



## ORIGINAL PAPER

# [Translated article] E-scooter accidents: A new epidemic



K. Bascones<sup>a,\*</sup>, T.E. Maio Méndez<sup>b</sup>, F.A. Yañez Siller<sup>c</sup>

<sup>a</sup> Cirugía Ortopédica y Traumatología, Unidad de Extremidad Superior, Hospital Asepeyo, Sant Cugat del Vallés, Barcelona, Spain

<sup>b</sup> Residente COT, Hospital Asepeyo, Sant Cugat del Vallés, Barcelona, Spain

<sup>c</sup> Cirugía Ortopédica y Traumatología, Unidad de Extremidad Inferior, Hospital Asepeyo, Sant Cugat del Vallés, Barcelona, Spain

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### KEYWORDS

E-scooter;  
In-itinere accident;  
Work-related  
accident;  
Work disability;  
Economic impact

### Abstract

**Introduction:** During the last years, the use of e-scooter has become more and more popular due to the versatility as the practicality in intra-urban mobility. However, e-scooter has turned into a spring of accidents, lot of them, severe, causing new public health problems and significantly increasing the direct and indirect healthcare costs.

**Objective:** To characterise the epidemiology of the injuries caused by e-scooter related accidents and to study their indirect economic impact in work-related accidents hospital.

**Materials and methods:** Retrospective and descriptive study in which has been checked all the medical information about the patients attended in the ER (emergency room) of the Hospital Asepeyo Sant Cugat, who suffered e-scooter accident from January 2018 to December 2020.

**Results:** 167 patients were included in the study. 55% (92) were male and 45% (75) were female. The average of age was 37.4 years-old. There were quantified 117 different fractures in 105 patients (63%). Other injuries documented were: 36 patients with multiple contusions, 16 head traumas and 4 wounds which required suture. The most frequent ligamentous injuries were 4 ACL ruptures, 3 ACJ dislocations and 2 patients with rupture of the UCL of the thumb. 105 patients required hospital admission, 3 of them in ICU. The 51% of the cases required surgical treatment of their injuries. In that period, as a consequence of the work inabilities generated by the total of the patients included in the study, the added cost for the hospital was around 1,062,444€.

**Conclusions:** The popularisation of e-scooters between the employed population has caused a high increased number of accidents in this range of age. Most of the injuries observed may be compared with those seen in high-energy traumas. These cause an important socio-economic

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\* Corresponding author.

E-mail address: [doctorabascones@gmail.com](mailto:doctorabascones@gmail.com) (K. Bascones).

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impact due to the nature of the injuries and the potential complications that could appear. The work disabilities observed as a consequence of e-scooter related injuries in the employed population have caused a substantial economic impact, shooting up to more than 1,000,000€ the indirect cost of our hospital during the reviewed period.

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## PALABRAS CLAVE

Patinete eléctrico;  
Accidente *in itinere*;  
Accidente laboral;  
Incapacidad laboral;  
Impacto económico

## Accidentes en patinete eléctrico: una nueva epidemia

### Resumen

**Introducción:** El uso de patinetes eléctricos se ha popularizado como medio de transporte en los últimos años, tanto por su versatilidad como por la practicidad en el uso de estos. Sin embargo, no dejan de ser una fuente de accidentes, muchas veces graves, generando nuevos problemas de salud pública y aumentando los costes de esta.

**Objetivo:** Caracterizar la epidemiología de las lesiones producidas por accidentes en patinete eléctrico y estudiar el impacto económico indirecto en una mutua laboral.

**Materiales y métodos:** Estudio descriptivo, donde se revisan retrospectivamente los pacientes atendidos en urgencias, del Hospital de Asepeyo en Sant Cugat, que han sufrido accidentes en patinete eléctrico en el periodo comprendido entre enero de 2018 y diciembre de 2020.

**Resultados:** Se incluyeron 167 pacientes. El 55% (92) de los pacientes fueron hombres y el 45% (75) mujeres, con una edad media de 37,4 años. Se diagnosticaron 117 fracturas en el 63% (105) de los pacientes. Otras lesiones frecuentes documentadas fueron: 36 policonusiones, 16 TCE y 4 heridas que requirieron sutura. Las lesiones ligamentosas más comúnmente observadas fueron: 4 casos de rotura aguda de LCA, 3 casos de luxación acromioclavicular y 2 casos de rotura del LCC del pulgar. Un total de 105 pacientes requirieron ingreso hospitalario, 3 de ellos en UCI. El 51% (85) de los pacientes requirieron tratamiento quirúrgico. Durante ese periodo, el coste generado como consecuencia de las bajas laborales ascendió a 1.062.444€.

**Conclusiones:** El patinete eléctrico está comportando un incremento significativo de accidentes de tráfico en población adulta joven. Las lesiones que provocan pueden compararse con las vistas en accidentes de alta energía, generando un alto impacto socioeconómico debido a la naturaleza de las lesiones y sus potenciales complicaciones. Como mutua laboral, el impacto económico generado por las incapacidades laborales ha sido significativamente notable, ascendiendo a más de 1.000.000€ en el periodo revisado.

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## Introduction

Intra-urban mobility has radically changed in recent years, due to increased traffic. In large cities this has promoted the development of new, faster and more economical ways of travelling compared to using standard vehicles.<sup>1</sup> Despite their earlier appearance, the use of the electric scooter in Spain as a means of transport did not become popular until the end of 2017, which was when these vehicles were officially launched by their leading manufacturers.

Electrical scooters have mainly become popular because of their versatility, and their practicality.<sup>2</sup> Furthermore, there are other advantage such as their sustainability, low cost, reduced dimensions, easy manoeuvrability and their speed, since they can go up to 20–30 km/h.<sup>3</sup> All of the above saves time for all users and in addition to this, no specific driving licence or state regulated protection equipment is required for use. Similarly to other means of transport, the e-scooter is a source of accidents, and of as yet unknown injury patterns. On many occasions, these accidents are of

considerable severity and to date have only been identified as high-energy accidents.

During the last 5 years, the international, published, medical literature on this type of injury has increased proportionally to the number of accidents with e-scooters.<sup>1–25</sup> To date, no article has been published in Spain referring to accidents associated with these means of personal mobility.

The aim of this study was to examine the frequency, characteristics, most common injury patterns and demographic distribution of the different injuries observed in working-age patients who were attended to in the emergency department of a of Spanish private work-related accident hospital, due to e-scooter accidents on the way to work.

## Material and methods

A retrospective study conducted in the Hospital Asepeyo Sant Cugat, Barcelona, Spain, which included all consecutive patients attended to in the emergency department after suffering an e-scooter accident on the way to work,

**Table 1** Inclusion and exclusion criteria for medical record review.

Inclusion criteria	Exclusion criteria
Main e-scooter driver	Another vehicle involved Not an electric scooter Not main driver/companion Doubtful cases where e-scooter use could not be confirmed

with them being the main scooter drivers, from 1st January 2018 to 31st December 2020. All medical records of the patients who suffered from the e-scooter accident en route to work, where they were the main scooter drivers, were reviewed. All patients were excluded when the mechanism of the injury was linked to a different means of transport, or a different type of scooter, when the patient was not the main driver and in all cases where there was some discrepancy, or the use of the e-scooter could not be confirmed (Table 1).

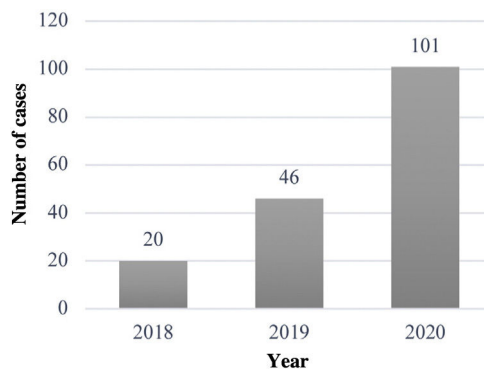
The following were recorded: demographic data (age and sex); clinical data (main diagnosis and secondary diagnoses according to the international classification of CIE-10 diseases); the affected anatomical region; treatment; complications; rate of admission; length of hospital stay, and length of sick leave in days. After data collection and prior to statistical analysis, the identifying data of each patient were anonymised.

The cohort of patients was divided into two groups: Group 1: patients who required surgical treatment as a consequence of the injuries they suffered; Group 2: patients who were treated using conservative management.

Descriptive statistical analysis was performed with SPSS software. The comparison between groups was made using parametric statistics with the Fisher test. The level of statistical significance was fixed at  $p < .05$ .

**Results**

The sample comprised 167 patients who met with the inclusion criteria between January 2018 and December 2020.



**Figure 1** Evolution of the number of patients involved in e-scooter accidents attended to by the emergency services in 2018, 2019 and 2020.

Of all the patients attended, 55% (92) of them were men and 45% (75) women, with a mean age of 37.4 years (range between 20 and 63 years), with the highest incidence being between 20 and 39 years (Table 2).

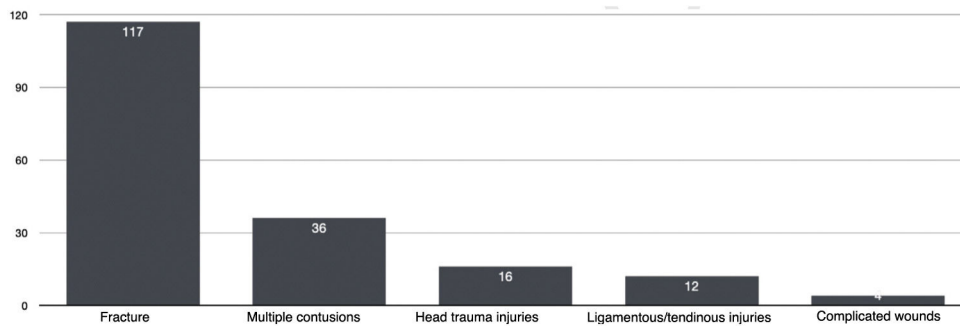
During the inclusion period an exponential increase of e-scooter use accidents was observed: 20 in 2018, 46 in 2019, 101 in 2020 (Fig. 1).

Between the different coded diagnoses (207 diagnoses according to the CIE-10), the most common was fracture in 62.8% (105) of patients, with a total of 117 fractures in different anatomical sites. Of the 117 fractures, 4 were coded as open fractures (3.41%). The other injuries reported were: 36 patients with multiple contusions (21.5%), 16 patients with head injuries (9.5%), 12 patients with ligament and/or tendon injuries (7.18%), and 4 patients with wounds that required suture (2.4%) (Fig. 2). Regarding the ligament and tendon injuries, there were 4 cases of acute anterior cruciate ligament (ACL), 3 cases of acromioclavicular joint injury (ACJ), 2 cases of ulnar collateral ligament rupture (UCL) of the thumb, one associated with a Stenner injury, one case of a patient with traumatic rotator cuff rupture, one patient with dislocation of the peroneal tendons due to a rupture of the retinaculum and one case of a patient with a first episode of glenohumeral dislocation. Other injuries included one case of pneumothorax requiring thoracic drainage, one

**Table 2** Demographic data of the two sample groups.

	ST (n = 84)	No ST (n = 83)	Total (n = 167)	p value
Age	39.0 ± 10.9	35.7 ± 9.2	37.4 ± 10.3	.125
<20	0	2 (2.41%)	2 (1.20%)	<b>.044</b>
20–29	20 (23.81%)	22 (26.51%)	42 (25.15%)	.67
30–39	24 (28.57%)	28 (33.73%)	52 (31.14%)	.506
40–49	23 (27.38%)	24 (28.92%)	47 (28.14%)	.864
50–59	15 (17.86%)	6 (7.23%)	21 (12.57%)	.06
≥60	2 (2.38%)	1 (1.20%)	1 (1.80%)	1
Sex				.5358
W	36 (42.86%)	40 (48.19%)	75 (44.91%)	
M	48 (57.14%)	43 (51.81%)	92 (55.09%)	

There were no statistically significant differences between the two groups with regard to sex and age except for the <20 years age range.



**Figure 2** Distribution of the most frequent diagnoses among patients attended to by the emergency services between 2018 and 2020.

case of conservatively managed liver laceration and one case of conservatively managed eye laceration.

Out of the total of 117 fractures, the most commonly affected anatomical site was the upper limb (56% of injuries). The most affected site was the shoulder girdle, followed by the wrist, elbow and hand, respectively (Fig. 3).

Fifty-one per cent of the total patients (85) required surgical treatment, with the most common surgery being osteosynthesis of the upper extremity. Only one significant difference was found regarding the type of treatment in fractures which affected the spinal area, where 100% were conservatively managed (Table 3).

Of the total patients, 62 were discharged on the same day as the accident and 105 needed to be admitted to hospital (62.87%); 7 patients required admission to assess the evolution of their injuries, despite not have received surgical treatment: 3 patients (1.7%) required admission to the ICU for pneumothorax (1), liver laceration (1) and severe head trauma with subarachnoid haemorrhage associated with subdural haematoma (1). The mean number of days of admission was 4.6 days for patients undergoing surgery and 4.2 days for those treated conservatively ((Table 4).

The average number of days sick leave from work generated by the 167 patients was  $109.68 \pm 20.47$  days (95% CI). Taking into account that the average cost generated per day of sick leave/patient for the occupational health insurance company is 58€, the average cost generated by the incapacity to work of each patient has been €6391 to date. The approximate total cost during the period under review has been €1,062,444.

No deaths of any patients were reported in our review.

## Discussion

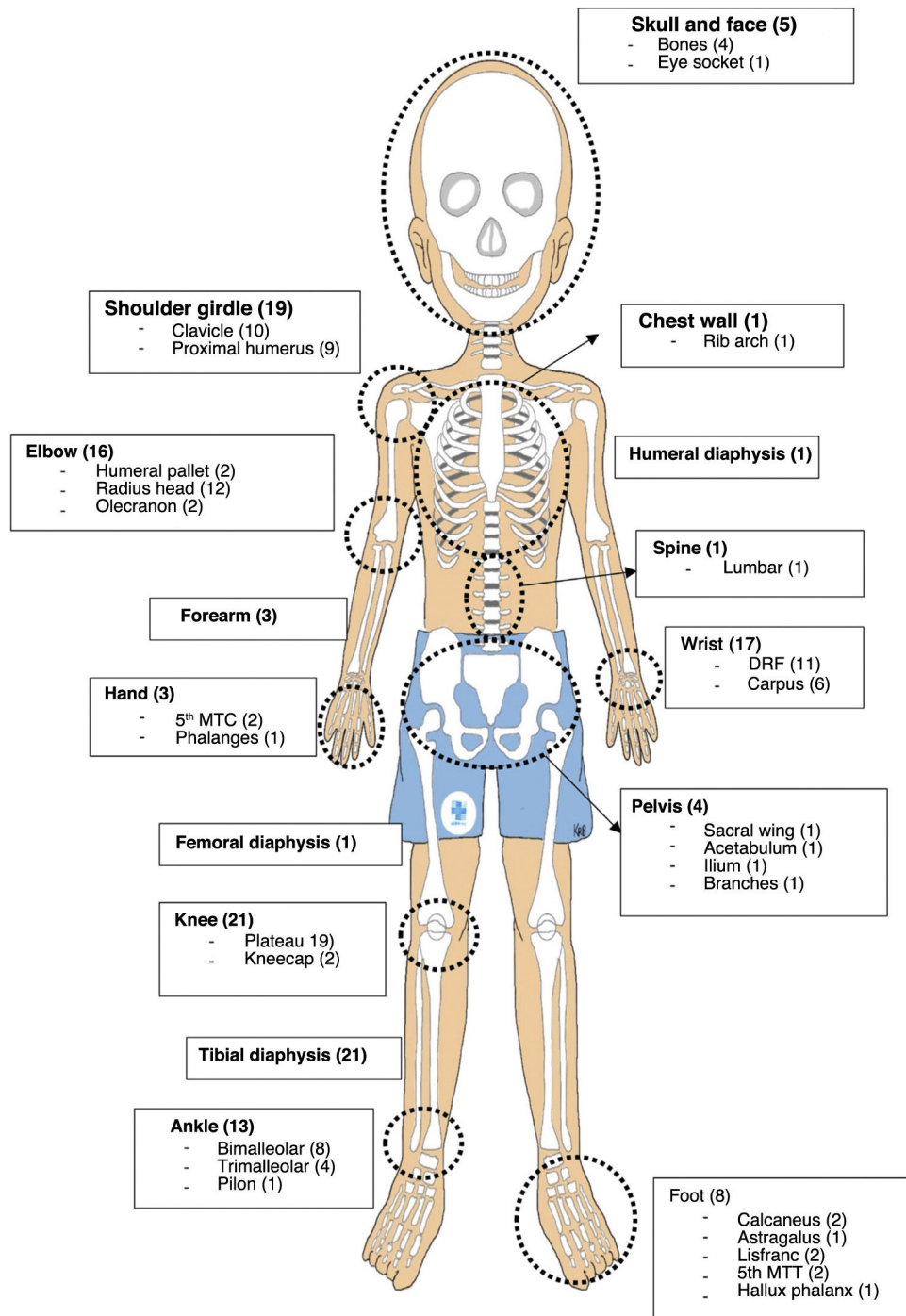
Since its appearance in 2017 the e-scooter has become an alternative form of transport in large cities worldwide.<sup>4</sup> Its reduced size and manoeuvrability, performance and low cost make it a fast and economical means of transport. This, together with the lack of enforcement for a specific driving licence and the lack of regularisation of its usage have currently made the e-scooter into one of the most affordable personal mobility tools for most citizens, optimising time and money compared with other modes of transport. However, this new form of urban mobility, similarly to the other means of transport, carries with it inherent risk of

injury. In the U.S.A. it has been estimated that the risk of injury from e-scooter use is 180 accidents per million uses,<sup>5</sup> generating mean costs of \$1213/accident.<sup>6</sup> It is probable that the number of accidents in e-scooters continues to rise since there has been an exponential increase of trips to the emergency services from e-scooter accidents and this also occurs in large cities in other countries, including the U.S.A.,<sup>4,7-13</sup> Austria,<sup>14</sup> New Zealand,<sup>15,16</sup> Denmark<sup>1</sup> and Germany.<sup>17</sup> In our review we also observed significant increases in emergency service usage since 2017.

The prototype of patient who went to the emergency department after an e-scooter-associated accident was a male with an average age of 38.6 years. This coincides with other studies published to date.<sup>4,6,8-11,15-21</sup> It is of note that the mean age of injured people using a manual scooter is below 15 years of age.<sup>1</sup> This may reflect that in Spain the e-scooter is becoming a highly common means of transport for users of working age. Therefore, if the number of accidents associated with an e-scooter continues to increase, the socio-economic impact that these accidents may generate and their consequent disabilities will be considerable.

Coinciding with that published by Aizpuru et al.,<sup>8</sup> Siow et al.<sup>20</sup> and Trivedi et al.,<sup>21</sup> the greatest injuries (fractures, dislocations, haemorrhages, internal injuries) were the most frequent causes of hospital admission, reflecting the high energy with which these accidents were caused. Ishmael et al. published an open fracture incidence of 12.3% (9 out of 75 patients), concluding that these patients could suffer from an increased risk of complications. Compared to this data, in our study the open fracture rate was lower, with 4 open fractures being reported (3.41%) out of the total of fractures.

In our review, the most affected anatomical site was the upper extremity, specifically the shoulder girdle and elbow. This is curious, bearing in mind that similar sports like skating or skateboarding typically lead to wrist fractures. Our results coincide with those published by Mofthakhar et al.<sup>14</sup> and Nellamattathil and Amber,<sup>22</sup> which found no typical injury pattern affecting the upper extremity but concluded that curiously elbow/shoulder fractures are more common than wrist ones. Other authors also found similar results to ours, concluding that the most commonly affected anatomical sites were the extremities and the head.<sup>3,6,8,9,12,13,15,17,18,20-22</sup> We should bear in mind that, both joint fractures and particularly those of the elbow, and



**Figure 3** Anatomical distribution of the 117 coded fractures.

severe head trauma injuries usually result in functional long-term limitations. In our study we observed a 9.5% of head injuries, but heads injuries of up to 40% have been published.<sup>1,14,15,19,21</sup> However, despite our lower rate of head injuries compared with the data published in the medical literature, around 40% of patients with a head injury diagnosis suffered from injuries which could have been classified as major (facial fractures, intracranial haemorrhages/haematomas). Störman et al. Published a rate of

38.46% of major head injuries, highlighting that only 1.33% of patients had worn helmets. To date, there is no regulation in Spain determining helmet use or the use of other personal protection materials for e-scooters, with citizens themselves making their own recommendations. A law regulating mandatory use of a helmet in Spain would significantly reduce major head injuries associated with the use of the e-scooter, as previously reported with motorcycle accidents,<sup>26</sup> bicycle accidents<sup>27</sup> or skateboard accidents.<sup>28</sup> All these per-

**Table 3** Rate of surgical treatment vs. non-surgical treatment depending on the anatomical site of the injury.

	ST (n = 98)	No ST (n = 114)	Total (n = 207)	p value
Head/face	8 (8.16%)	19 (16.67%)	26 (12.56%)	.148
Chest/trunk	2 (2.04%)	4 (3.51%)	4 (1.93%)	.688
Spine	0 (0%)	7 (6.14%)	7 (3.38%)	<b>.0159</b>
Pelvis	1 (1.02%)	2 (1.75%)	5 (2.42%)	1
Upper extremity	45 (45.92%)	47 (41.23%)	92 (44.4%)	.5784
Lower extremity	42 (42.86%)	35 (30.70%)	73 (35.27%)	.085

Only one statistically significant difference was observed in patients with a spinal injury where in 100% of cases management was conservative.

**Table 4** Number of patients who required hospital admission and mean hospital stay in days.

Admission	ST	No ST	Total	p value
Patients	98	7	105	.00001
Mean days	4.66	4.2	4.77	Not significant

sonal mobility methods, including the e-scooter, are similar, due to their high speeds, short distance to the ground and lack of reaction time. This is why we believe that improvement in the rate of severe intracranial injury following mandatory helmet usage in these means of transport could be extrapolated to an improvement with the electric scooter.

The rate of surgical treatment associated with the e-scooter is between 5.5% and 33%.<sup>10–12,14–20,22</sup> These studies include hospital centres of all levels. We believe our rate of surgery is higher (51%) due to the pyramidal structure of this occupational health insurance company, with the Hospital Asepeyo being at the top of the pyramid in Spain. We believe these centres could have acted as a filter for lesser injuries, and increased the rate of surgery and the rate of hospital admission (62.87%), which is higher than other published figures.<sup>10,15,18,19,21</sup> Patients requiring ICU admission were 1.7%, with no differences found to ICU admission rates published to date (1%–8%).<sup>6,10,11,17–19</sup>

The mean stay in our hospital was 4.53 days, with no significant differences between the patients who required surgery and those who did not. This result did not differ from rates published by Kobayashi et al.<sup>10</sup> and Puzio et al.,<sup>11</sup> indicating a mean stay of 3 days. In these studies only patients who had been admitted to Level 1 Trauma Centre type hospitals were reviewed, which is how our hospital could be classified.

After reviewing 23 cases of e-scooter accident patients Campbell et al.,<sup>23</sup> specified that the loss of total earnings associated with these accidents was \$44,368 (\$1930 per patient). Lavoie et al.<sup>24</sup> reported that the mean professional cost in their hospital per patient was \$9334. In our review there was a mean cost for sick leave per patient of €6931 during the study period.

In our review to date fortunately there have been no deaths. Since 2017, 3 deaths have been reported in the

United States from e-scooter accidents,<sup>16</sup> all of them from traumatic intracranial injuries,<sup>25</sup> and one of them also associated with severe chest trauma.<sup>13</sup>

## Limitations

Since this is a retrospective study our conclusions are limited by available data collected in each electronic medical record. Furthermore, for most patients, the use or non use of protective clothing was not reported. We also believe our study may have a bias of severity from the filter possibly generated by the health centres which referred the more heavily injured cases that required more specialised care to our hospital. Lastly, as this was a retrospective study, there could have been limitations associated with the review of cases at a specific time, without taking into account mid-term and long-term development.

## Conclusions

The electric scooter is leading to a considerable increase in young adult traffic accidents. These accidents appear to most frequently affect the shoulder girdle, wrist, and elbow. No typical injury pattern was found but, in several cases, the injuries were comparable with those observed in medium-to-high-energy accidents. The socio-economic impact this type of injury may cause in the young adult population is high. The cases reviewed at our hospital generated a significant economic impact for our occupational mutual insurance company as a result of work incapacities. These social and healthcare costs are likely to increase in Spain over the next few months or years if the use of the e-scooter is not officially regulated for its users.

## Level of evidence

Level of evidence IV.

## Conflict of interests

The authors have no conflict of interests to declare.

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