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Special
feature

**When riding a motorcycle, wear a helmet
and securely fasten the chin strap**



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1 Introduction

In recent years, traffic accident fatalities have shown a declining trend, including the number of deaths among motorcycle riders, which has also decreased year by year. However, fatalities among motorcycle riders have still exceeded 400 in the past few years, with many riders continuing to lose their lives. In this context, motorcycles include mopeds.

Unlike occupants of four-wheeled vehicles, motorcycle riders do not have the protection of a body structure. This lack of protection means that accidents, such as falls or collisions, may lead to riders being thrown from their motorcycles, potentially hitting other vehicles or the ground. For this reason, a helmet is an essential protective gear for the head.

Wearing a helmet while riding a motorcycle is a legal requirement, and most riders comply. However, in many cases, helmets are not worn properly, leading to situations where they become separated during an accident, resulting in severe head injuries. In fact, approximately 30% of fatalities while riding a motorcycle involve helmets that were separated from the riders. Therefore, this article aims to emphasize the importance of wearing a helmet and securely fastening the chin strap while riding a motorcycle.

2 Actual conditions surrounding fatal accidents involving head injuries

Primary body part injured in accidents while riding a motorcycle

Fig. 1 shows the number of fatalities categorized by the primary body part injured in motorcycle accidents from 2013 to 2022. Notably, the majority of fatalities resulted from head and chest injuries. Except for 2017, when chest injuries were most prevalent, head injuries accounted for the majority of fatalities in all other years. These findings emphasize the importance of wearing helmets.

Characteristics of helmet-wearing status and number of fatalities

How was the helmet, which is designed to protect the head, worn at the time of the accident? Fig. 2 shows the number of fatalities from 2013 to 2022 in three categories: cases where the helmet was worn and did not come off ("wearing-no separation"), cases where the helmet came off due to the impact of the accident despite being worn ("wearing-separated"), and cases where the helmet was not worn at all ("not wearing"). Over the past 10 years, the number of fatalities has decreased overall, including those in the "wearing-separated" category. However, in 2022, 115 riders still died because their helmets came off during the accident. If those helmets had remained securely on, they might have protected the riders' heads, potentially saving their lives.

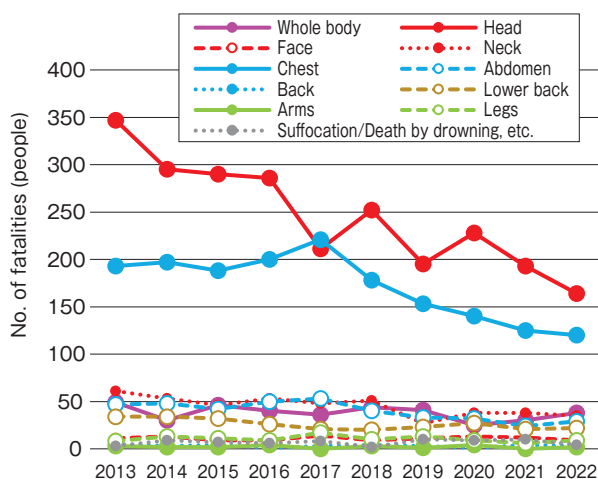


Fig. 1. Number of fatalities in accidents while riding a motorcycle by the primary body part injured (2013-2022)

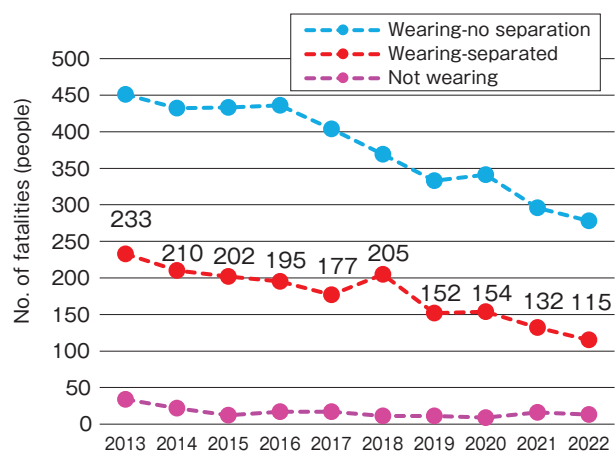


Fig. 2. Number of fatalities in accidents while riding a motorcycle by helmet-wearing status (2013-2022)

Fig. 3 shows the number of fatalities based on helmet-wearing status, as shown in Fig. 2, as a composition ratio of the total fatalities while riding a motorcycle. While the number of fatalities due to “wearing-separated” incidents has decreased, the composition ratio has remained around 30% over the past decade. This suggests that there has been no significant change in the proportion of cases where a helmet is not worn correctly and subsequently comes off (“wearing-separated”). Ideally, both the percentages for “wearing-separated” and “not wearing” helmets should be 0%, but the data indicates that the situation has not improved.

Fig. 4 indicates the trends in the ratio of fatalities resulting from accidents while riding a motorcycle based on helmet-wearing status. The fatality ratio is calculated as the ratio of the number of fatalities to the total number of casualties for each status. In 2022, the fatality ratios were 5.1% for “wearing-separated,” 3.0% for “not wearing,” and 0.8% for “wearing-no separation.” Compared to “wearing-no separation,” the fatality ratio for “wearing-separated” is approximately 6.4 times higher, while for “not wearing,” it is about 3.8 times higher. This highlights the significance of not only wearing a helmet but also ensuring that it remains securely in place.

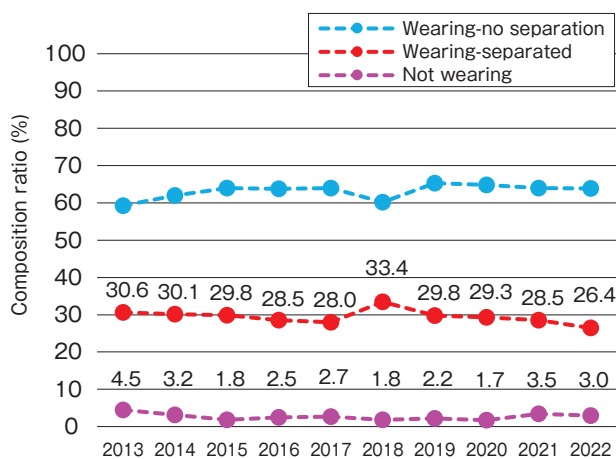


Fig. 3. Composition ratio of the number of fatalities in accidents while riding a motorcycle by helmet-wearing status (2013-2022)

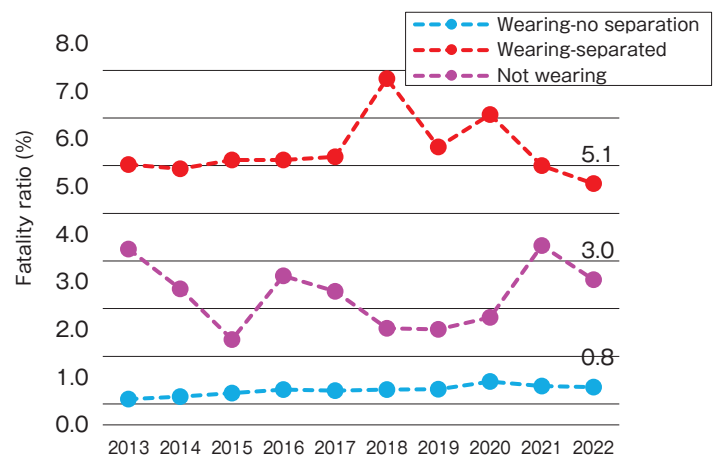


Fig. 4. Fatality ratios in accidents while riding a motorcycle by helmet-wearing status (2013-2022)

■ Trends in helmet separation rates among fatalities in accidents while riding a motorcycle

Let us examine the circumstances under which helmets, essential for protecting the head, become separated. We analyzed the trend in helmet separation rates among fatalities in accidents while riding a motorcycle using data from a 10-year period spanning 2013 to 2022. The helmet separation rate is calculated as the percentage of “wearing-separated” fatalities out of the total number of “wearing-no separation” fatalities and “wearing-separated” fatalities.

The helmet separation rate is higher for riders of motorcycles with smaller engines, particularly among class-I moped riders of less than 50 cc. (Fig. 5). By age group, the helmet separation rate is highest for those aged 16-25 years and tends to decrease with age. However, there is an increasing trend for those over 56 years old, indicating that the helmet separation rate is elevated among young and elderly riders (Fig. 6). In terms of speed, the separation rate is high in the high-speed range of “over 100km/h,” yet the highest separation rate occurs in the low-speed range of “over 10 km/h and 20 km/h or less” (Fig. 7). Regarding the primary body part injured, it is evident that the separation rate is high for head injuries (Fig. 8). When considering the part of the motorcycle that collided, the number of fatalities is highest for frontal collisions; however, the separation rate is markedly high at 41.8% when the motorcycle is hit from the rear (e.g., rear-end collision) (Fig. 9).

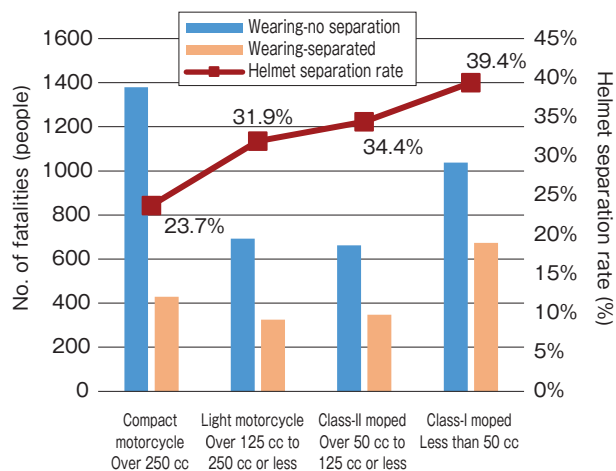


Fig. 5. Helmet separation rate by motorcycle type (Total for 2013-2022)

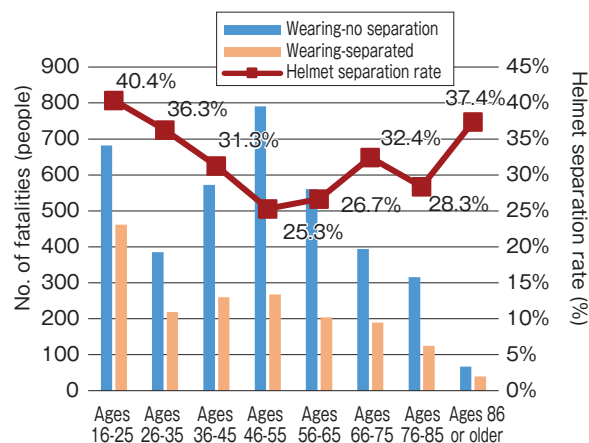


Fig. 6. Helmet separation rate by age group of motorcycle riders (Total for 2013-2022)

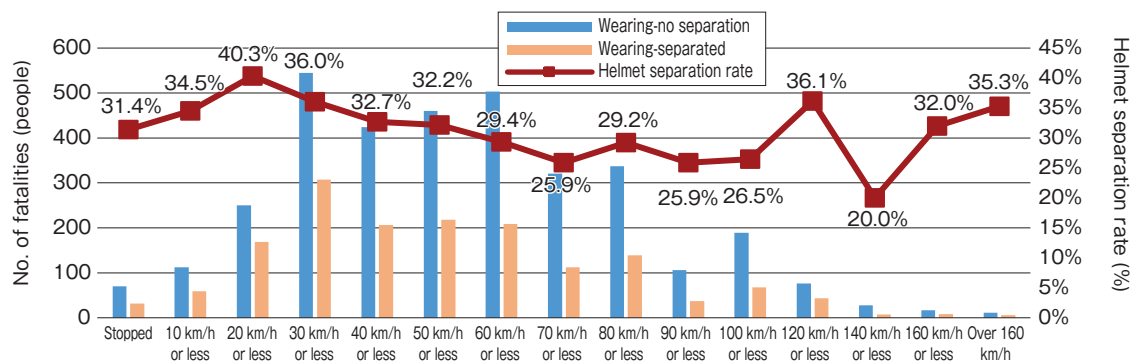


Fig. 7. Helmet separation rate by speed of motorcycles (Total for 2013-2022)

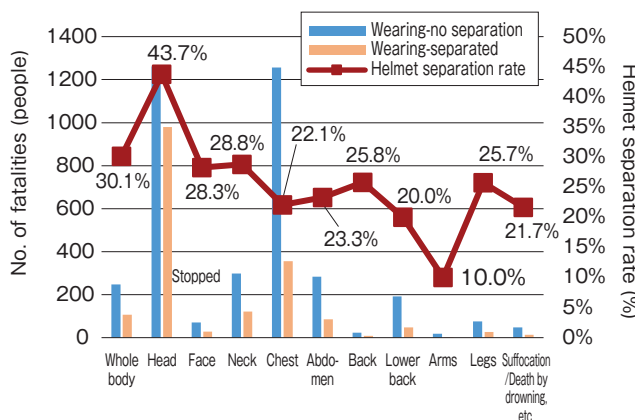


Fig. 8. Helmet separation rate by the primary body part injured (Total for 2013-2022)

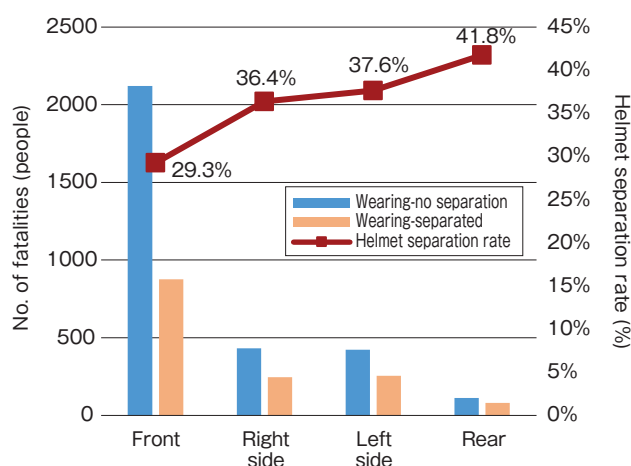


Fig. 9. Helmet separation rate by the part of motorcycle collided (Total for 2013-2022)

3

Relationship between helmet style, etc., and separation status

We analyzed ITARDA's microdata along with accident data from the Tokyo Metropolitan Police Department to confirm the relationship between the helmet style, the fastening condition of the chin strap, and the helmet separation status of riders who died in accidents while riding a motorcycle.

■ Microdata analysis

We analyzed ITARDA's microdata to examine the relationship between helmet style, the fastening condition of the chin strap, and the status of helmet separation (defined as a helmet detachment in the microdata).

The information about helmets in the microdata includes detailed items beyond the helmet-wearing status found in the macro data, such as helmet style, whether the helmet became separated, when it became separated (before or after the collision), and the fastening condition of the chin strap. Our investigation covered a total of 499 accidents involving motorcycle riders from 1993 to 2021, with helmet information available for 44 deceased riders.

Fig. 10 illustrates the styles and names of the helmets included in the microdata. While multiple names may refer to the same style, the terminology used here follows the notation from the microdata.

Microdata notation	Styles and other details	
Cap-type helmet		HA: Half-type Also known as "half cap-type" or "construction cap" helmets, this helmet does not provide ear coverage.
Semi-jet-type helmet		TQ: Three-quarter-type Also referred to as the "semi-jet-type," this helmet offers a greater protective range, extending down to the lower part of the ears, compared to the half-type.
Jet-type helmet		OF: Open face-type Also referred to as the "jet-type," this helmet provides greater protection to the lower part of the sides compared to the three-quarter-type.
Full face-type helmet		HA: Half-type The helmet is an integrated structure that incorporates the chin and typically features a face shield attached to the visor opening for eye protection.

Fig. 10. Helmet styles and notations (Microdata)

Table 1 presents data on the number of riders who died in accidents while riding a motorcycle, based on microdata, for whom the status of helmet separation and the fastening condition of the chin strap, categorized by helmet style, were confirmed.

Table 1. Number of fatalities by helmet style, separation status, and chin strap fastening condition (microdata)

	Unseparated	Separated after collision (chin strap not fastened)	Separated after collision (fastening condition of chin strap unknown)	Separated after collision (chin strap loose)	Separated after collision (chin strap broken, fastening part damaged)	Separated before collision (chin strap not fastened)	Separated before collision (chin strap loose)	Total	Separation rate
Cap-type helmet	9		3	2				14	36%
Semi-jet-type helmet	3			1				4	25%
Jet-type helmet	6	2	2					10	40%
Full face-type helmet	15		1					16	6%
Total	33	2	6	3	0	0	0	44	25%

Five riders wearing "cap-type" helmets were confirmed to have had their helmets separate after a collision. Additionally, one person in a "semi-jet-type" helmet, four riders with "jet-type" helmets, and one rider with "full face-type" helmet also experienced separation. Furthermore, it was confirmed that the riders had chin straps that were either not fastened or loose. When calculating the helmet separation rate from these results, it was found that the "full face-type" helmets had the lowest separation rate and were less likely to become separated.

■ Analysis of accident data from the Tokyo Metropolitan Police Department

The report by Kato (2021) analyzes accident data from the Tokyo Metropolitan Police Department, covering the period from 2011 to 2020, with a focus on separation rates by helmet style. Fig. 11 shows the separation rates by helmet styles, and it can be seen that the half cap-type helmet, which is the cap-type helmet shown in Fig. 10, exhibits a significantly higher separation rate of 57% compared to other helmet styles.

The half-cap helmet covers less of the head, making it more susceptible to movement that could loosen the chin strap or cause it to come off, depending on the helmet position.

Additionally, the report includes findings from an interview survey conducted by the Tokyo Metropolitan Police Department regarding actual helmet usage. It reveals that approximately 27% of motorcycle users did not have their chin straps properly fastened, as shown in Fig. 12.

Full face-type: n=164 people	: same style as the full face-type shown in Fig. 10.
Open face-type / Jet-type: n=131 people	: same style as the semi-jet/jet-type shown in Fig. 10.
Half cap-type: n=93 people	: same style as the cap-type shown in Fig. 10.

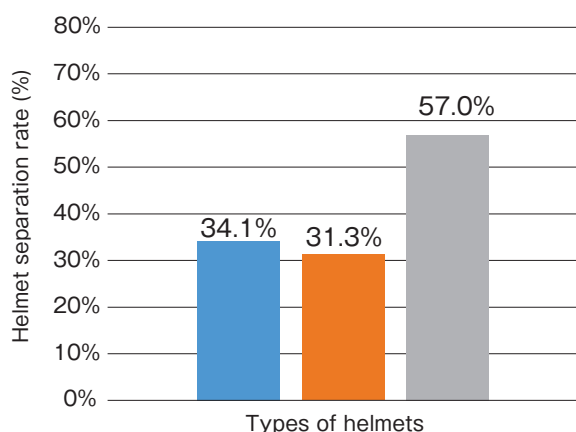


Fig. 11. Separation rates by helmet style for all motorcycles (Total for 2011-2020)

Created by the author using data from
“Tokyo Metropolitan Police Department:
Number of Fatalities by Motorcycle Type
and Helmet Type, 2011-2020 (Kato, 2021,
p. 79, Figure 5-3-3)”

2021

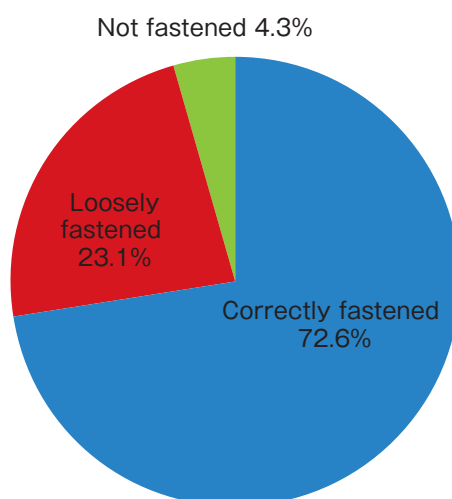


Fig. 12. “Results of the Tokyo Metropolitan Police Department Interview Survey on Helmet Chin Strap Fastening Condition
(Kato, 2021, p. 80, Figure 5-3-5)”

4

Estimation of the effects of helmet separation prevention

■ Analysis of changes in fatality risk associated with helmet separation

To what extent does the prevention of helmet separation reduce the risk of fatal injuries? This section aims to calculate the fatal injury risk associated with helmet-wearing status and estimate the effects by comparing these risks using a risk ratio. The risk ratio is calculated as follows: (fatality ratio in the “wearing-separated” group) ÷ (fatality ratio in the “wearing-no separation” group). The ratio indicates the extent to which the fatality risk is elevated when a helmet detaches compared to when it remains in place.

Fig. 13 shows the fatality ratio attributed to helmet-wearing status among motorcycle riders whose heads were the primary body part injured in accidents while riding a motorcycle.

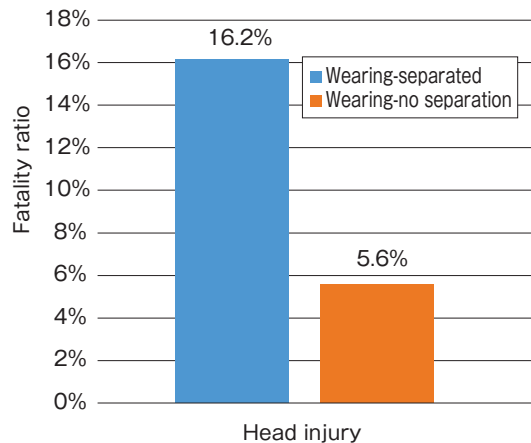


Fig. 13. Fatality ratio by helmet-wearing status among riders with head as the primary body part injured in accidents while riding a motorcycle (2022)

As shown in Fig. 13, a comparison of the fatality ratio between the "wearing-separated" and "wearing-no separation" scenarios reveals that the fatality ratio for "wearing-no separation" is 5.6%, which is lower than the ratio for "wearing-separated," which stands at 16.2%.

The calculated risk ratio here is 2.9.

This indicates that the risk of fatalities is 2.9 times higher when the helmet detaches compared to when it remains securely in place.

■ Estimation of the effects of helmet separation prevention

From the abovementioned fatality risk ratio and based on the following assumptions, we will estimate the damage reduction effects of preventing helmet separation.

- All the helmet "wearing-separated" accidents could be prevented, ensuring head protection. Consequent to this assumption, we can expect the following improvements in fatality ratios, etc.
- The fatality ratio of riders with a "wearing-separated" helmet status, where the primary body part injured was the head, will be equivalent to that of riders with a "wearing-no separation" helmet status, with the primary body part injured being the head.
- The number of fatalities, which decreases in accordance with the risk ratio, becomes the number of casualties, excluding fatalities.

The effect will be estimated using macro data from 2022. The relevant data includes the following:

- | | |
|---|--------------|
| 1. Number of fatalities while riding a motorcycle: | 435 people |
| 2. Number of fatalities with "wearing-separated" helmet status: | 115 people |
| 3. Number of fatalities with "wearing-separated" helmet status and the head as the primary body part injured: | 59 people |
| 4. Number of casualties with "wearing-separated" helmet status and the head as the primary body part injured: | 365 people |
| 5. Fatality ratio with "wearing-separated" helmet status and the head as the primary body part injured: | 16.2% |
| 6. Number of fatalities with "wearing-no separation" helmet status: | 278 people |
| 7. Number of fatalities with "wearing-no separation" helmet status and the head as the primary body part injured: | 84 people |
| 8. Number of casualties with "wearing-no separation" helmet status and the head as the primary body part injured: | 1,509 people |
| 9. Fatality ratio with "wearing-no separation" helmet status and the head as the primary body part injured: | 5.6% |
| 10. Risk ratio based on whether or not the helmet was separated ($16.2 \div 5.6 = 2.9$): | 2.9. |

Assuming that the "3. Number of fatalities with 'wearing-separated' helmet status and the head as the primary body part injured: 59 people" became the fatalities associated with a "wearing-no separation" helmet status where the head is the primary body part injured, and presuming that the number of fatalities has decreased in accordance with the risk ratio, the calculation would thus be $59 \div 2.9 = 20.3$.

Consequently, the total fatalities would reduce to 21, representing a decrease of $59 - 21 = 38$ people.

Therefore, it can be inferred that among the 59 fatalities, 38 experienced a reduction in overall damage, sustaining only injuries.

5 Conclusion

As shown above, the fatality ratio in accidents involving a motorcycle rider whose helmet came off due to the impact, despite wearing one, has consistently remained around 30%. Additionally, if a helmet separates during an accident, the fatality risk increases 2.9 times compared to when the helmet stays securely fastened.

Based on several assumptions, we have calculated the damage reduction effect in cases where helmets did not come off compared to those where helmets were separated. Our estimates suggest that the number of fatalities from accidents while riding a motorcycle in 2022 could be reduced by 38 people from 435 to 397, representing a reduction of approximately 9%.

We hope that you have come to understand the critical importance of head protection. When riding a motorcycle, please make sure to wear a helmet and securely fasten the chin strap.

(Toshiaki Yagi)

Citations and References:

Ryusuke Kato: Research on Reducing Accidents and Casualties by Analyzing the Characteristics of Motorcycle Accidents —Characteristics of Single-Vehicle Motorcycle Accidents—Joint Research Report R03-07 (2021) by the Japan Automobile Manufacturers Association, Inc. and the Institute for Traffic Accident Research and Data Analysis.

Ryusuke Kato: Aiming to Reduce Motorcycle-Fatality Accidents among Young Persons: What Can Be Seen from Trends Regarding Helmet Separation, 25th Presentation Session for Traffic Accident Investigations, Analysis, and Research (2022)

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