

## Electronic Bicycles and Scooters: Convenience at the Expense of Danger?

### Dear Editor,

Electronic bicycles and scooters—or personal mobility devices (PMDs)—are becoming popular means of commute given their convenience, low cost and ease in obtaining regulatory approval. They have also been successfully marketed as a fun and environment-friendly way to travel. However, the recent surge in PMD-related accidents is cause for concern. Singapore has witnessed a threefold increase in PMD-related accidents between 2016 (n = 46) and 2017 (n = 128).<sup>1</sup> In the first half of 2017, there were 4 mortalities and up to 90 injuries reported.<sup>2</sup> In an effort to regulate the sale and usage of PMDs in the country, the Singapore government passed the Active Mobility Act in January 2017 (Fig. 1).<sup>3-5</sup> Since May 2018, the Land

Transport Authority (LTA) has been regulating the use of PMDs under the Act.<sup>4,5</sup>

In light of the spike in PMD-related accidents, our study aimed to examine the prevalence, patterns and severity of injuries related to the use of PMDs in our institute. A secondary objective was to identify trends that could potentially improve current safety regulations.

### Materials and Methods

A retrospective review of patients admitted to Tan Tock Seng Hospital for PMD-related accidents between January 2014 and November 2017 was conducted. We included patients with tiers 1 and 2 injuries defined as having an injury severity score (ISS) of at least 9. We excluded



Fig. 1. Safety regulations governing the sale and use of PMDs under the Active Mobility Act (infographics by authors). PAB: Power-assisted bicycle; PMA: Personal mobility aid; PMD: Personal mobility device.

patients below 16 years old since they were transferred to the nearest paediatric hospital after stabilisation. Patient demographics, injury profile and helmet use were obtained from electronic medical records. Data on surgeries, length of stay, mortality and hospital bills were collected.

**Results**

A total of 22 PMD-related accidents with ISS of at least 9 were seen in our centre. Over the years, we observed an increasing trend of accidents with significant injuries. There were 6 accidents in 2015, 7 in 2016 and 9 in 2017 (Fig. 2). The mean age of patients was  $48.8 \pm 19.3$  years (range, 16-73 years). Most were males (82%) and Chinese (63.6%), followed by Malays (18.2%), Indians (13.6%) and others.

Mean ISS score was  $17.7 \pm 10.0$ . It was highest in 2017 at 23.4. The most common PMD-related injuries involved the head and neck region followed by extremities (Fig. 3). There were 3 deaths in this study.

Nine injuries occurred on the roads and involved other vehicles. Mean ISS score was higher for PMD accidents that occurred on roads and involved other vehicles (19.1 vs 11.8,  $P = 0.195$ ). Two of the 3 deaths occurred on roads ( $P = 0.476$ ). Only 4 patients had donned helmets. ISS score in patients without helmets was higher than in patients with helmets (18.7 vs 13.5,  $P = 0.365$ ). All 3 deaths occurred in patients without helmets (Fig. 4).

A total of 8 (32%) patients required surgery. The most common surgeries performed were related to bony fractures of extremities and spine followed by soft tissue debridement and repair. Mean hospital stay was 4 days (range, 1 to 16 days) and annual average hospital bill ranged from \$2700 to \$4300 (Table 1).

**Discussion**

PMD-related accidents highlight a significant public health issue. Their rising incidence could be explained

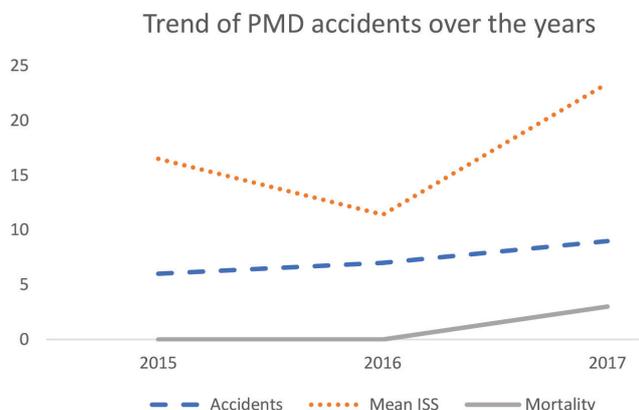


Fig. 2. Growing trend of PMD-related accidents, ISS and mortality. ISS: Injury severity score; PMD: Personal mobility device.

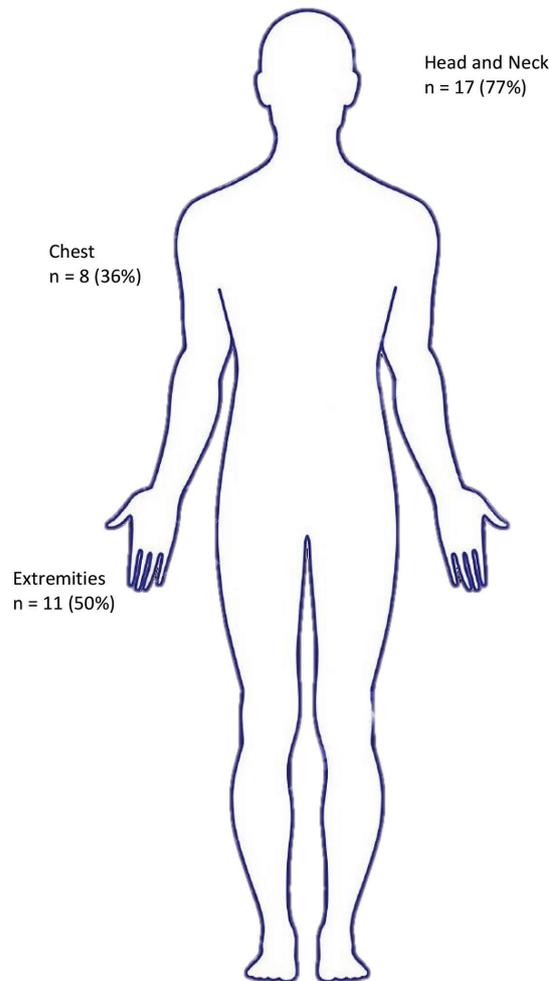


Fig. 3. Injury profile of users of personal mobility devices.

by the rapid adoption of PMDs over the years and the recent introduction of safety regulations mandated by the government.<sup>6</sup> It was also aggravated by a lack of public awareness of the perils of PMDs and regulations enshrined in the Active Mobility Act. Besides a spike in the number of PMD-related accidents, there was also a rise in the severity of injuries (higher ISS score) and mortality.<sup>7</sup>

In our study, riders who suffered injuries tended to be males in their 40s. This observation was corroborated by similar findings in current literature (Table 2).<sup>8-10</sup> The impact of injuries in this age group is more than just health-related morbidities. They also include the loss of productive years, long-term cost of caregiving and opportunity cost to the economy. Although mean inpatient stay ranged from 2 to 5 days, it did not include the period of rehabilitation required to achieve functional recovery. The adjusted average hospital bill size also ranged from \$2600 to \$4300 for each patient.

The most common injuries were seen in the head and neck region. This is a common finding in the literature.<sup>8-10</sup>

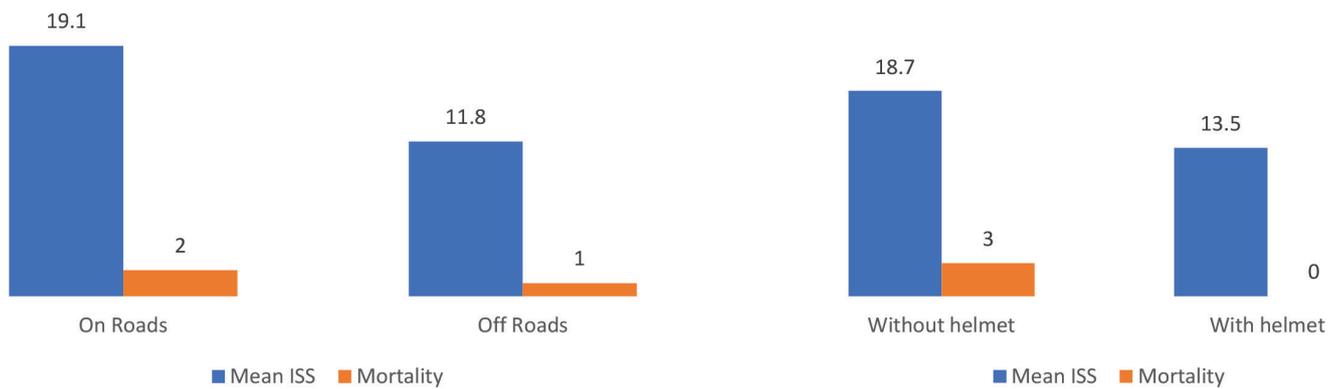


Fig. 4. Association between accidents that occurred on roads and helmet use with ISS/mortality rates. ISS: Injury severity score.

Table 1. Length of Hospital Stay and Hospital Bill Size between 2015 and 2017

	2015	2016	2017
Mean hospital stay (days)	4.8	5.9	2.1
Annual hospital bill (\$)	21,306.60*	29,504.50	24,612.50
Average hospital bill (\$)	4261.30	4214.90	2734.70
Adjusted average for 2014 healthcare cost (\$) <sup>†</sup>	4265.80	4174.50	2642.60

\*Excludes a patient with a medical bill of \$22,500 in 2015.

<sup>†</sup>Adjusted to 2014 dollars based on healthcare division of consumer price index (www.singstat.gov.sg).

In our study, all 3 mortalities were riders who had sustained fatal head and neck injuries and did not wear helmets. The failure to don helmets is one of the most common reasons that has been attributed to the rise in PMD-related injuries in China.<sup>11</sup> It is therefore important that there are preventive

measures in place to ameliorate head and neck injuries related to PMD accidents. The authors feel that helmet use should be enforced.

One observation from our study was that injuries sustained on roads where PMDs were not allowed were more severe than those that were. The 3 mortalities in our study occurred on roads where PMDs had collided with other vehicles. As such, public awareness on road safety and designated pathways where PMDs are allowed should be raised. Much value can be gained from improving traffic infrastructure by building more designated paths for PMDs since shared paths between pedestrians and PMDs may still risk injuries to pedestrians due to the faster travel speed—albeit strict (<25 km/h)—of PMDs.

In our study, mean ISS score of 17.7 was higher than that reported in studies from China, Israel and Switzerland (Table 2). Although this result may be attributed to the selection

Table 2. Summary of Literature on PMD-Related Injuries

First Author	Year	Country	PMD Type	Age Group	Mean ISS Score	Most Common Injury	No Helmet Use	Surgery Required	In-Hospital Mortality
Zhou	2017	China	Electric bicycles (n = 482)	41 – 60	10	1) Head 2) Extremities 3) Trunk	–	34.9%	6.26%
Siman-Tov	2016	Israel	Electric bicycles, electric scooters (n = 795)	<14	1 – 14	1) Head 2) Face and neck	–	–	0.37% (n = 3)
Weber	2014	Switzerland	Electric bicycles (n = 504)	40 – 65	–	–	43.8%	–	0.4% (n = 2)
Papoutsis	2014	Switzerland	Electric bicycles (n = 23)	21 – 62	8.48	1) Head 2) Face and neck 3) Extremities	25%	–	–

ISS: Injury severity score; PMD: Personal mobility device

of only tiers 1 and 2 injuries in our study, the severity of injuries continues to highlight the perils faced by users of PMDs in this country. Mortality (13.6%) was also much higher in our study compared to the study by Papoutsi and associates who used a comparable sample size and did not report any mortality in their study.<sup>10</sup> The number of patients (36.4%) who required surgery for PMD-related accidents in our study were similar to the study by Zhou and colleagues.<sup>8</sup>

The limitations of our study include the small number of PMD-related accidents seen in a single institute. However, it is the first study in Singapore to highlight the prevalence of severe PMD-related injuries, injury patterns and mortality. Future studies will include a collaborative nationwide study of PMD-related accidents and factors that influence safe riding practices. It is also important to compare the incidence and severity of PMD-related accidents before and after the implementation of the Active Mobility Act.

## Conclusion

Accidents involving electronic bicycles and scooters are a rising national health, economic and social problem. To truly enjoy the cost efficiency and convenience offered by PMDs, public awareness should be heightened on its potential perils and legislation should be tightened to ensure safety regulations are adhered to. Donning of helmets should be considered to ameliorate serious head and neck injuries in PMD-related accidents.

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