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Fatal accidents involving four-wheeled vehicles and pedestrians and high-performance headlights

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1. Background and Purpose

Although traffic accident data from 1990 to 2022 shows a slight change in the proportion of overall traffic accident fatalities and injuries due to traffic accidents at night, this proportion has remained below 30% for roughly the past 15 years (see Fig. 1). On the other hand, less than 70% of those who died in traffic accidents while walking involved in nighttime accidents (see Fig. 2). This trend has remained almost constant for 30 years, and contrasts with the fact that the number of deaths under other circumstances, such as those involving four-wheeled vehicle passengers or bicycle riders, has converged to less than 40% over the past 15 years. Although pedestrians may be somewhat difficult to see at night, why exactly do pedestrian deaths account for 70% of fatalities or injuries at night, which make up less than 30% of all traffic accident fatalities and injuries?

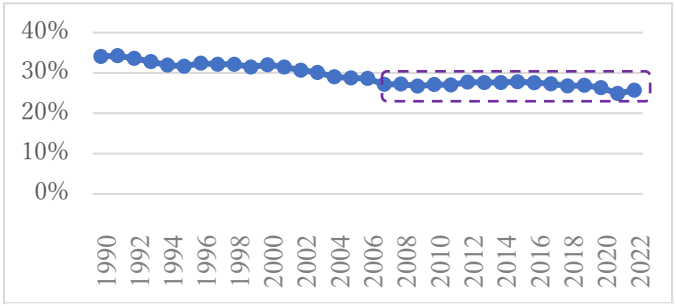

Fig. 1 Proportion of nighttime traffic accident fatalities or injuries

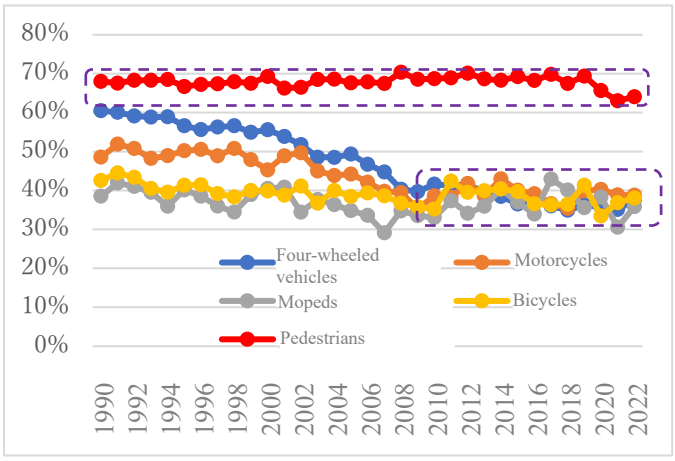

Fig. 2 Proportion of nighttime traffic accident fatalities by circumstance

Considering that more than 90% of the parties involved in fatal pedestrian accidents (involving a primary and secondary party) are four-wheeled vehicles (see Fig. 3), subsequent analysis was performed by examining fatal accidents involving four-wheeled vehicles and pedestrians (primary and secondary parties).

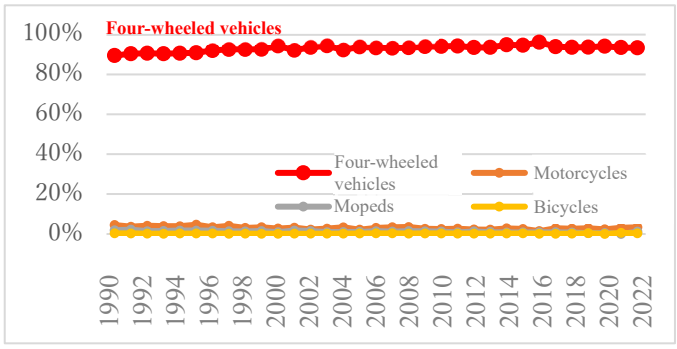

Fig.3 Proportion of parties involved in fatal pedestrian accidents (nighttime)

According to a survey and analysis conducted by Japan's National Police Agency [(1)] in 2016, 56% of fatal accidents involving four-wheeled vehicles and pedestrians (at night and with the four-wheeled vehicle driving straight ahead) were more likely to have been avoided had the driver tilted their headlights upwards (by using high beams). The use of high beams has since been promoted through revisions to traffic regulations, etc. And, in the past 10 years, approximately 95% of fatal accidents involving four-wheeled vehicles and pedestrians (primary and secondary parties) have been caused by drivers with their headlamps tilted downwards (using only their low beams) (see Fig. 4).

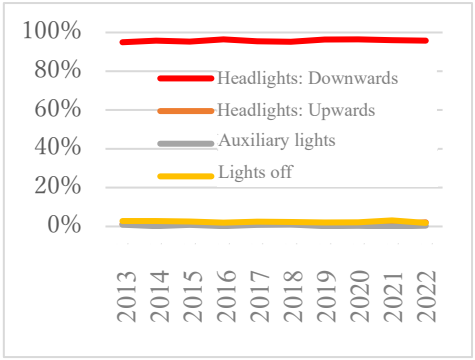

Fig. 4 Headlight direction by proportion

Based on the above, we conducted our research with the aim of helping to reduce the number of traffic accident victims by investigating the causes of many nighttime fatal pedestrian accidents and proposing effective ways of reducing nighttime accidents involving pedestrians.

2. Methods used

With the proliferation of preventive safety equipment, most new vehicles are now equipped with high-performance headlights [(2)]. The high-performance headlights currently being equipped to many new vehicles come in two types: An auto-switching type that automatically switches the headlights upwards and downwards, and an auto-dimming type that dims the headlights only in the direction of oncoming and preceding vehicles while controlling light distribution so that the light is directed to other areas as much as possible. Providing that these systems function normally, it is highly likely that drivers will be able to avoid collisions in many of the 56% accidents reported by the National Police Agency. Therefore, if such proliferation of high-performance headlights were to continue, one can assume that statistically, the effectiveness of such adoption would be evident. That said, because high-performance headlights are not regulated by laws and many require driver operation to be activated, they may necessarily not be activated at the time of an accident, nor is there is any obligation for records to be kept of whether the headlights were facing upwards or downwards. Therefore, during our research on this topic, we performed grouping based on whether or not the vehicle involved in the traffic accident was equipped with high-performance headlights (see Table 1) while making the following assumptions.

Table 1. Vehicle classification by high-performance headlight equipping status

Classification	Details
Standard-equipped A	This includes vehicles with high-performance headlights with functions that activate automatically and without the need for the driver to take action, vehicles with high-performance headlights that continue to remain powered on and activated via use of a dedicated switch that only needs to be turned on once, vehicles with high-performance headlights that activate only when the high-/low-beam switch is set in the low-beam position, and those that activate regardless of the switch position.
Standard-equipped B	Other than Standard-equipped A above. This includes vehicles with high-performance headlights that require a dedicated switch to be turned on in order for them to be powered on, or those that only activate when the high-/low-beam switch is set in the high beam position.
Non-standard-equipped	This applies to vehicles in which high-performance headlights are an option, or in which only some models are equipped with high-performance headlights.
Not equipped	This applies to vehicles not equipped with high-performance headlights

- In vehicles standard equipped with high-performance headlights, their functionality is activated in a certain proportion of traffic accidents.
- A certain proportion is divided into two types depending on whether driver action is necessary for operation.

High-performance headlights that do not require driver action to be activated are categorized as “Standard-equipped A”, while those that require driver action are categorized as “Standard-equipped B”. Based on this, we can assume that in the event of an accident, Standard-equipped A high-performance headlights are more likely to be in a high-beam state than Standard-equipped B high-performance headlights.

- Compared to vehicles in which high-performance headlights are standard equipped (Standard-equipped A/B), a lower proportion of vehicles in which high-performance headlights are not standard equipped (Non-standard-equipped) have high-performance headlights. For this reason, in the event of an accident, the likelihood of such vehicles using their high beams is even less than that of Standard-equipped B vehicles.

The indicator used here is based on the number of deaths per vehicle (1 million registered vehicles) for each vehicle classification. When classifying vehicles by high-performance headlight equipping status, it is necessary to look at the equipping status of each model. This was done by referring to the “List of Safety Equipment Equipping Statuses [(3)]” published by NASVA (National Agency for Automotive Safety & Victims' Aid) in addition to the owner’s manuals from each automobile manufacturer.

All available data from 2019 to 2022 for each model name was used for aggregation these totals. The number of registered vehicles, which was used as the denominator in these calculations, was first calculated by obtaining information on the number of registered vehicles by model name at the end of each year from 2018 to 2022 using a formula such as that below.

	No. of vehicle types	No. of registered vehicles	Proportion
Standard-equipped A	25	4,856,860	2%
Standard-equipped B	49	7,967,417	3%
Nonstandard-equipped	133	76,364,763	33%
Not equipped	830	142,925,134	62%
total	1037	232,114,174	100%

Table 2. Numbers of registered vehicles per vehicle classification (4 years from 2019 to 2022)

Example: Number of registered vehicles in 2019 = (end of 2018 + end of 2019)/2

Total number of registered vehicles for 4 years = 2019 + 2020 + 2021 + 2022 (number of registered vehicles in each year)

Table 2 shows these calculation results.

3. Results

Our results can be seen in Figure 5. Using four years data (2019 to 2022) from the Traffic Accident/Vehicle Integrated Database, we calculated the number of accidents involving a four-wheeled vehicle and pedestrian in which the pedestrian died and in which the pedestrian was the primary or secondary party. The vertical bars in the figure indicate a 95% reliability interval. As shown in the figure to the left, the number of deaths per one million registered vehicles at nighttime is as follows:

Not equipped > Nonstandard-equipped > Standard-equipped A or Standard-equipped B

As can be seen, there are significant differences between each. However, regarding whether driver action is necessary for operation, there are no major differences between Standard-equipped A and Standard-equipped B, as their reliability intervals overlap. Furthermore, no significant differences were seen between the different classifications in the case of the daytime. Due to the above, Standard-equipped A and Standard-equipped B will both be treated as “Standard-equipped” in this report.

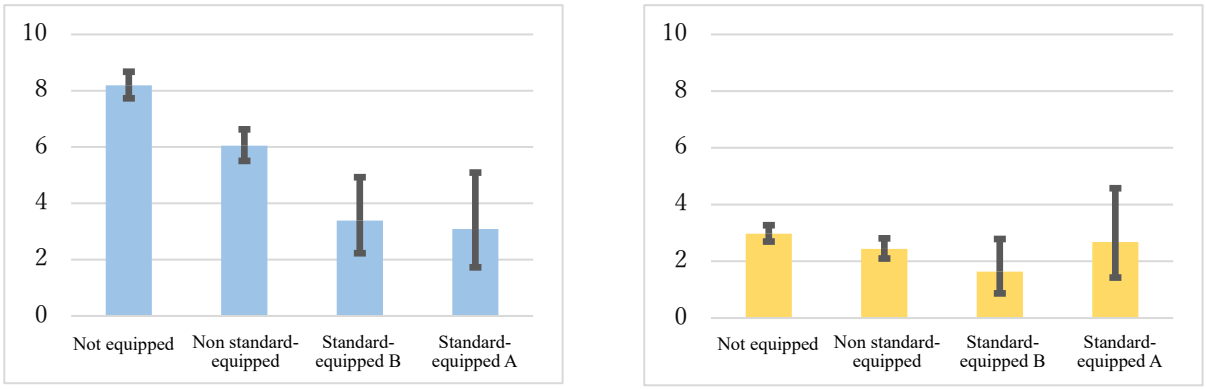

Fig. 5 Numbers of deaths per one million registered vehicles at nighttime (left figure) and in the daytime (right figure)

Next, in order to understand the reduction level of fatal accidents when compared with “Not equipped”, “Nonstandard-equipped” and “Standard-equipped” were divided by the value of “Not equipped” respectively, and expressed as a proportion (see Fig. 6). In the case of “nighttime”, “Standard-equipped” saw a reduction of 60% compared to “Not equipped”. However, in the case of “daytime”, the number of deaths reduced by about 30% for “Standard-equipped”. If a reduction in accidents through the use of high beams is not evident in the case of daytime when headlights are not used, any reductions in fatalities during the daytime can be considered as being due to AEB (Automatic Emergency Braking) activation in response to pedestrians.

Because AEB responds to pedestrians even at night, any effects from AEB should also be included in the results for nighttime in Figure 6. Therefore, by dividing the proportion for nighttime in Fig. 6 by the proportion for daytime, the effects from AEB are offset, resulting in fatalities being reduced by 40% for “Standard-equipped” when compared with “Not equipped” (see Fig. 7). This leads us to assume that the effectiveness of the AEB during the daytime and nighttime is equal, and is regarded as the scenario in which the reductions in accidents due to high beam usage at night is estimated to be the lowest.

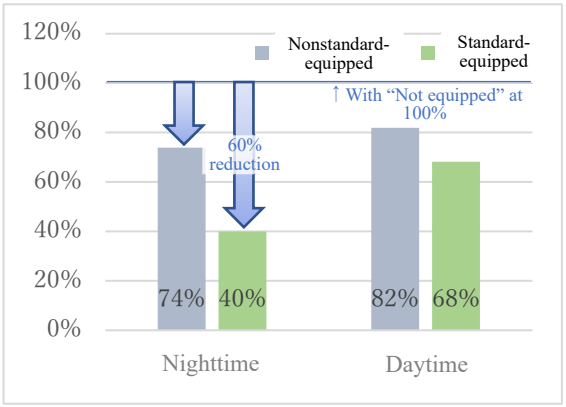

Fig. 6 Proportion of deaths due to vehicles not equipped with high-performance headlights

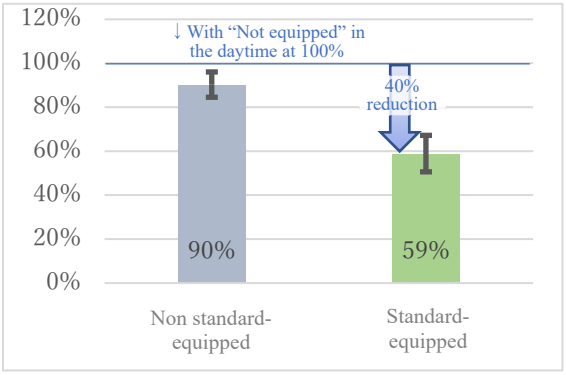

Fig. 7 Fatality proportions (nighttime/daytime/not equipped)

4. Summary

4-1. Findings

By aggregating data from 2019 to 2022 on accidents involving four-wheeled vehicles and pedestrians at nighttime in which the pedestrian was killed, we were found that vehicles standard-equipped with high-performance headlights saw a 40% to 60% reduction in fatal accidents (per number of registered vehicles) compared to vehicles not equipped with high-performance headlights. Because only 5% of registered vehicles are standard-equipped with high-performance headlights, we expect further reductions in the number of pedestrian fatalities at nighttime as the proportion of registered vehicles standard with high-performance headlights continues to increase.

4-2. Future issues for research

The results of this research are based on the assumption that high-performance headlights will function to some extent for models in which they are standard-equipped, meaning our conclusion is only an estimate. Because headlights automatically distribute light upwards and downwards, data showing the direction of light distribution at the time of an accident is necessary in order for more rigorous analysis to be conducted. In the case of the auto-dimming headlamps, not only is data on upwards/downwards light distribution necessary, but so is information on which areas are being illuminated. Because such data is recorded by EDRs (Event Data Recorders) and because dashcams can also be used to record images of vehicle light distribution, we will be able to provide more accurate analysis results as vehicles equipped with such equipment continue to increase. As someone who investigates, analyzes, and disseminates the results of research on traffic accidents, I hope that the proliferation of such functions will continue.

<References/Sources>

(1) National Police Agency Website “Preventing Nighttime Accidents Involving Pedestrians by Skillfully Utilizing High Beams”
https://www.npa.go.jp/bureau/traffic/anzen/highbeam.html

(2) Ministry of Land, Infrastructure, Transport and Tourism (MLIT) “Survey Data on Technology Proliferation Status” (see No. 30 and 31 in the table)
https://www.mlit.go.jp/jidosha/anzen/01asv/data/r3souchakudaisu.pdf

(3) NASVA Website “List of Safety Equipment Equipping Statuses”
https://www.nasva.go.jp/mamoru/download/car_download.html
(A link for latest edition of the “List of Safety Equipment Equipping Statuses” can be found in the middle of the page.)