Assessing the Risks Associated with Alternative Mobility: Incidence of Musculoskeletal Injuries Related to the Use of Electric Scooters in a University Hospital in Bogotá

Abstract

Introduction: Electric scooters have significantly increased in cities like Bogotá, presenting new challenges for healthcare systems due to the rise in associated injuries. This study examines the incidence and characteristics of musculoskeletal injuries related to electric scooter accidents treated at a university hospital in Bogotá between 2022 and 2023.

Methods: A retrospective, observational, and descriptive study was conducted, analyzing 190 patients over 18 years old with injuries related to using electric scooters. Data were collected from electronic medical records and included demographic, clinical, and treatment variables, focusing on fractures, sprains, dislocations, and muscle or tendon tears. Annual incidence and clinical and temporal patterns were calculated.

Results: The annual incidence was 6.8 cases per 1000 consultations in 2022 and 8.8 cases per 1000 consultations in 2023, reflecting a 29% increase. The average age of patients was 35 years, with 68% male. The most common mechanism was the rider's fall (82%). 43% of patients presented fractures, with the radius (27%) and humerus (12%) being the most affected bones, followed by the proximal tibia and phalanges. 28% suffered sprains, predominantly in the wrist and ankle, while 7.9% presented dislocations, mainly in the acromioclavicular joint (3.7%) and shoulder (1.6%). 17% of patients required surgical intervention through open reduction and internal fixation, with fractures of the radius and proximal tibia being the most intervened.

Conclusions: This study documents a significant increase in injuries from electric scooter accidents in Bogotá, highlighting the high incidence of fractures and the need for surgical management. The findings underscore the importance of implementing adequate infrastructure, specific regulations, and educational strategies to mitigate the impact of these injuries on the healthcare system.

Keywords: electric scooters, musculoskeletal injuries, fractures, urban mobility, public health.

Introduction

In recent years, electric scooters have become a consolidated micro-mobility alternative in urban areas, offering a low operational cost option and contributing to reducing pollutant emissions. In densely populated cities like Bogotá, where mobility challenges include traffic congestion and restrictions such as "pico y placa" (a traffic management strategy used in some cities, particularly in Latin America, to reduce traffic congestion during peak hours), electric scooters have emerged as a popular solution, especially in areas with high economic and student activity like Usaquén and Chapinero. However, their growing popularity has led to an increase in the incidence of injuries related to their use, raising concerns among the medical community and public health systems (1).

International studies have identified recurring injury patterns among electric scooter users, including fractures, dislocations, and cranioencephalic trauma. Significant risk factors include limited helmet use, inadequate road infrastructure, and the consumption of alcohol or drugs among users (2,3). In Denver and Tel Aviv, a

significant proportion of patients require hospitalization and even surgery, highlighting the impact of these accidents on hospital resources (1,4).

In Bogotá, although regulations for electric scooter use include speed limits and mandatory helmet use, the implementation and enforcement of these measures remain insufficient (5). This, combined with road infrastructure that does not always accommodate micromobility users, creates a high-risk environment for accidents. However, there is little local information characterizing the injuries associated with these devices and their impact on hospital institutions.

This study aims to evaluate the incidence and characteristics of musculoskeletal injuries related to electric scooter accidents, using data from patients treated at a university hospital located in a high-density electric scooter use area in Bogotá between 2022 and 2023. This analysis will contribute to a better understanding of the clinical implications of this form of mobility and provide inputs for future prevention and regulation strategies.

Methods

Study Design

This is an observational, descriptive, and retrospective study. Data were collected from patients treated in the orthopedic emergency department and through consultations at a university hospital located in a high-density electric scooter usage area in Bogotá from January 1, 2022, to December 31, 2023. The institutional ethics committee granted ethical approval, and data management was conducted in compliance with local and international data protection regulations.

Population Selection

The study included adult patients (≥18 years) who presented to the emergency department with musculoskeletal injuries related to electric scooter accidents, either as riders or pedestrians. The injuries included fractures, sprains, tears, and dislocations confirmed through physical examination and imaging studies, coded according to the International Classification of Diseases (ICD-10).

Inclusion Criteria: Adult patients treated in the emergency department for injuries related to electric scooters. Confirmed diagnosis of fractures, sprains, tears, or dislocations.

Exclusion Criteria: Injuries related to devices other than electric scooters (e.g., non-motorized scooters, hoverboards, bicycles). Injuries were not directly attributable to the use of electric scooters.

Data Collection

Information was obtained through a retrospective review of all orthopedic emergency triages and consultations conducted in the hospital's emergency department during the study period. Data was collected using an electronic database designed explicitly on the RedCap platform, configured with automatic quality controls to ensure accuracy in data collection. Measured variables included demographic data such as age and gender, the mechanism of the accident, injury characteristics (location, type, and classification, including AO classification for fractures and grade for sprains), required treatments (such as immobilization, reduction, or surgery), and clinical outcomes. Data on the need and duration of hospitalization, the presence of associated injuries such as cranial or thoracic trauma, and the Injury Severity Score (ISS) as an indicator of severity were also collected.

Statistical Analysis

Statistical analysis was performed using Stata software version 14.0. Categorical variables were described using absolute and relative frequencies, while continuous variables were analyzed using central tendency and dispersion measures according to their distribution. A time series analysis was conducted to assess temporal trends in the incidence of injuries over the study period, represented by line graphs. Additionally, comparisons between subgroups based on the type of injury and the

mechanism of the accident were made to identify potential significant differences. The p-*value* of <0.05 was considered statistically significant.

Results

Demographic and Clinical Characteristics of Patients

One hundred ninety patients with musculoskeletal injuries associated with electric scooter accidents were analyzed during the study period. The average age was 35 years (range: 18–65 years, SD: 9.9). Of these patients, 68% were male and 32% were female. Most cases (94%) were admitted directly through the emergency department, while 6% were seen through interconsultations. The analysis of arrival times at the emergency department following an electric scooter accident showed a relatively uniform distribution throughout the day, with no marked preference for a specific time interval. Peaks in arrivals were observed in the afternoon (12:00 to 17:59, 32%) and morning (6:00 to 11:59, 32%), closely followed by the evening (18:00 to 23:59, 30%). The least frequent time was from 00:00 to 05:59, with only 5% of cases.

Mechanism of Injury

The most common mechanism of injury was the rider's fall, accounting for 82% of cases. Less frequent mechanisms included collisions between riders (4.7%), collisions with vehicles (3.7%), and collisions with pedestrians (1.6%). A small percentage (0.5%) was classified as "other," in 7.4% of cases, the mechanism was unspecified.

Annual Incidence and Temporal Distribution

The incidence of injuries related to electric scooter accidents, calculated about the total number of orthopedic emergency consultations, was 6.8 cases per 1000 consultations in 2022 and 8.8 cases per 1000 consultations in 2023, reflecting a 29% increase in annual incidence. This increase may be related to the rise in the use of electric scooters as a means of transportation during this period.

Monthly analysis (Figure 1) shows significant variations between the two years. In 2022, the peak number of cases occurred in August, with 15 patients treated, while in 2023, prolonged peaks were observed in August, September, and October, with 14 cases each month. In contrast, the months with the fewest cases in both years were April and June, with as few as 2 cases in 2022 and 3 cases in 2023. The trend line in the figure highlights a general upward pattern towards the end of each year, followed by a decline in the early months. These fluctuations could be influenced by factors such as increased mobility in specific months or weather conditions affecting the use of electric scooters.

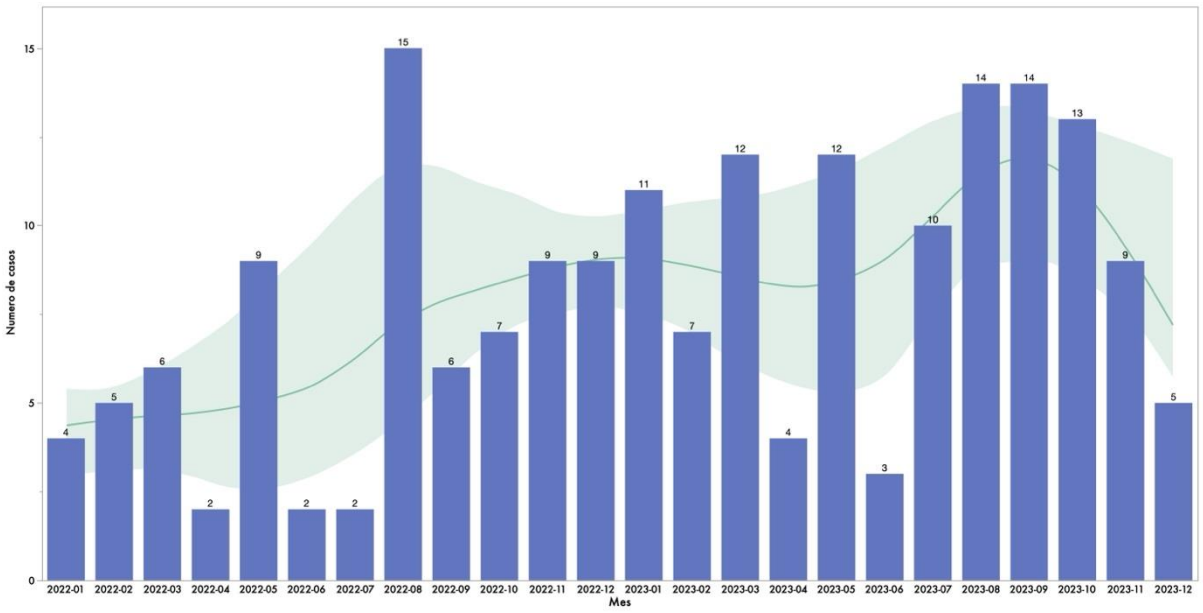

Figure 1. Monthly Trend of Injuries from Electric Scooter Accidents (2022-2023). The monthly distribution of cases attended in orthopedic emergencies related to electric scooter accidents. The bars represent the number of monthly cases, while the curved line depicts the overall trend. The shaded area indicates the confidence interval, highlighting the variability in the data.

Musculoskeletal Injuries

Among the 190 patients analyzed, 43% had at least one documented fracture. The radius was the most affected bone, accounting for 27% of all fractures in this cohort. According to the AO classification, 67% of radial fractures were located in the proximal

region, while 33% were in the distal region, reflecting the direct impact on this structure during falls. The humerus was the second most frequently fractured bone, representing 13.4% of fractures, with 80% located in the proximal region, 16% in the diaphysis, and 4% in the distal region. Proximal tibia fractures accounted for 10% of the lower extremities, followed by patellar fractures (4.9%). In the wrist and hand, fractures were documented in the scaphoid (3.7%), lunate (3.7%), metacarpals (7.3%), and phalanges (9.8%), highlighting the frequent impact on the hands in these types of accidents.

Regarding sprains, 28% of patients experienced at least one. The wrist was the most common location (13%), followed by the ankle (13%), knee (7.4%), and fingers (3.7%). Less frequent sprains affected the acromioclavicular joint (2.2%) and elbow (0.7%). Although most sprains did not specify the degree of injury (82%), among those classified, grade II was predominant (9.3%), followed by grade I (7.4%) and grade III (1.9%), reflecting a higher incidence of moderate and mild injuries.

Dislocations were present in 7.9% of patients, with the acromioclavicular joint being the most common (3.7%), followed by the shoulder and radioulnar joints (1.6% each). Less frequent dislocations were observed in the elbow and fingers (0.5% each). Two-thirds of the dislocations (67%) required reduction, while 33% did not need this intervention.

Finally, muscle or tendon tears were observed in 3.7% of patients, primarily affecting the rotator cuff (three cases, including one suspected) and the medial gastrocnemius (two instances, both grade II). Specific injuries such as peroneus brevis tendinitis and mallet finger were also documented, reflecting the diversity of structures affected in this group of injuries. Figure 2 illustrates the most affected anatomical regions,

highlighting the distribution of musculoskeletal injuries and the main impact areas in the upper and lower extremities.

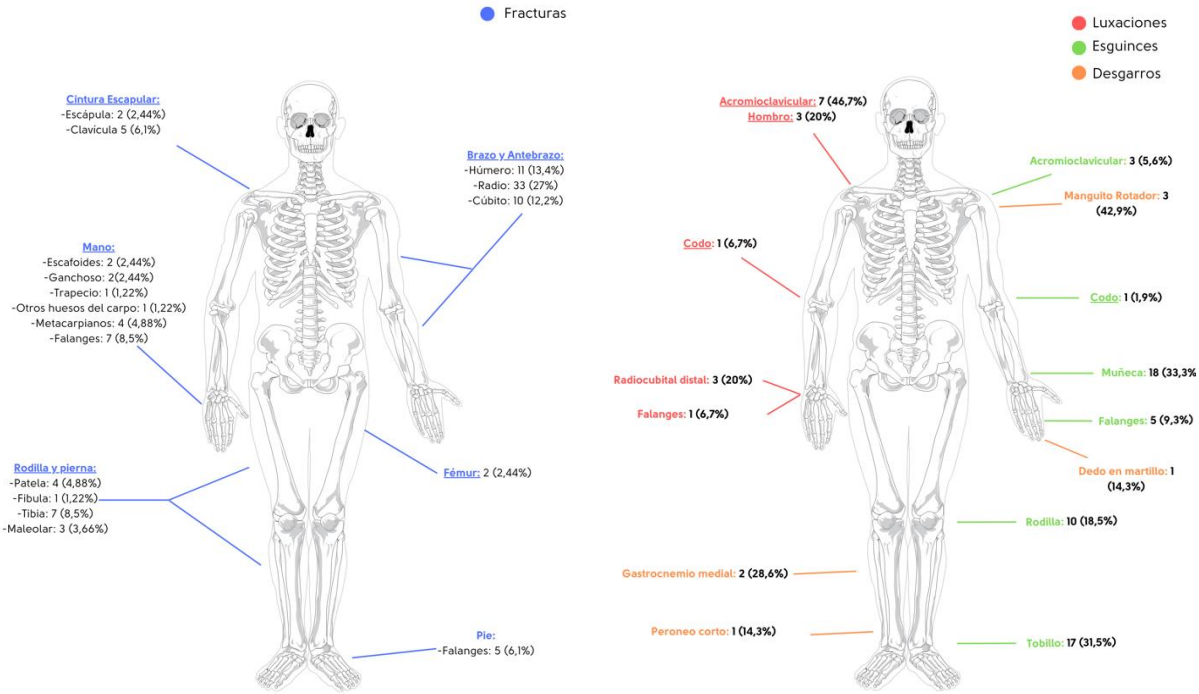

Figure 2. Distribution of all musculoskeletal injuries included in the study. Anatomical region and values are presented for each bone, joint, or soft tissue, including the total number of injuries and the percentage in their respective cohort.

Severity and Hospitalization

Most patients presented with low-severity injuries according to the Injury Severity Score (ISS), with an average score of 2.5 (range: 1–10, SD: 1.78). Only 6.3% of patients required hospitalization, with an average hospital stay of 1.35 days (range: 1–19 days, SD: 1.52). Although 75% of hospitalized patients had a one-day stay, an extreme case involved a prolonged hospitalization of 19 days. This data highlights the variability in injury severity and clinical needs.

Computed tomography (CT) scans were necessary in 23% of cases. This group primarily included patients with more complex fractures or suspected complications that required advanced imaging studies for confirmation.

Surgical Interventions

Seventeen percent of patients (33 cases) underwent surgical procedures. Open reduction and internal fixation were the only types of surgical intervention documented in this cohort. Among the patients who required surgery, 70% (23 cases) had a specific date recorded for the procedure. Most of these interventions were performed within the first few weeks following the accident, underscoring the urgency in managing these injuries.

Associated Injuries

Ninety percent of patients did not present with additional injuries. However, concomitant injuries were observed in the head (5.8%), thorax (3.2%), and maxillofacial region (3.2%). Only 0.5% were abdominal injuries.

Discussion

The adoption of electric scooters has significantly transformed urban mobility by providing an efficient and economical solution for short distances. However, this innovation has led to a substantial increase in related injuries, many of which are orthopedic and affect both users and pedestrians. Studies conducted in Tel Aviv, San Diego, and Denver have documented similar injury patterns, highlighting the most frequent fractures of the radius, tibia, and humerus. These findings underscore the need for localized studies to understand the impact in different urban contexts (1–4). Based on data from a university hospital in Bogotá, this study provides key insights into the demographic, clinical, and surgical characteristics of injuries associated with electric scooter use, contributing to the local understanding of this global issue.

The incidence of injuries related to electric scooter accidents increased by 29% between 2022 and 2023, with rates of 6.8 cases per 1000 consultations in 2022 and 8.8 cases per 1000 consultations in 2023. This increase reflects a pattern observed in other cities, where the growth in the availability and use of electric scooters has led to peaks in orthopedic emergency visits. Also, temporal analysis showed more cases in August, September, and October, although the reasons behind this monthly distribution are unclear. Seasonality, climate changes, vacation periods, or other urban mobility events could influence this pattern. However, these aspects require further analysis to understand their actual impact on the incidence of accidents.

Regarding injuries, fractures dominated the clinical landscape, primarily affecting the radius, humerus, and proximal tibia. These results align with previous studies documenting the typical biomechanics of falls on electric scooters, where users tend to cushion the impact with their hands, explaining the high prevalence of upper limb fractures (1–4). More complex fractures, such as those of the proximal radius and proximal tibia, required surgical intervention in a significant percentage of cases, highlighting the need for specialized resources to manage these injuries. On the other hand, although less frequent, sprains, dislocations, and tears reflected a varied anatomical distribution, with predominant involvement of the wrist, ankle, and acromioclavicular and shoulder joints. These findings underscore the diversity of injuries observed in high-energy accidents like these.

Surgical interventions accounted for 17% of cases, all performed through open reduction and internal fixation. Fractures of the radius, ulna, and proximal tibia are frequently operated on, reflecting their vulnerability in electric scooter accidents worldwide. The need for surgery in these injuries reinforces the importance of clear management protocols and access to specialized surgical services. Although the percentage of surgical patients in our cohort was lower than reported in other studies, this could be related to differences in the severity of cases treated or local surgical practices.

Bogotá's context makes this issue more complex. Although the Mobility Secretariat has issued basic recommendations for using electric scooters, such as helmet use and speed limits, these lack legal enforceability and are not widely disseminated or followed. Additionally, the city faces a significant deficit in specific infrastructure for micro-mobility, such as exclusive lanes and parking areas. These regulatory and infrastructure gaps force users to share space with motorized vehicles and pedestrians, increasing the risk of accidents. The lack of a culture of respect for traffic rules and recognition of the risk associated with electric scooter use also contributes to the problem, as reflected in the injury patterns observed in this study.

Despite its contributions, this study has limitations that should be considered. Its retrospective design depends on the quality and completeness of medical records, which could introduce information biases. Additionally, by focusing solely on a university hospital located in a high-density electric scooter usage area, the findings may not represent other areas of Bogotá or other cities in Colombia. Finally, data on the use of personal protective equipment and the specific circumstances of the accident were not included in factors that could enrich the analysis and aid in designing preventive strategies.

The increased incidence of electric scooter-related injuries and the various injury patterns observed reflect a growing challenge for health services. In addition to improving clinical management, this work aims to be a tool to raise awareness among the population and authorities about the importance of developing and implementing more effective measures to mitigate the impact of these accidents. These measures include creating clear and mandatory regulations, designing adequate road infrastructure, and strengthening educational campaigns aimed at both users and the

public. Although limited in scope, this study provides valuable information for developing comprehensive strategies that address the prevention and treatment of injuries related to electric scooter use.

Conclusion

This study highlights the growing impact of injuries associated with electric scooter use in Bogotá, dominated by fractures that frequently require surgical management. The lack of regulation, infrastructure, and road safety culture underscores the need for strategic interventions. These findings encourage the development of public policies and preventive measures to promote safer use and reduce the impact on public health.

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