

2024

27th Presentation Session for Traffic Accident Investigations, Analysis, and Research

Characteristics of Motorcycle Accidents Involving Thoracic Injuries
—Recommendations for Use of Chest Protectors—

Toshiaki Yagi
Senior Researcher, Research Division

1. Introduction

The number of fatalities and severe injuries due to motorcycle accidents has generally been trending downwards over the past decade, with 435 fatalities and 6,398 severe injuries reported in fiscal year 2022 (see Fig. 1 and 2). However, many people are still dying or sustaining severe injuries. Furthermore, fatality rates (fatalities/fatal injuries) and combined fatality and severe injury rates ((fatalities + severe injuries)/fatal injuries) are both trending upwards. Fatality rates are approximately three times higher, with combined fatality and severe injury rates being approximately five times higher for motorcyclists than those occupants of four-wheeled vehicles (see Fig. 3 and 4). These trends for severe accidents are a serious issue and are likely due to motorcycles traveling at speeds similar to those of four-wheeled vehicles, despite the fact that riders lack the protection of an enclosed structure around them, as is the case with four-wheeled vehicles.

To mitigate the harm caused by such traffic accidents involving motorcycle riders, the use of protective gear such as helmets and protectors is crucial. The aim of this paper is to promote the use of chest protectors as part of motorcycle rider protective gear by presenting the results of analysis performed on accident statistical data and which focused on the injuries sustained by motorcycle riders during accidents and the relationship between the use of protective gear and those injuries.

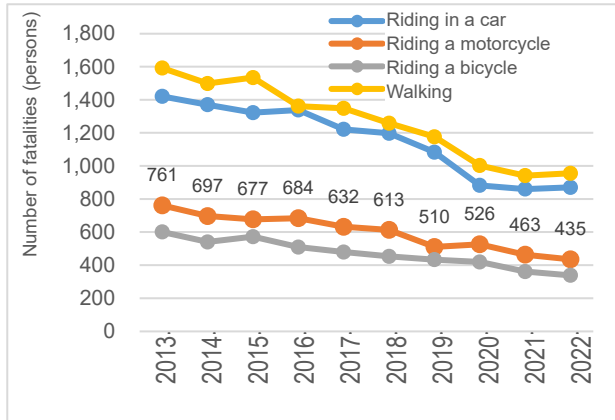


Fig 1. Number of fatalities by circumstance (2013-2022)

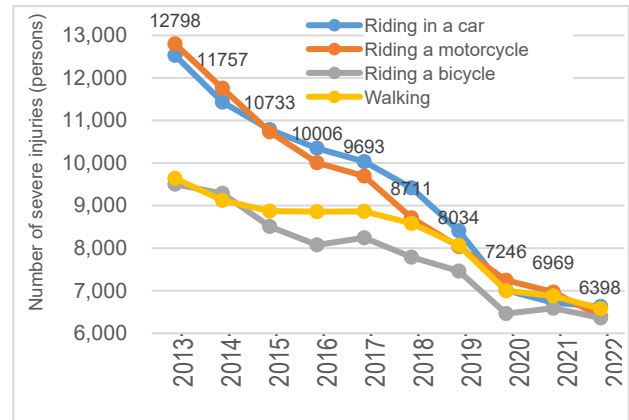


Fig 2. Number of severe injuries by circumstance (2013-2022)

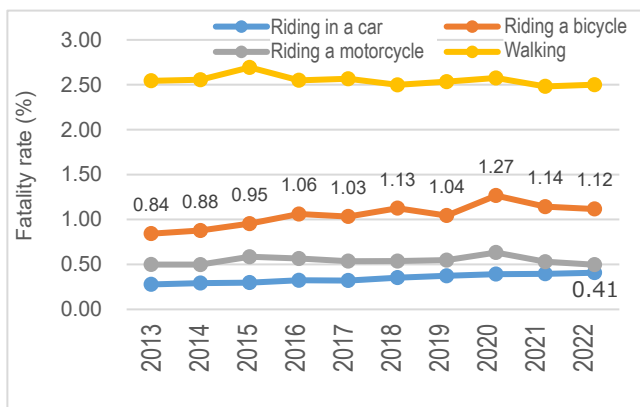


Fig 3. Fatality rate by circumstance (2013-2022)

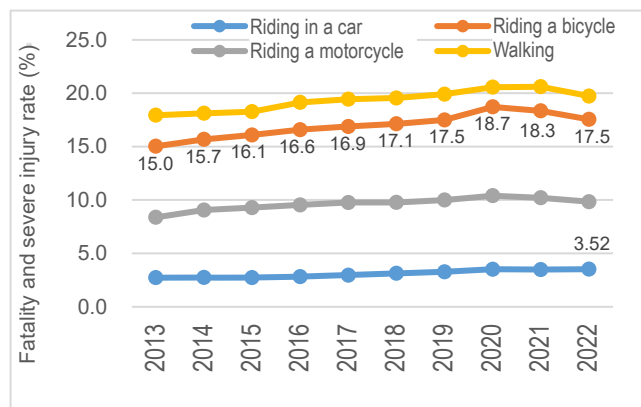


Fig 4. Severe injury rate by circumstance (2013-2022)

2. Characteristics of Accidents Involving Thoracic Injuries

Figure 5 shows the number of fatalities broken down by primary site of injury in motorcycle fatal accidents that

occurred from 1995 to 2022.

The most common primary site of injury among motorcycle riders is the head, with the number of fatalities significantly decreasing over the past 28 years. The second most common primary site of injury is the chest, which shows a lower downward trend in fatalities.

Based on trends from the past 10 years (2013 to 2022), it is predicted that in the near future, the number of fatalities from thoracic injuries may surpass those from head injuries.

This downward trend in fatalities from head injuries is thought to be due to the widespread use of helmets when riding motorcycles, yet it remains important to continue promoting the proper use of helmets moving forward. On the other hand, the lack of any significant reductions in fatalities stemming from thoracic injuries is likely due to the extremely low rate of chest protector usage, despite the fact that their use is recommended.

In descending order, numbers of severe injuries are highest for the legs, followed by the arms, chest, and head.

Moving forward, our analysis will focus on motorcycle accidents in which the primary site of injury is the chest, due to the high number of fatalities and severe injuries in this area.

Note: “Primary site of injury” refers to the body part in which damage is the most severe.

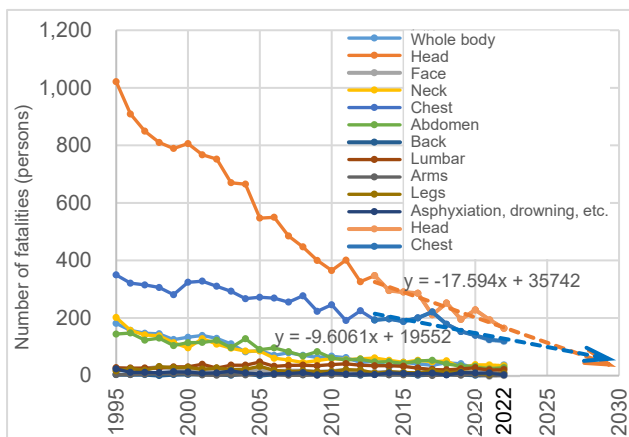


Fig 5. Number of fatalities by primary site of injury (1995 to 2022)

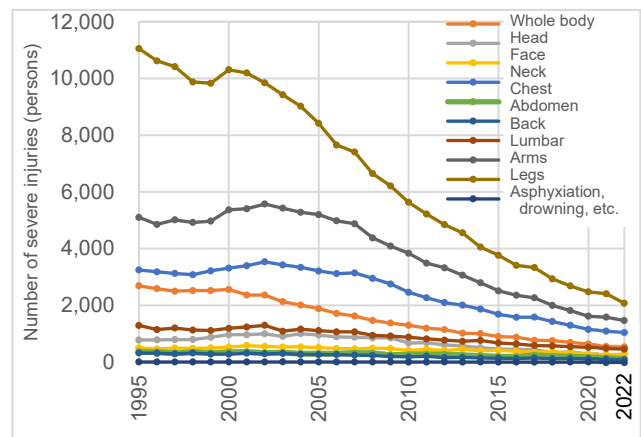


Fig 6. Number of severe injuries by primary site of injury (1995 to 2022)

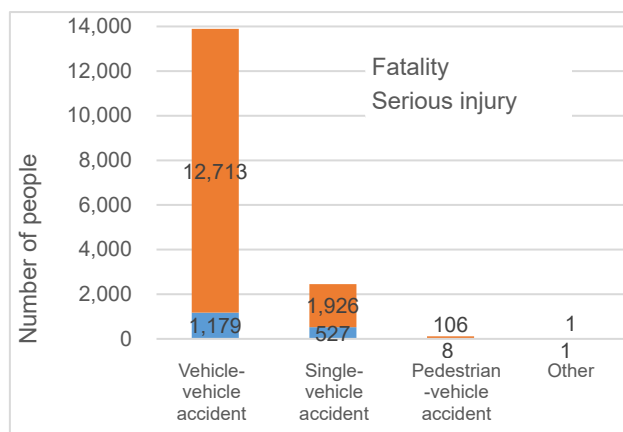


Fig. 7 Fatalities and severe injuries by accident type (thoracic injuries) (2013 to 2022)

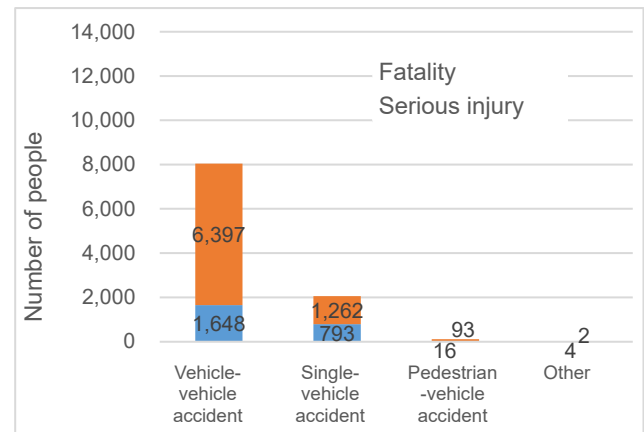


Fig. 8 Fatalities and severe injuries by accident type (head injuries) (2013 to 2022)

2-1. Fatalities and Severe Injuries by Accident Type

Figure 7 shows the number of thoracic fatalities and severe injuries by accident type, while Figure 8 shows the

number of head fatalities and severe injuries by accident type.

Trends are the same for both thoracic and head injuries, with the highest number of injuries occurring in the order of vehicle-to-vehicle accidents, single-vehicle accidents, pedestrian-to-vehicle accidents, and other types of accidents. In terms of fatalities, the number of thoracic injuries is about 0.7 times that of head injuries, while the total number of fatalities and severe injuries combined is 1.6 times higher for thoracic injuries than for head injuries. This shows that thoracic injuries account for a larger proportion of severe injuries.

2-2. Percentage of Thoracic/Head Fatalities and Severe Injuries at Each Danger Perception Speed

Figure 9 shows the percentages of thoracic/head fatalities and severe injuries relative to the total number of fatalities and severe injuries at each danger perception speed (2013 to 2022).

At speeds of 70 km/h and below, there is a higher rate of thoracic injuries than head injuries. In the case of head injuries, percentages for fatalities and severe injuries tend to increase as speed rises. However, in the case of thoracic injuries, there is little fluctuation between percentages for fatalities and severe injuries across all speed ranges, with a higher percentage of fatalities and severe injuries occurring during accidents at lower speeds.

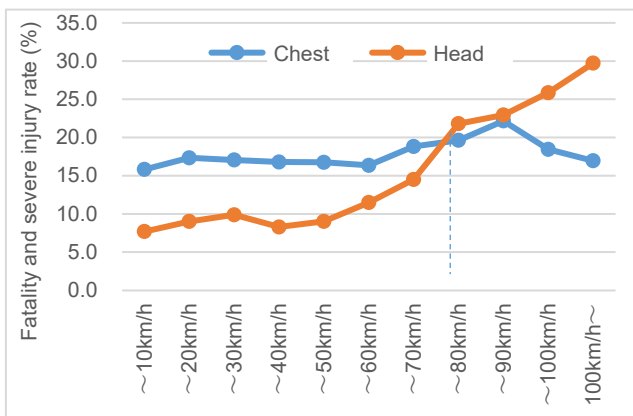


Fig. 9 Percentage of thoracic/head fatalities and severe injuries relative to total fatalities and severe injuries at each danger perception speed (2013 to 2022)

2-3. Types of Thoracic Injuries

Figure 10 shows percentages for different types of thoracic injuries (2013 to 2022), while Figure 11 shows percentages different types of head injuries (2013 to 2022). In the case of thoracic injuries, fractures are the most common injury for both fatalities and severe injuries. Some differences can be seen among the injury types between thoracic and head injuries. Head injuries more commonly involve lacerations, abrasions, and contusions, while chest injuries more commonly involve fractures. In the case of accidents entailing thoracic injuries, 84.7% of fatalities and severe injuries involve fractures.

For this reason, preventing fractures is considered the most important factor when designing chest protection.

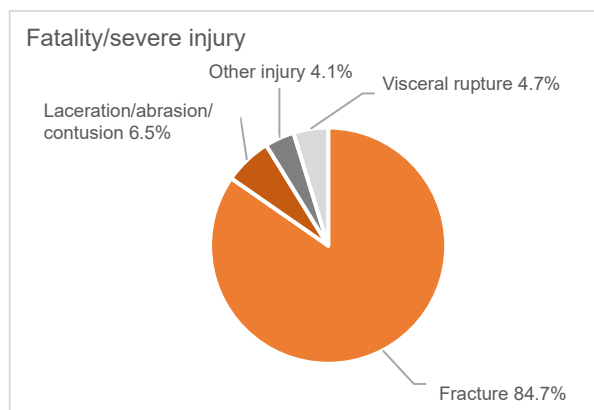


Fig. 10 Types of thoracic injuries by percentage (2013 to 2022)

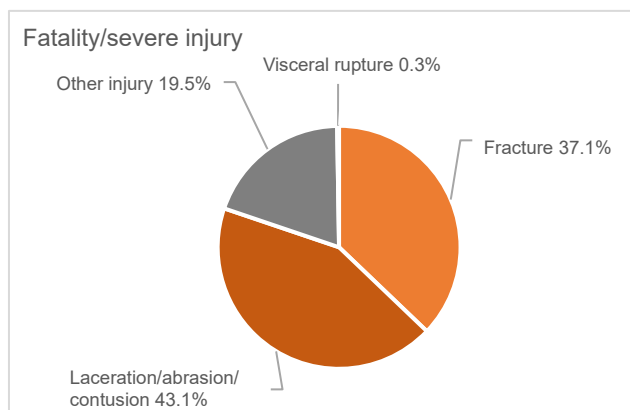


Fig. 11 Types of head injuries by percentage (2013 to 2022)

3. Effectiveness of Chest Protectors

3-1. Chest protector usage rates (calculated using accident data from 2017 to 2022)

Figure 12 shows the chest protector usage rate among motorcycle riders (2017 to 2022), while Figure 13 shows the chest protector usage rate by motorcycle type (2017 to 2022).

Chest protector usage has been included traffic accident statistics since 2017, and based on six years of data through 2022, the average chest protector usage rate is 4.2%.

By motorcycle type, the chest protector usage rate decreases as the engine displacement decreases.

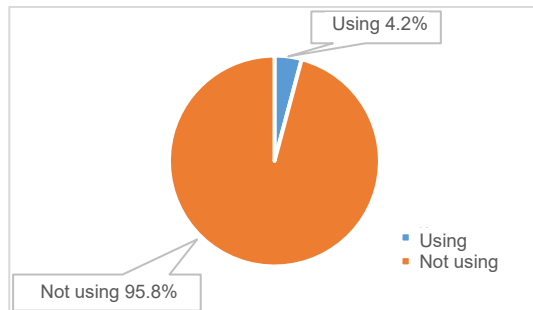


Fig. 12 Chest protector usage rates among motorcycle riders (2017 to 2022)

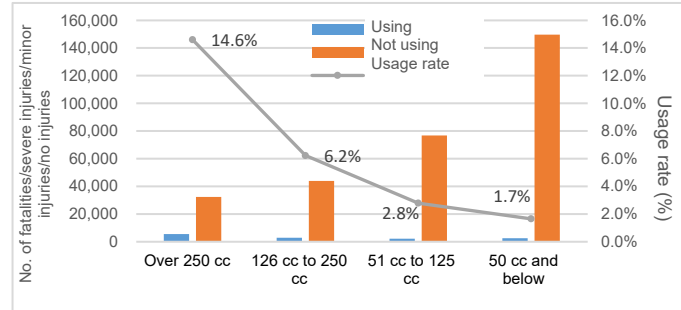


Fig. 13 Chest protector usage rates by motorcycle type (2017 to 2022)

3-2. Fatality and Severe Injury Rates by Danger Recognition Speed and Chest Protector Usage Status

Figure 14 shows fatality rates by danger recognition speed and chest protector usage status (2017 to 2022), while Figure 15 shows severe injury rates by danger recognition speed and chest protector usage status (2017 to 2022).

At speeds of 40 km/h and below, the fatality rate for those wearing chest protectors is lower, indicating their effectiveness. Due to the low number of fatalities at each speed, testing could not be performed for individual speeds. For this reason, a chi-square test was conducted by grouping speeds of 40 km/h and below, revealing that chest protector usage led to a significant difference in fatality rates at a 5% significance level for danger recognition speeds of 40 km/h and below.

In the same manner as fatality rates, a chi-square test was conducted for severe injury rates by grouping speeds of 40 km/h and below. This test also revealed a significant difference at a 5% significance level for danger recognition speeds of 40 km/h and below.

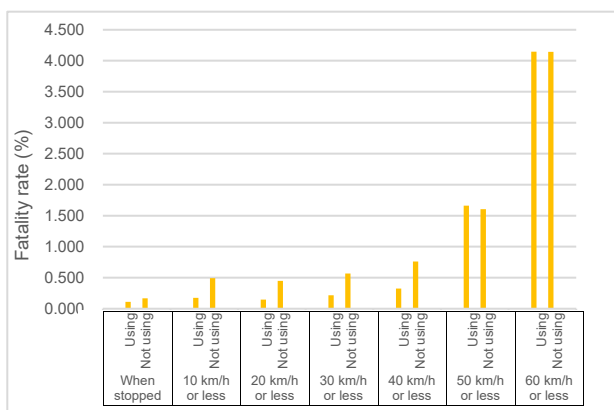


Fig. 14 Chest protector usage rates among motorcycle riders (2017 to 2022)

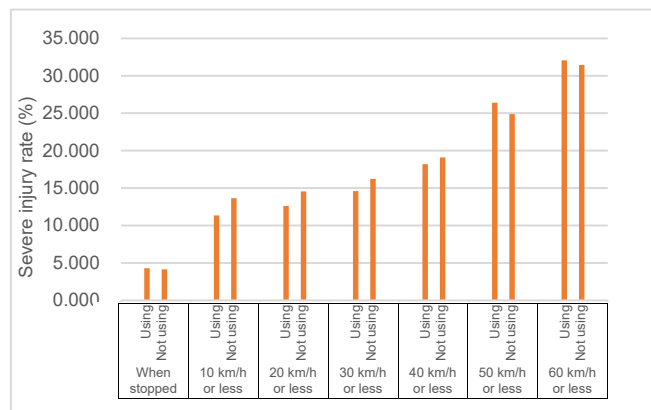


Fig. 15 Chest protector usage rates by motorcycle type (2017 to 2022)

3-3. Impact of danger recognition speeds in motorcycle accidents involving fatalities and severe injuries

We next investigated danger recognition speeds in motorcycle accidents involving fatalities and severe injuries. Figure 16 shows the number of fatalities by danger recognition speed in motorcycle accidents, while Figure 17 shows the number of severe injuries by danger recognition speed in motorcycle accidents.

Although danger recognition speeds in accidents involving fatalities are also common in high-speed ranges, the speed range with the highest number of fatalities is between 20 km/h and 30 km/h. Because the most common speed range for danger recognition in accidents involving severe injuries is also between 20 km/h and 30 km/h, this suggests that increased chest protector usage rates could reduce both fatalities and severe injuries.

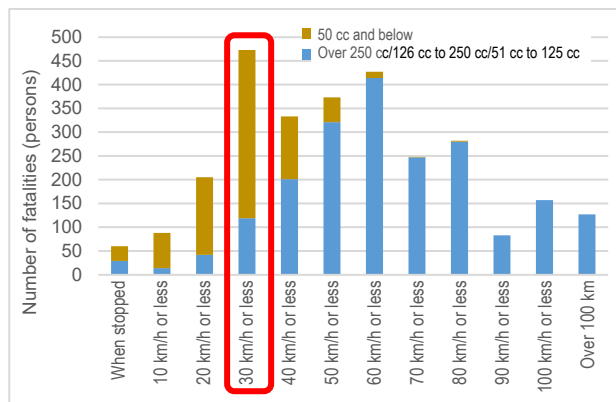


Fig. 16 Numbers of fatalities by danger recognition speed in motorcycle accidents (2017 to 2022)

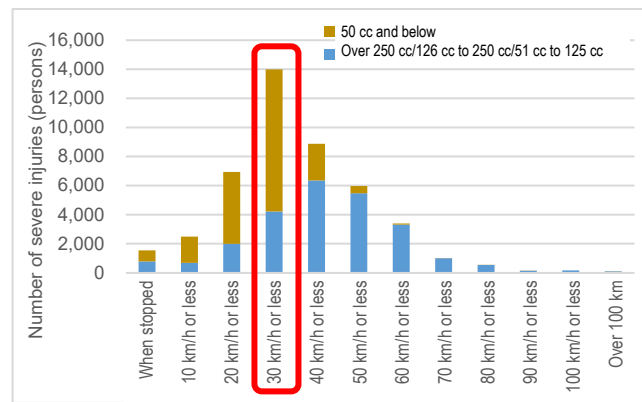


Fig. 17 Numbers of severe injuries by danger recognition speed in motorcycle accidents (2017 to 2022)

3-4. Actual Conditions Surrounding Motorcycle Accidents Involving Fatalities and Severe Injuries

The most common type of accident involving thoracic injuries is crossing collisions. Figure 18 shows the number of fatalities by motorcycle type and chest protector usage status in crossing collisions involving thoracic injuries. Although small motorcycles (50 cc and below) stand out significantly in terms of fatalities, the non-use of chest protectors is predominant across all motorcycle types. Figure 19 shows the number of fatalities from the graph in Figure 18, categorized by danger recognition speed. Of small motorcycle (50 cc and below) accidents involving thoracic injuries resulting in fatalities, 98% occur at danger recognition speeds of 40 km/h and below. Even for small motorcycle (51 cc to 125 cc) accidents involving thoracic injuries resulting in fatalities, 56.9% occur at danger recognition speeds of 40 km/h and below.

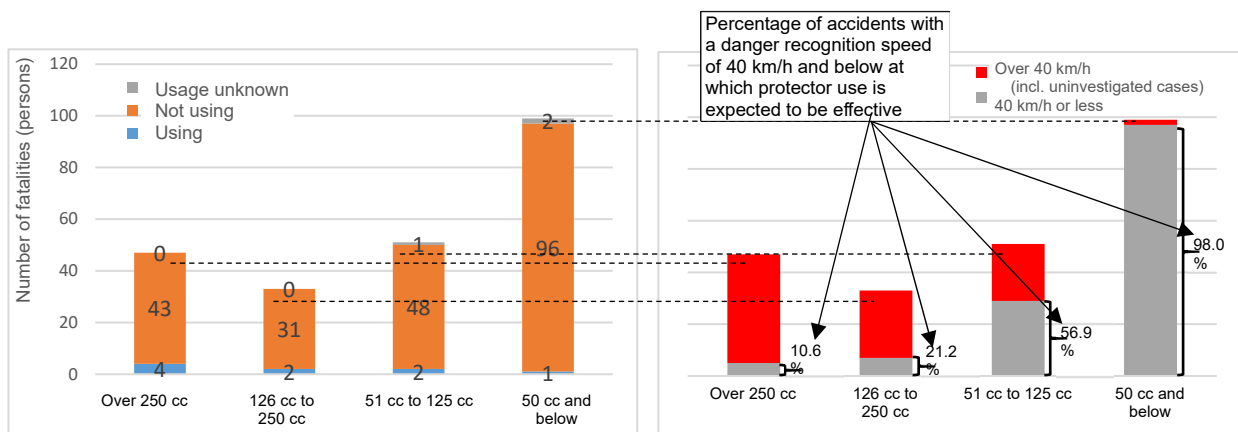


Fig. 18 Number of fatalities by motorcycle type and chest protector usage status in crossing collisions involving thoracic injuries (2017 to 2022)

Fig. 19 Number of fatalities by motorcycle type in crossing collisions involving thoracic injuries and percentage of danger perception speeds at 40 km/h and below (2017 to 2022)

The same analysis was also performed for severe injuries. Figure 20 shows the number of fatalities by motorcycle type and chest protector usage status in crossing collisions involving thoracic injuries. Small motorcycles (50 cc

and below) also stand out significantly in terms of severe injuries, with the non-use of chest protectors being predominant across all motorcycle types. Similarly, the data was categorized by danger recognition speed, as shown

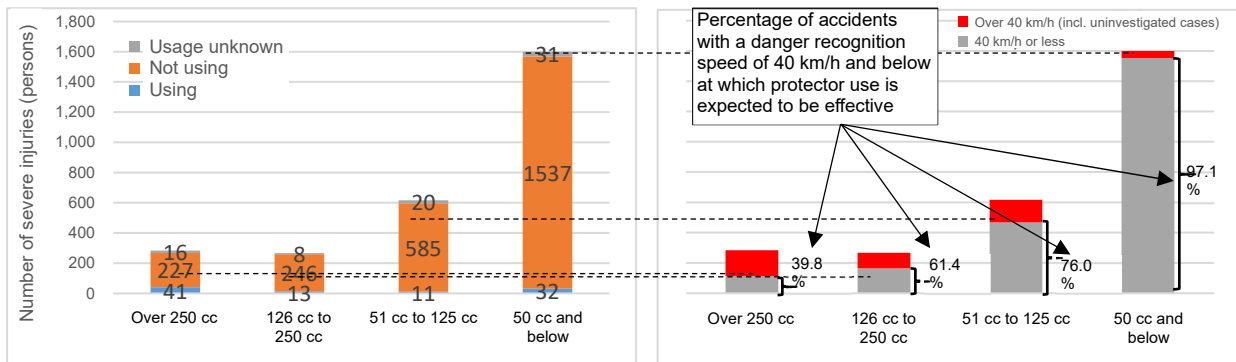


Fig. 20 Number of severe injuries by motorcycle type and chest protector usage status in crossing collisions involving thoracic injuries (2017 to 2022)

Fig. 21 Number of severe injuries by motorcycle type in crossing collisions involving thoracic injuries and percentage of danger perception speeds at 40 km/h and below (2017 to 2022)

in Figure 21. Of small motorcycle (50 cc and below) accidents involving thoracic injuries resulting in severe injuries, 97.1% occur at danger recognition speeds of 40 km/h and below. Although the use of chest protectors is recommended and not mandatory as in the case of helmets, our analysis revealed numerous cases in which riders encounter accidents at low speeds, suffer thoracic fractures from impact with other vehicles or the road surface, leading to fatalities or severe injuries.

4. Conclusion

This analysis of accident statistical data on the relationship between protective gear and injuries among motorcycle riders yielded various findings.

The following findings are of particular significance:

- Chest protector usage rates remain low at 4.2%.
- The use of chest protectors has been shown to reduce the proportion of fatalities and severe injuries at danger recognition speeds of 40 km/h and below.
- The most common speed range for danger recognition in motorcycle accidents involving fatalities and severe injuries is between 20 km/h and 30 km/h.

These suggest that chest protector usage can reduce both fatalities and severe injuries, highlighting the need to improve the usage rates among riders.