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Electric bicycle-related injuries presenting to a provincial hospital in China

A retrospective study

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Abstract

The use of electric bicycles (EBs) in China is growing. In the present study, we aimed to characterize the pattern and outcomes of EB-related injuries presenting to a major general hospital in China.

This was a retrospective review of EB-related injuries presenting to Zhejiang Provincial People's Hospital from 2008 to 2011. Cases were identified from medical records according to diagnosis codes. Data captured included demographics, injury characteristics, and outcomes.

A total of 3156 cases were reviewed in the present study. There were 1460 cases of traffic accidents, of which 482 cases were EB-related (32.7%). In addition, most of EB-related cases (44.6%) belonged to the 41- to 60-year-old age group. Median injury severity score was 10. Moreover, 34.9% underwent surgery and 24.7% were admitted to intensive care unit. The median hospitalization cost was 14,269 USD. Fracture (56.5%) was the most frequently diagnosed injury type, and head was the most commonly injured body region (31.1%).

EB-related injuries have become a major health concern, making up a sizeable proportion of injuries presenting to the emergency department. Therefore, it is necessary to establish injury prevention and strategies for EB road safety. Implementation of policy such as compulsory helmet use, as well as popularization of EB road safety education should be considered to improve the current situation of EB-related injuries in China.

Abbreviations: CI = confidence interval, EB = electric bicycle, ED = emergency department, ICD-10 = International Classification of Diseases 10th edition, ICU = intensive care unit, IQR = interquartile range, ISS = injury severity score, OR = odds ratio, USD = United States dollars.

Keywords: China, electric bicycles, injury prevention, motor vehicle accident, road traffic accident, trauma

1. Introduction

Motor vehicle accidents have become a global health concern, exerting large societal and economic tolls on society. According to the World Health Organization, road accidents were responsible for approximately 12% of deaths worldwide in 2012.[1] As a growing mode of transport, electric bicycles (EBs) have been rapidly becoming a substantial contributor to road accidents.

EBs are 2-wheeled bicycles propelled in part or solely by rechargeable electric batteries.[2] EBs were introduced to the China market in the 1980s[3] but did not gain adoption on a large scale until the 1990s. The sales of EBs in China now has exceeded 30 million United States dollars (USD) and is projected to exceed 38 million USD by 2018.[4] In 2011, there were 120 million registered EBs in China.[5] A report on the national use of EBs in China has attributed the recent growth to improved technology, increased demand, and policy factors.[2] Popularity amongst EB consumers is understandable considering its affordable price, maintenance, and convenience.[6,7]

While banned in a few Chinese cities, the majority of EBs are classified as nonmotorized vehicles and regulated as bicycles, although they can be used as fast as motor vehicles.[8] The speed limit of EBs is below 20 km/h under Hangzhou legislature since May 1, 2008. However, it is still difficult to regulate the use of EBs, as there are currently no mandates on licensure, insurance, or helmet use under Hangzhou legislature.

Along with its rapid rise in popularity, EB-associated injuries are quickly becoming a concern. A hospital in Suzhou, China has found that half of the attendances for motor vehicle accidents can be attributed to EBs,[9] while studies based on police data have found year-on-year increase in EB-related injuries.[10] This problem does not appear to be confined to China, with related reports from Switzerland[11,12] and the United States[7] along with the spread of its use worldwide.

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In this paper, we aimed to elucidate the prevalence, patterns of injuries, and outcomes of EB-related accidents presenting to a Hangzhou Provincial Hospital.

2. Materials and methods

2.1. Setting

As the capital and largest city of Zhejiang Province in Eastern China, Hangzhou was classified as the fourth-largest metropolitan area in China with a population of 21.1 million over an area of 34,585 km^2, according to the 2010 Hangzhou Municipal Statistic Bureau Report. Until 2013, there were 208 hospitals in Hangzhou, including 19 provincial hospitals and 10 city hospitals. There were 7.37 beds per 1000 people, including 6.60 beds in tertiary or secondary hospitals and the other 1.17 beds in community hospitals. Zhejiang Provincial People's Hospital, a major general hospital in Zhejiang Province, possessed 2500 inpatient beds and an annual emergency department (ED) attendance of 130,000. Zhejiang Provincial People's Hospital was also the headquarters of Zhejiang Emergency Medical Services. Ethics approval for this study was obtained from the Ethics Committee of Zhejiang University.

2.2. Study population

Cases of EB-related injuries presenting to the ED from 2008 to 2011 were identified through retrospective review of ED electronic medical records. All cases were identified according to International Classification of Diseases 10th Edition (ICD-10) codes relating to trauma or injury. Cases were included in the present study if EB was involved. Chart review was performed by trained personnel consisting of an ED physician and a medical student.

Demographic data, including age, gender, and education level, were collected. Incident-related data included time and location of the accidents. Injury-related data included type of injury, injured body region, severity of injury, and subsequent inpatient care. Injury types were divided into fracture, sprain, open injury, bruise, cerebral concussion, unknown injury, and others. Injured body regions were divided into multiple sites, head and brain, upper limb, lower limb, trunk, respiratory system, digestive system, and nervous system. Injury severity was classified based on the injury severity score (ISS).

2.3. Statistical analysis

Data entry was performed using Excel 2010 (Microsoft Corp., Redmond, WA), and data analysis was conducted using IBM SPSS Statistics 21 (IBM, Armonk, NY). Missing data were excluded from the analysis. Frequencies and proportions were computed for injured body regions and injury type. Multinomial logistic regression modeling was used to determine adjusted odds ratios (OR) with 95% confidence intervals (CI) for age groups, controlling for variables, such as sex, residential status, highest education level, and length of stay. P value $<.05$ was considered statistically significant.

3. Results

Among the 3156 reviewed cases, there were 1460 cases of traffic accidents. Of these cases, 482 cases were EB-related (32.7%). Table 1 describes the demographics and hospitalization characteristics of these cases. The median age was 41.5 years (interquartile range [IQR] 29, 52), and 63.9% were males. With regard to highest education level, 69% received high school education or lower. In addition, 33.6% of casualties were Hangzhou residents, 54.7% were Zhejiang residents outside Hangzhou, while 11.7% were from other provinces.

Table 1

Demographics and hospitalization characteristics.

Characteristics	N = 482
Age, median (IQR), years	41.5 (29–53)
Sex, n (%)	
Male	308 (63.9)
Female	174 (36.1)
Residence, n (%)	
Hangzhou	162 (33.6)
Zhejiang	194 (40.2)
Others	126 (26.2)
Highest education, n (%)	
≥Bachelor	92 (19.1)
Diploma	57 (11.8)
≤High school	333 (69.1)
Length of stay, median (IQR)	16 (11–22)
Surgery, n (%)	
Yes	168 (34.9)
No	314 (65.1)
Admitted to ICU, n (%)	
Yes	119 (24.7)
No	363 (75.3)
ISS, median (IQR)	10 (8–14)
Hospitalization cost*, median (IQR)	14,269 (10,663–18,184)

* USD.

ICU = intensive care unit, IQR = interquartile range, ISS = injury severity score, USD = United States dollar.

Among the 482 cases, median ISS was 10 (IQR 8, 14). A total of 13 patients (2.7%) were critically injured (ISS more than 25), and 33 patients (6.8%) were seriously injured (ISS between 16 and 25 inclusive). In addition, 34.9% underwent surgery, and 24.7% were admitted to intensive care unit (ICU). The median hospitalization cost was 14,269 USD (IQR 10,663, 18,184). Median length of stay was 16 days (IQR 11, 22) and in-hospital mortality was 6.26%.

Table 2 shows the injury characteristics. Fracture (56.5%) was the most commonly diagnosed injury type, followed by cerebral concussion or contusion (23.4%) and bruise (5.8%). The most frequently injured body region was head (31.1%), followed by multiple regions (25.9%) and lower limb (22.8%). Less frequently injured body regions were upper limb (8.7%), trunk (8.0%), respiratory system (0.7%), digestive system (2.0%), and nervous system (0.8%).

Table 3 shows the demographics and hospitalization characteristics of the cases stratified by age group. Most cases belonged to the 41- to 60-year-old age group (44.6%), followed by the 21- to 40-year-old age group (38.2%). Table 4 shows the adjusted OR for different age strata. Taking the more than 60-year-old age group as a reference, patients in the 21- to 40-year-old (OR, 0.979, $P = .015$) and 41- to 60-year-old age groups (OR, 0.982, $P = .028$) had shorter length of stay. Taking the more than 60-year-old age group as a reference, patients in the 41- to 60-year-old age group were associated with increased OR of being native residents of Hangzhou (OR, 3.02, $P = .047$). Taking the 21- to 40-year-old age group as a reference, patients with higher level of education had increased OR of injury compared to cases with lower level of education.

Table 2

Injury characteristics.

Characteristic	N = 482
Injury type, n (%)	
Fracture	273 (56.5)
Cerebral concussion or contusion	113 (23.4)
Bruise	28 (5.8)
Sprain	21 (4.5)
Open injury	14 (2.8)
Unknown	29 (6.1)
Others	4 (0.8)
Injured body region, n (%)	
Multiple	125 (25.9)
Head	150 (31.1)
Upper limb	42 (8.7)
Lower limb	110 (22.8)
Trunk	38 (8.0)
Respiratory system	3 (0.7)
Digestive system	10 (2.0)
Nervous system	4 (0.8)

4. Discussion

In this study, we found that almost one third of road traffic accidents were EB-related. Our results confirmed previous studies and the authors' observation that EB-related injury is a major health concern, significantly contributing to the trauma disease burden of China. Recently, an investigation by China Disease Center in Jinhua, another city in Zhejiang Province, has shown that speeding, carrying passengers, running the red-light and riding against traffic flow are the key unlawful acts among EB riders, suggesting that targeted intervention should be carried out to reduce the prevalence of unlawful riding acts and the incidence of EB-related injuries and deaths.[15] However, that report lacked some useful clinical characteristics.

To the best of our knowledge, this is one of the first few studies investigating EB-related injuries from China based on hospital data. Our study complemented a previous Zhejiang study using police department data,[10] which did not include useful clinical characteristics as these were seldom recorded in police databases.

In addition to medical care delivered through prehospital and hospital systems, an effective system of injury prevention must necessarily involve public education and legislature.[13] Given the rise in EB-related injuries, strategies for injury prevention are urgently needed. A significant number of patients in our study were critically or seriously injured with likely long-term impairment, indicating the need for greater regulations of EBs. Our study showed that the majority of the EB-injury victims were not residents of Hangzhou, suggesting that public education efforts need to be pitched at a provincial or national level.

Surprisingly, our study showed that patients in the 21- to 40-year-old age group, with higher level of education were more likely to sustain EB-related injuries compared to patients with lower level of education. We conjectured that this might be due to a sense of "time urgency" in this group of patients. Moreover, unlike car drivers, driving license or road safety education is not required for EB users. Therefore, having a higher level of education did not seem to place this group of patients at an advantage with regard to the risk of EB-related accidents and injuries. It is vital to implement road safety education in schools and the traffic departments.

In the present study, we found that a sizeable number of cases suffered from head injury, suggesting that helmet laws should be mandatory for EB users. However, a similar study about orthopedic injury in EB-related collisions has revealed that fewer patients over the age of 60 years were wearing helmets at the time of accident compared to those in other age groups.[14] Further studies on head injury in EB-related collisions should be conducted to provide legislative basis for using helmets.

As a convenient, low-cost and environmental-friendly mode of transport, EB is a promising solution, especially in cities with

Table 3

Demographics and hospitalization characteristics stratified by age group.

	Age (0–20) years	Age (21–40) years	Age (41–60) years	Age (>60) years	*P*-value
N (%)	46 (9.5)	184 (38.2)	215 (44.6)	37 (7.7)	
Sex, n (%)					.115
Male	35 (11.4)	120 (39.0)	127 (41.2)	26 (8.4)	
Female	11 (6.3)	64 (36.8)	88 (50.6)	11 (6.3)	
Residence, n (%)					.001
Hangzhou	23 (14.2)	58 (35.8)	75 (46.3)	6 (3.7)	
Zhejiang	10 (5.2)	66 (34.0)	97 (50.0)	21 (10.8)	
Others	13 (10.3)	60 (47.6)	43 (34.1)	10 (7.9)	
Education, n (%)					<.001
≥Bachelor	0 (0.0)	66 (71.7)	22 (23.9)	4 (4.3)	
Diploma	10 (17.5)	36 (63.2)	9 (15.8)	2 (3.5)	
≤High school	36 (10.8)	82 (24.6)	184 (55.3)	31 (9.3)	
Length of stay, median (IQR)	15 (12–19)	16 (10–22)	16 (10–23)	19 (16–35)	.015
Surgery, n (%)					.038
Yes	24 (14.3)	65 (38.7)	70 (41.7)	9 (5.4)	
No	22 (7.0)	119 (37.9)	145 (46.2)	28 (8.9)	
Admitted to ICU[†], n (%)					.598
Yes	14 (11.8)	40 (33.6)	55 (46.2)	10 (8.4)	
No	32 (8.8)	144 (39.7)	160 (44.1)	27 (7.4)	
ISS, median (IQR)	11 (8–15)	10 (8–14)	10 (8–14)	10 (6.5–15)	.327
Hospitalization cost[*], median (IQR)	14277 (10539–16674)	13495 (9983–19896)	14284 (10159–17976)	14473 (11382–27363)	.343

[*] USD.

[†] Statistically significant ($P<.05$).

ICU = intensive care unit, IQR = interquartile range, ISS = injury severity score, USD = United States dollar.

Table 4

Adjusted OR and 95% CI for different age groups.

	Age (0–20) years OR (95% CI)	*P*	Age (21–40) years OR (95% CI)	*P*	Age (41–60) years OR (95% CI)	*P*
Sex						
Male	1.239 (0.452–3.398)	.677	0.935 (0.418–2.091)	.870	0.605 (0.280–1.306)	.200
Female	Reference					
Residence						
Hangzhou	3.408 (0.983–11.812)	.053	2.164 (0.713–6.562)	.173	3.019 (1.013–9.000)	.047*
Zhejiang	0.381 (0.121–1.193)	.098	0.645 (0.270–1.543)	.324	1.115 (0.477–2.605)	.802
Others	Reference					
Education						
≥Bachelor	N.A.	N.A.	6.143 (2.02–18.684)	.001*	0.897 (0.283–2.844)	.854
Diploma	5.936 (1.142–30.851)	.034*	7.981 (1.737–36.664)	.008*	0.853 (0.170–4.279)	.847
≤High school	Reference					
Length of stay	0.985 (0.963–1.008)	.210	0.979 (0.962–0.996)	.015*	0.982 (0.966–0.998)	.028*

Reference of the age group is ">60" year category.

* Statistically significant ($P<.05$).

CI = confidence interval, N.A. = not available, OR = odds ratio.

developing public transport systems.[2] Recognition of its health impact would facilitate its benefits in a safe and effective manner. This study offered useful insights for policy-makers within and outside China.

A limitation of our study is the incomplete case capture. Since our case identification relied on ICD-10 codes and the narrative documentation by the attending physician, it is possible that some EB-related cases were not captured. In addition, owing to peculiar healthcare-seeking behavior characteristics of the population, some patients involved in an accident might either not present to a medical practitioner, or choose to visit a traditional Chinese medical practitioner. Consequently, our data might underestimate the prevalence and magnitude of the problem. Further investigations on this topic may include province-wide multicenter analyses for greater power and registry-based studies.

5. Conclusions

EBs-related injuries have become a major health concern, accounting for a sizeable proportion of injuries presenting to the ED. Therefore, it is necessary to establish injury prevention and strategies for EB road safety. Implementation of policy such as compulsory helmet use, as well as popularization of EB road safety education should be considered to improve the current situation of EB-related injuries in China.

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