantial potential for success [58].

We acknowledge certain limitations that may affect the generalizability of the findings. Specifically, only 2 EDs from 2 cities were included, potentially resulting in missed e-scooter-related visits and limited ability to extrapolate our results to other hospitals. However, the inclusion of data from 2 different cities in Poland provides a partial representation of the larger picture. In the future, multicenter studies should be conducted for a more comprehensive evaluation of this matter. Additionally, the study design did not allow for investigation of geographic and architectural factors that could have influenced the pattern of injuries. There is a possible bias from the learning curve for the use of e-scooters. There is an unknown number of injuries resulting from e-scooter use that were not severe enough to present to EDs. Furthermore, due to limitations in available patient history, the study was unable to investigate any other potential risk factors. Pre-hospital data regarding care or details about the accident (other than injury mechanism) were not available. This results from the separation of in-hospital care and out-of-hospital emergency services in Poland, and all data available in the ED are from patients or are brief case presentations by paramedics.

Conclusions

Our study highlights the significant public health problem posed by injuries related to standup e-scooter use. The increasing popularity and use of e-scooters require appropriate regulations to ensure their safe use. With most users being young adults, often students or employees, the injuries resulting from such accidents can have a significant impact on their ability to engage in daily activities. Injuries to the head and extremities are particularly concerning, as they can lead to long-term disability and further increase the burden on the healthcare system. The median cost of hospitalization was $291, with higher costs for male patients. Surprisingly, there were few documented alcohol-related injuries, but alcohol intoxication significantly increased hospitalization costs and length of stay, suggesting the need for stricter regulations. Collaborative efforts with policymakers are paramount in enhancing e-scooter regulations, fortifying protective measures, refining e-scooter design, and securing funding for further research. These findings underscore the importance of understanding and addressing e-scooter-related injuries to promote safety and improve patient care in emergency settings.

Department and Institution Where Work Was Done

Department of Emergency Medicine, Faculty of Health Sciences, Poznań University of Medical Sciences, Poznań, Poland and Department of Emergency Medicine, Faculty of Health Sciences, Collegium Medicum in Bydgoszcz, Nicolaus Copernicus University in Toruń, Bydgoszcz, Poland.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors, who confirm that the images are original with no duplication and have not been previously published in whole or in part.

References:

1. Northway J, Round J, Jack C. eScooters – a novel device causing significant trauma. J Transp Health 2022;26:101489
2. Badeau A, Carman C, Newman M, et al. Emergency department visits for electric scooter-related injuries after introduction of an urban rental program. Am J Emerg Med 2019;37:1531-33
3. Jindal A, Fernandes JP. Impact of the lockdown due to COVID-19 pandemic on the spectrum and outcome of trauma in India. Indian J Crit Care Med 2021;25:273-78
4. Ross GM. Public transport and public health: Regulatory focus and the impact of COVID-19 on the choice of public transport mode. J Transp Health 2021;22:101238
5. Harrington DM, Hadjiconstantinou M. Changes in commuting behaviours in response to the COVID-19 pandemic in the UK. J Transp Health 2022;21:101313
6. Kwiatkowski MA, Szymańska D. Cycling policy in strategic documents of Polish cities | Environment, Development and Sustainability. Environment Development and Sustainability. 2020;23:10357-77
7. Ziemba P, Gago I. Compromise multi-criteria selection of e-scooters for the vehicle sharing system in Poland. Energies 2022;15:5048
8. Poland proposes new legislation for e-scooters and other personal transport devices – European Commission n.d. https://urban-mobility-observatory.transport.ec.europa.eu/news-events/news/poland-proposes-new-legislation-e-scooters-and-other-personal-transport-devices-2021-02-18_en (accessed April 16, 2024)
9. Savitsky B, Radomislensky I, Goldman S, Kaim A. Electric bikes and motorized scooters – popularity and burden of injury. Ten years of National trauma registry experience. Journal of Transport & Health. 2021;22:101235
10. Cho NY, Kim S, Tran Z, et al. National trends and clinical outcomes after scooter injury in the US: 2016-2020. J Am Coll Surg. 2023;238(3):254-60
11. Labetski A, Chum A. Built environmental correlates of cycling accidents involving fatalities and serious injuries in London, UK. Front Sustain Cities. 2020;2
12. Harkort L, Walker BB, Lakes T. Spatiotemporal patterns of cyclist collisions in Germany: Variations in frequency, severity of injury, and type of collision in 2019. Appl Spat Anal Policy. 2023;16:209-28
13. Næss I, Galteland P, Skaga NO, et al. The number of patients hospitalized with bicycle injuries is increasing – a cry for better road safety. Accid Anal Prev 2020;148:105836
14. National Center for Statistics and Analysis. Bicyclists and other cyclists: 2017 data. Wash DC Natl Highw Traffic Saf Adm. 2017
15. Arya S, Bahl A. Epidemiology of trauma patients admitted to a trauma center in New Delhi, India. Indian J Crit Care Med. 2021;24:1193-97
16. Toofany M, Mohsenian S, Shum LK, et al. Injury patterns and circumstances associated with electric scooter collisions: A scoping review. Inj Prev. 2021;27:490-99
17. Bresler AY, Hanba C, Svider P, et al. Craniofacial injuries related to motorized scooter use: A rising epidemic. Am J Otolaryngol. 2019;40:662-66
18. Coelho A, Feito P, Corominas L, et al. Electric scooter-related injuries: A new epidemic in orthopedics. J Clin Med 2021;10:3283

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

19. Störmann P, Klug A, Nau C, et al. Characteristics and injury patterns in electric-scooter related accidents – a prospective two-center report from Germany. J Clin Med. 2020;9:1569
20. Bekhit MNZ, Fevre JL, Bergin CJ. Regional healthcare costs and burden of injury associated with electric scooters. Injury. 2020;51:271+77
21. Serra GF, Fernandes FAO, Noronha E, de Sousa RJA. Head protection in electric micromobility: A critical review, recommendations, and future trends. Accid Anal Prev. 2021;163:106430
22. Li Y, Chen Q, Ma Q, et al. Injuries and risk factors associated with bicycle and electric bike use in China: A systematic review and meta-analysis. Saf Sci. 2022;152:105769
23. Ahluwalia R, Grainger C, Coffey D, et al. The e-scooter pandemic at a UK Major Trauma Centre: A cost-based cohort analysis of injury presentation and treatment. Surg J R Coll Surg Edinb Irel. 2023;21:256-62
24. Osti N, Aboud A, Gumbs S, et al. E-scooter and E-bike injury pattern profile in an inner-city trauma center in upper Manhattan. Injury. 2023;54:1392-95
25. Uluk D, Lindner T, Dahne M, et al. E-scooter incidents in Berlin: An evaluation of risk factors and injury patterns. Emerg Med J EMJ. 2022;39:295-300
26. Siang Koh DT, Woo YL, Wong TH, Tan MH. Patterns of orthopaedic injury among hospitalised personal mobility device users and bicycle riders: A comparative study. Singapore Med J. 2022;63:445-49
27. Mitchell G, Tsao H, Randell T, et al. Impact of electric scooters to a tertiary emergency department: 8-week review after implementation of a scooter share scheme. Emerg Med Australas. 2019;31:930-34
28. Sheikh M, Islam A, Kroeker N, et al. Electric scooter related injuries in Calgary emergency departments. CJEM 2022;24:735-41
29. Kültür Y, Tütüncü MN, Ulutaş S. Using e-scooters: An easy way to get home or a nightmare? An orthopedic perspective on e-scooter accidents. Turk J Trauma Emerg Surg. 2023;29:1158-66
30. Heuer S, Landschoof S, Kornherr P, et al. Epidemiology and injury pattern of e-scooter injuries – initial results. Z Orthopadie Unfallchirurgie. 2022;160:559-63
31. Mackie D. Role of the emergency department. Emerg Med Australas. 2019;31:1109-10
32. Savioli G, Ceresa IF, Gri N, et al. Emergency department overcrowding: Understanding the factors to find corresponding solutions. J Pers Med. 2022;12:279
33. Choron RL, Sakran JV. The integration of electric scooters: Useful technology or public health problem? Am J Public Health. 2019;109:555-56
34. Shichman I, Shaked O, Factor S, et al. Emergency department electric scooter injuries after the introduction of shared e-scooter services: A retrospective review of 3,331 cases. World J Emerg Med. 2022;13:5-10
35. Raubenheimer K, Dodd J, Jarmin MJ, et al. Western Australian State Trauma Registry analysis of incidence and injury patterns associated with e-Scooter injuries: 5-year retrospective case series. ANZ J Surg 2023;93:1890-95
36. Vasara H, Toppari L, Harjola V-P, et al. Characteristics and costs of electric scooter injuries in Helsinki: A retrospective cohort study. Scand J Trauma Resusc Emerg Med. 2022;30:57
37. English KC, Allen JR, Rix K, et al. The characteristics of dockless electric rental scooter-related injuries in a large U.S. city. Traffic Inj Prev 2020;21:476-81
38. Reito A, Öljymäki E, Franssila M, Mattila VM. Incidence of electric scooter – associated injuries in Finland from 2019 to 2021. JAMA Netw Open. 2022;5:e227418
39. Fisher ND, Nwakoby E, Hernandez H, McLaurin TM. Electric scooter injuries: Incidence and injury patterns at a level I trauma center. Chin J Traumatol. 2023;26:334-38
40. Bryniarska Z, Jarosiński K. Analysis of the satisfaction and preferences of people using electric scooter rentals in Krakow with a comparison to Wavelo city bike rental. Regional and Urban Transport n.d.;11: 38-52
41. Namiri NK, Lui H, Tangney T, et al. Electric scooter injuries and hospital admissions in the United States, 2014-2018. JAMA Surg. 2020;155:357-59
42. Richmond SA. Ontario Agency for Health Protection and Promotion (Public Health Ontario), Berenbaum E. Escooter injuries. Queen's Printer for Ontario 2021
43. İğrek S, Ulusoy İ. E-scooter-related orthopedic injuries and the treatments applied: Are these scooters a new means of transportation or a new source of trauma? BMC Emerg Med. 2023;23:110
44. Gan-El E, Ngatchou Djomo W, Pascu Ciobanu AM, et al. Risk assessment, consequences, and epidemiology of electric scooter accidents admitted to an emergency department: A prospective observational study. Eur J Trauma Emerg Surg. 2022;48:4847-55
45. Cholerzyńska H, Zasada W, Kłosiewicz T, et al. The burden of alcohol-related emergency department visits in a hospital of a large European city. Healthcare (Basel). 2023;11:786
46. Kayaalp ME, Kilic NC, Kandemir I, et al. Electric scooter-associated orthopedic injuries cause long absence from work, regret and are emerging as a major cause of hip fractures in young individuals: A comprehensive study from a regional trauma center in a densely populated urban setting. Eur J Trauma Emerg Surg. 2023;49(6):2505-13
47. Lingamanaicker K, Geelhoed E, Fatovich DM, Alcohol Harm in Emergency Departments (AHED) Investigators. Direct cost of alcohol-related presentations to Royal Perth Hospital emergency department. Emerg Med Australas EMA 2019;31:1045-52
48. Trivedi B, Kesterke MJ, Bhattacharjee R, et al. Craniofacial injuries seen with the introduction of bicycle-share electric scooters in an urban setting. J Oral Maxillofac Surg. 2019;77:2292-97
49. Lustenberger T, Talving P, Barmparas G, et al. Skateboard-related injuries: Not to be taken lightly. A National Trauma Databank Analysis. J Trauma. 2010;69:924-27
50. Fournier M, Bailly N, Schäuble A, Petit Y. Head impact kinematics and injury risks during E-scooter collisions against a curb. Heliyon. 2023;9:e19254
51. Mohanavalli S, Thinakaran M, Bala G. Evaluation of influencing factors and commonly involving side in maxillofacial injuries in road traffic accidents by motorized two wheelers: A cross-sectional study. World J Dent. 2017;8:49-54
52. Shiffler K, Mancini K, Wilson M, et al. Intoxication is a significant risk factor for severe craniomaxillofacial injuries in standing electric scooter accidents. J Oral Maxillofac Surg. 2021;79:1084-90
53. Ishmael CR, Hsiue PP, Zoller SD, et al. An early look at operative orthopaedic injuries associated with electric scooter accidents: Bringing high-energy trauma to a wider audience. J Bone Joint Surg Am. 2020;102:e18
54. Trivedi TK, Liu C, Antonio ALM, et al. Injuries associated with standing electric scooter use. JAMA Netw Open 2019;2:e187381
55. Büyükceran İ, Ersoy A, Şay CŞ, et al. The epidemiology and the treatment of fractures due to electric scooters: A comparison of pediatric and adult age groups. Cureus 2023;15:e37807
56. Rix K, Demchur NJ, Zane DF, Brown LH. Injury rates per mile of travel for electric scooters versus motor vehicles. Am J Emerg Med. 2021;40:166-68
57. White E, Guo F, Han S, et al. What factors contribute to e-scooter crashes: A first look using a naturalistic riding approach. J Safety Res. 2023;85:182-91
58. Macioszek E, Cieśla M, Granà A. Future development of an energy-efficient electric scooter sharing system based on a stakeholder analysis method. Energies 2023;16:554

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]