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**Aiming to Reduce Motorcycle-Fatality Accidents among Young Persons:
What Can Be Seen from Trends Regarding Helmet Separation**

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1. Trends and challenges regarding motorcycle accidents

In regard to motorcycle demand in recent years, amid the impact of the COVID-19 crisis, the usefulness of motorcycles for applications such as mobility and leisure has been becoming increasingly recognized. The number of motorcycles sold in Japan in FY2020 stood at 371,000 units, marking a slight increase from 358,000 units in FY2019⁽¹⁾, and thus it seems that going forward motorcycles will continue to be used as a convenient means of transportation and as vehicles for leisure purposes. Meanwhile, over the past 10 years, although the number of fatalities in motorcycle accidents has generally been in a decreasing trend, with the number at 526 in FY2020 (Figure 1), the fatality ratio (number of fatalities/number of casualties) has been in an increasing trend. (Figure 2) Challenges with regard to further decreasing fatalities seem to include the fact that number of fatalities of young persons (ages 16 to 24) is high (Figure 3), and the fact that helmet separation during fatality accidents occurs in around 30% of cases. In this report, we have carried out factor analysis regarding these challenges, placing a focus on trends regarding the speed of young persons during accidents, and the status of helmet separation. Below we introduce the results of this analysis and our observations in this regard.

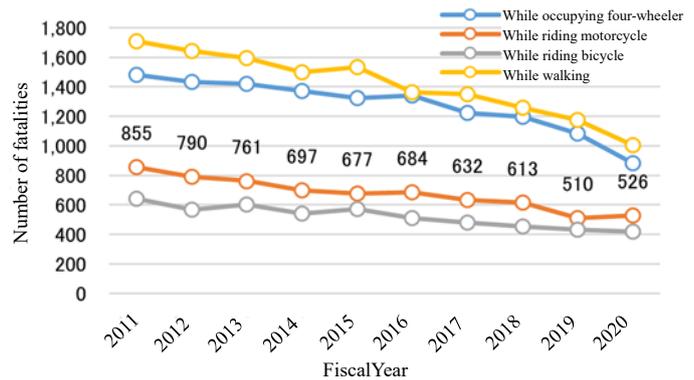


Fig 1. Trend regarding number of fatalities (2011 to 2020)

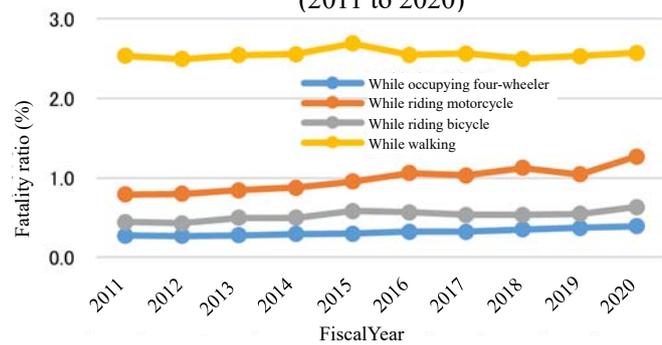


Fig 2. Trend regarding fatality ratio (2011 to 2020)

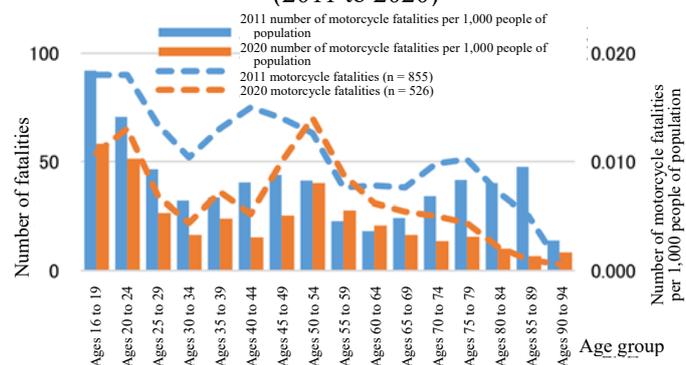


Fig 3. Number of motorcycle fatalities by age group (2011 and 2020)

2. Trends regarding young persons

During the period of 2011 to 2020, overall, the number of fatalities, along with the number of fatalities per 1,000 people of the population, were in decreasing trends, and looking at the situation by age group, it is clear that both of these are high among young persons (ages 16 to 24). (Figure 3)

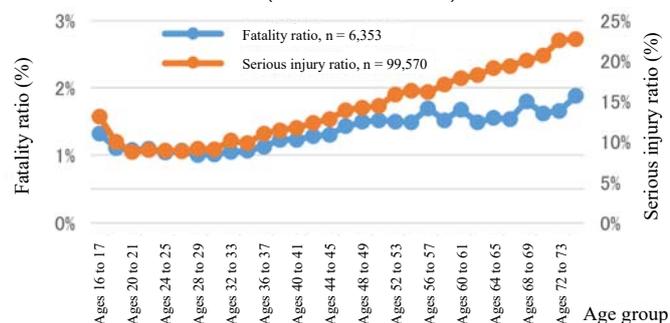


Fig 4. Motorcycle fatality & serious injury ratio by age group (2012 to 2021)

Looking at the fatality & serious injury ratio (the percentage of these among the number of casualties) by age group, “generally the tolerance of the human body declines as age increases,” so the fatality & serious injury ratio

rises with age. Although this trend can be seen regarding persons age 20 and above, comparing the under-20 age group with the 20-to-21 age group, the reverse is true and there appears to be an increase. (Figure 4)

Next, we will look at the relationship with speed at the time of the accident, which has a high correlation with the degree of injury. Although the weighted average of the danger-recognition speed during fatality & serious injury accidents (2012 to 2021) appears to be in a trend of increasing as age decreases, there is a trend in which it peaks at the 20-to-21 and 22-to-23 age groups and then decreases. (Figure 5)

Furthermore, looking at the persons involved in motorcycle accidents (primary parties and secondary parties) by age group, the number of speed-limit violators is large among young persons (ages 16 to 24). (Figure 6)

Based on the above results, it can be presumed that driving at high speeds during motorcycle driving is more common among young persons compared with other age groups. As such, it seems that the number of fatalities is greater due to a higher risk of injury accompanying higher speeds, and a higher risk of unsuitable steering operations and so on.

Nevertheless, among young persons, the 16-to-19 age group has the highest number of fatalities in proportion to the population (Figure 3), and a higher fatality & serious injury ratio than the 20-to-21 and 22-to-23 age groups (Figure 4). Meanwhile, the weighted average of danger-recognition speed is low (Figure 5). We carried out factor analysis, viewing the abovementioned circumstances as characteristics of the 16-to-19 age group. As a result of this, we noticed a relationship with helmet separation.

Looking at the relationship between helmet separation rate^(a) and age group, there is a trend in

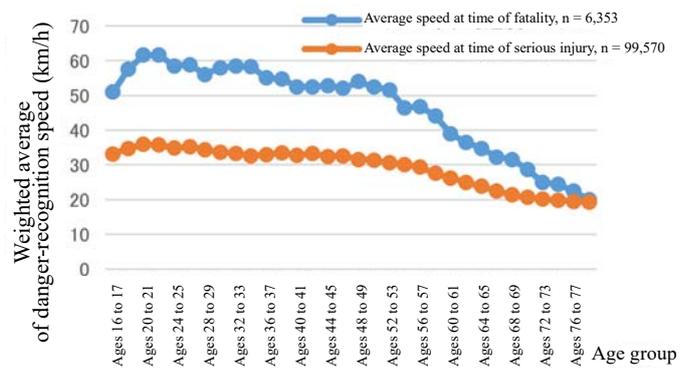


Fig 5. Weighted average of danger-recognition speed by age group (2012 to 2021)

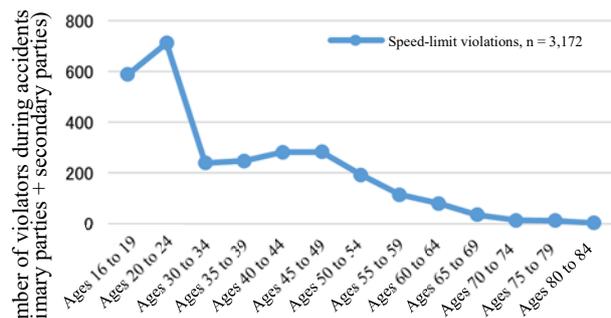


Fig 6. Number of motorcycle speed-limit violators by age group (2012 to 2021)

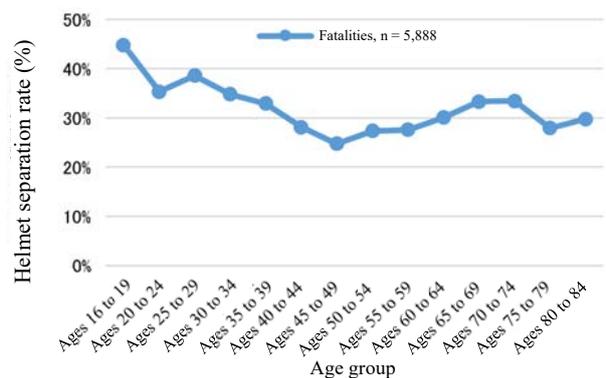


Fig 7. Helmet separation rate by age group (2012 to 2021)

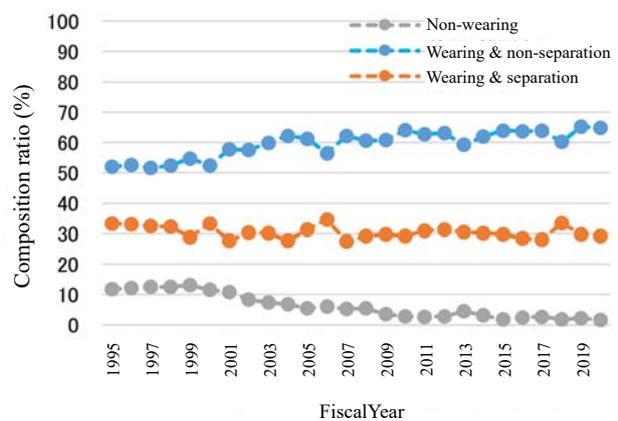


Figure 8. Trend regarding helmet wearing status (1995 to 2020)

which this is high among young persons, followed by elderly persons, and is the highest regarding the 16-to-19 age group (Figure 7). During accidents, helmet separation increases the chance of head injuries, and thus this trend seems to be one factor among the abovementioned characteristics of the 16-to-19 age group. At the same time, this trend seems to be connected with the fact that the number of fatalities is high among young persons.

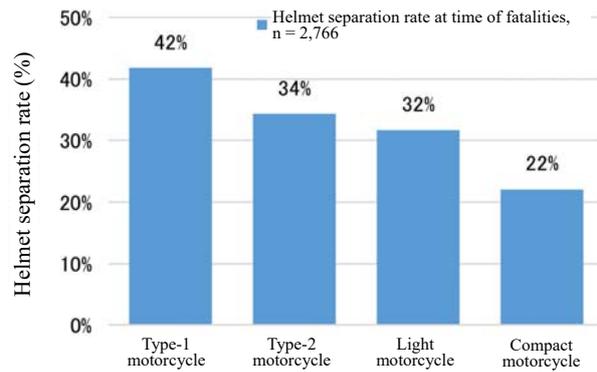


Figure 9. Helmet separation rate by vehicle type (2016 to 2020)

3. Factors regarding helmet separation and effects of countermeasures

In the previous chapter, we showed the helmet separation rate by age group, and below we will cover the general situation regarding helmet separation during accidents. Looking at the composition ratio of helmet “wearing & non-separation” during motorcycle-fatality accidents over the past 25 years, there was an increase from 52% in 1995 to approximately 65% in 2020. Meanwhile, “non-wearing” stood at 11.8% in 1995 and then was in a decreasing trend, and in recent years, it has declined to around 2%. Nevertheless, “wearing & separation” hovered at around 30% throughout the 25-year period. (Figure 8) The results of our analysis regarding the various factors related to helmet “wearing & separation” are shown below.

3-1. Vehicle type & danger-recognition speed

Looking at the situation by vehicle type, the helmet separation rate was the highest regarding type-1 motorcycles, and the separation rate decreased as the engine-displacement volume of the vehicle type increased. (Figure 9) As for the helmet separation rate relative to the danger-recognition speed, although we predicted that the separation rate would increase in proportion to the speed due to a rise in the impact force during accidents, the rate was higher regarding the lower speeds than the higher speeds, and was at the highest regarding the low speed of “20 km/h or below.” (Figure 10)

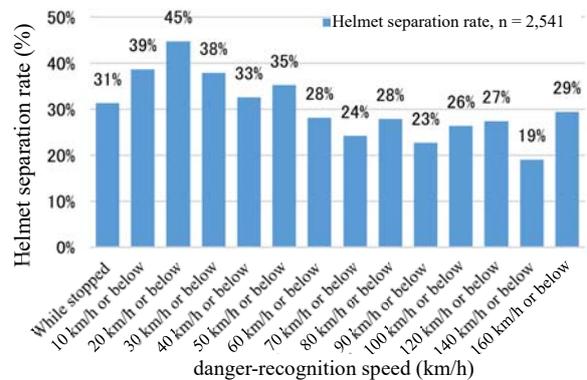


Figure 10. Helmet separation rate by danger-recognition speed (2016 to 2020)

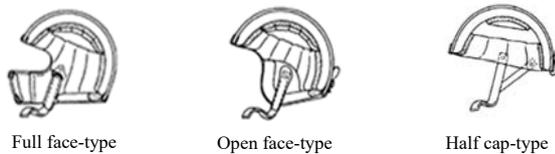
^a Percentage of cases in which a helmet was being worn during an accident but became separated from the wearer due to the impact of the accident

3-2. Helmet shape

Within the accident data of the Tokyo Metropolitan Police Department^(b), type of helmet shape is recorded, and using this, we confirmed trends regarding helmet separation rate during fatality accidents by helmet shape in 2011 to 2020. Figure 11 shows a comparison of the separation rates of three types of helmet shapes (Chart 1) during motorcycle-fatality accidents. It can be seen that the separation rate of half cap-type helmets is more than 20 points higher than that of the other full face-type and open face-type shapes. (Figure 11)

3-3. Status of chin strap fastening

Chart 1. Helmet shape



Factors that affect helmet separation seem to include how the helmet is being worn on head, and the status of the fastening of the chin strap. The Tokyo Metropolitan Police Department has implemented a survey in which it interviewed motorcycle users regarding their “status of helmet chin-strap fastening” (n = 3,202 people, 2021)⁽²⁾. It appears that in 2021, approximately 27% of motorcycle users had a status in which their chin strap was not properly fastened (was not fastened, or was loosely fastened). (Figure 12)

As for factors related to helmet separation, the trends seem to be related to age, vehicle type, speed, helmet shape, and chin-strap status. Based on this, we envisioned a specific type of case in which “a person of a younger age group (or an elderly person) travels short distances on a type-1 motorcycle while wearing a half cap-type helmet, which is considered to be easy to put on, and does not properly fasten the chin strap.”

3-4. Helmet separation risk and estimated reduction in fatalities

During helmet separation, there is a high possibility to head injuries, so in order to check the danger of such, we

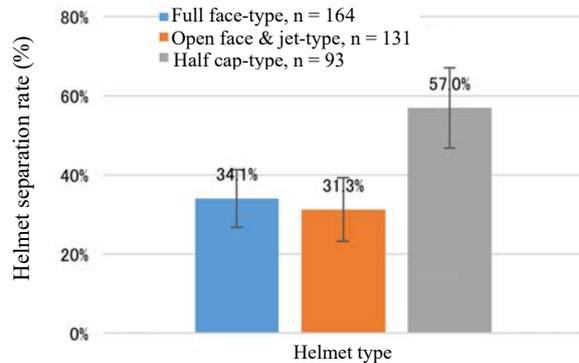


Figure 11. Separation rate by helmet shape (Tokyo Metropolitan Police Department, 2011 to 2020)

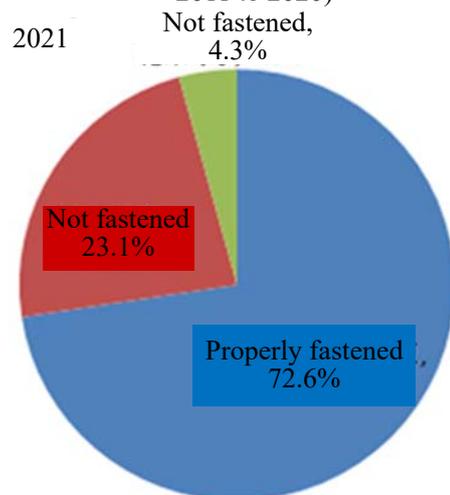


Figure 12. Interview survey on chin straps (Tokyo Metropolitan Police Department, 2021)

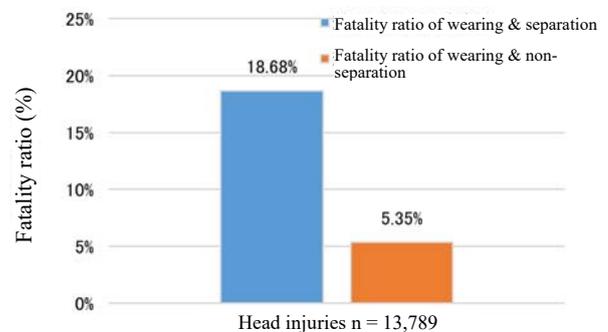


Fig 13. Fatality ratio according to whether there was helmet separation

With head as main part of body injured (2016 to 2020)

^b This is accident data of the Tokyo Metropolitan Police Department and not national accident data.

sought to find out fatality risk based on fatality ratios (number of fatalities/number of casualties) during head injuries in accordance with whether there was helmet separation. The various fatality ratios are shown in Figure 13. During fatality accidents, the ratio of the composition ratio of “wearing & separation” in the case that there was separation, to the composition ratio of “wearing & non-separation” in the case that there was non-separation (fatality risk ratio), was $18.68 / 5.35 = 3.49$, and thus it appears that when there is helmet separation, the fatality risk is approximately 3.5 times higher.

Next, taking into consideration the abovementioned fatality risk ratio, we estimated the fatality reduction effects in the case that helmet separation has been eliminated. We set the conditions as follows.

- If helmet “wearing & separation” is prevented, the “head” is protected, and thus the number of fatalities in which the main part of the body injured is the “head” has the same fatality composition ratio as with “wearing & non-separation.”

Reduction effects are sought based on the number of fatalities separated by the main part of the body injured in motorcycle-fatality accidents in FY2020 (Figure 14).

- Total number of motorcycle fatalities in FY2020: 526
- Number of fatalities in which there was helmet “wearing & separation” and the main part of the body injured was the “head”: 87
- Fatality risk ratio regarding “head” when there is helmet “wearing & separation”: 3.49

The number of fatalities in which there was “wearing & separation” and the main part of the body injured was the “head” was 87. Based on the fatality risk ratio, it can be presumed that if there was no helmet separation in these cases, $87 \times (1 - 1/3.49) = 62.1$ of the fatalities would not have occurred. As a result, the number of fatalities in 2020 would have been 464, which corresponds with a reduction of approximately 12%.

4. Conclusion

With the aim of reducing motorcycle-fatality accidents, we analyzed accident trends regarding young persons, factors related to helmet separation, and so on, and confirmed the following.

1. Among young persons (ages 16 to 24), the weighted average of danger-recognition speed during accidents is high, and at the same time, the number of speed-limit violations is large. Thus, it can be presumed that there is a situation in which travel speeds are high, so there seems to be a high risk of injuries during accidents. Therefore, it appears that in order to reduce fatalities, measures for decreasing speeds during accidents, such as reducing speed-limit violations, are essential.
2. Among trends related to helmet separation, we identified various characteristics regarding age, vehicle type, danger-recognition speed, and helmet shape, as well as the status of helmet chin-strap fastening, and the trends appeared to include a high helmet separation rate among young persons. Furthermore, we showed that

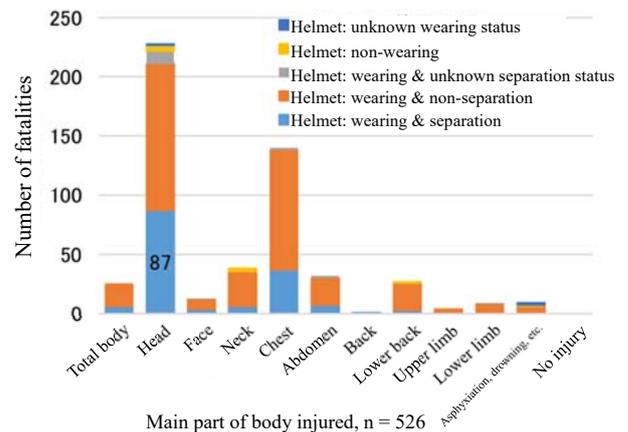


Fig 14. Number of fatalities by main part of body injured (FY2020)

by preventing helmet separation, it would be possible to reduce the number of accident fatalities of all age groups by up to 12%.

In order to prevent helmet separation, it is important to wear a helmet of the proper size and fasten the chin strap. It seems that reducing helmet separation will require ongoing awareness-raising activities targeting drivers. At the same time, based on the fact that over the past 25 years the separation rate during fatality accidents has hovered at 30%, it seems that one way to reduce motorcycle-fatality accidents will be to consider new policies for improving the situation, which could include taking legal measures.

<Acknowledgments >

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<Citations & references>

(1) Japan Automobile Manufacturers Association, FY2021 motorcycle market trend survey:

https://www.jama.or.jp/release/news_release/2022/1300/

(2) Tokyo Metropolitan Police Department webpage:

https://www.keishicho.metro.tokyo.lg.jp/kotsu/jikoboshi/nirinsha/heru_pro.html