ITARDA INFORMATION
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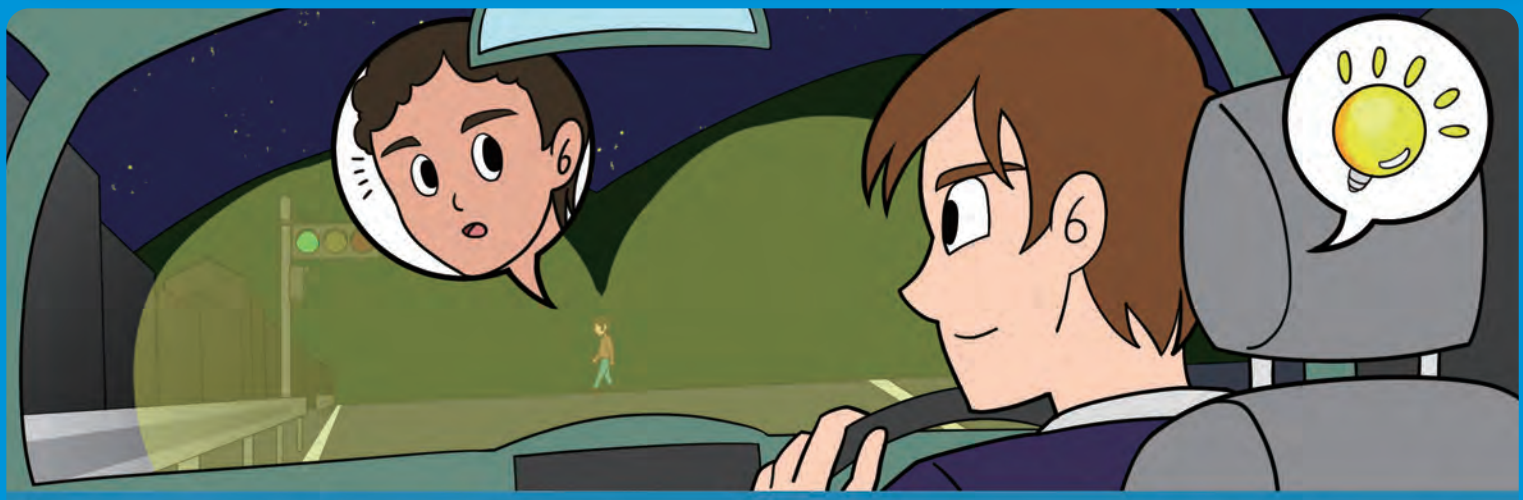
Special feature

Prevent fatal pedestrian accidents at night

~Use high-performance headlights~



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1 Introduction

In 2022, approximately half of the individuals who died in nighttime traffic accidents were pedestrians (see Table 1). It has been a long time since the words "use high beams skillfully"[1] have been used; however, over the past decade, about 95% of nighttime fatal pedestrian accidents resulted from using the headlights tilted downwards (low beam)[2] . In-depth accident case studies indicate that the reasons for driving with low beams were often simply "none" or "out of habit," suggesting that many drivers may be unaware that skillfully utilizing high beams can help prevent accidents. In this issue, we will explore high-performance headlights, such as automatic switching and automatic anti-glare types, which effectively use high beams by automatically alternating between high and low beams. We will also present an analysis of how effectively this functionality reduces fatal pedestrian accidents.

When driving at night, it is standard practice to direct the headlights upwards (high beam), and when approaching an oncoming vehicle or when there's a vehicle ahead, it is necessary to switch the direction of the headlights downwards (low beam). However, this operation can become challenging when it coincides with other driving maneuvers, such as navigating a curve. In recent years, there has been a significant increase in the number of new model vehicles equipped with high-performance headlights that automatically switch between high and low beams (see Fig. 1). An analysis of Road Traffic Accident Statistics from 2019 to 2022 revealed that in cases of nighttime fatal pedestrian accidents, the number of fatalities per registered vehicle was approximately 30% to 60% lower in vehicles standard-equipped with these high-performance headlights compared to those without them.

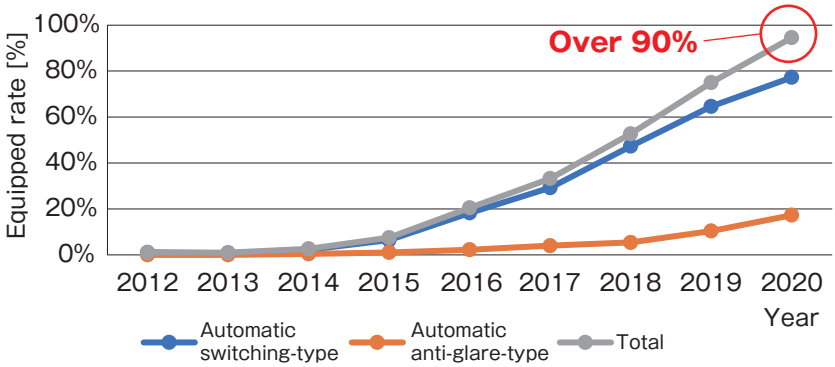

Fig. 1 Trends in the equipped rate (number of equipped vehicles/total number of vehicles produced) of high-performance headlights on new vehicles (passenger vehicles including small-sized vehicles)
(Source: Ministry of Land, Infrastructure, Transport and Tourism (MLIT) "Survey Data on Technology Proliferation Status" [3])

In most cases, you can check whether your vehicle is equipped with high-performance headlights using the following method: After it gets dark, start the engine or turn the power ON, and set the headlight switch to "Auto." Next, operate the lever that raises and lowers the headlights. If the instrument panel displays " " or " ," the high-performance headlights are operational. (For safety, please ensure you perform this check while the vehicle is stopped. Please refer to the manual or consult your dealer for official information.)

2 Accidents involving pedestrians and four-wheeled vehicles at night

In 2022, the total number of traffic accident fatalities was 2,610. Analyzing the data by time of day, there were 1,374 fatalities during the day and 1,236 at night, indicating a higher number of casualties during daylight hours when people tend to be more active (see Table 1 and Fig. 2). Breaking down the fatalities by circumstance, the highest number occurred while walking, totaling 955 persons. This was followed by 870 fatalities while riding in a four-wheeled vehicle, with motorcycle and bicycle fatalities occurring in that order. When considering fatalities while walking by day and night, contrary to the overall trend, there were 612 deaths (64%) at night, which is about 1.8 times greater than the number during the day when activity levels are higher. This exception highlights that pedestrians are likelier to be involved in fatal accidents at night. Why are fatal pedestrian accidents more common at night?

Table 1: Number of deaths by day and night and by circumstance (persons; figures within ( ) indicate the percentage of each circumstance) (2022)

	Walking	Riding in a vehicle	Riding a motorcycle	Riding a bicycle	Riding a moped	Other	Total
Daytime	343(25%)	543(40%)	210(15%)	210(15%)	59(4%)	9(1%)	1,374(100%)
Nighttime	612(50%)	327(26%)	133(11%)	129(10%)	33(3%)	2(0%)	1,236(100%)
Total	955(37%)	870(33%)	343(13%)	339(13%)	92(4%)	11(0%)	2,610(100%)

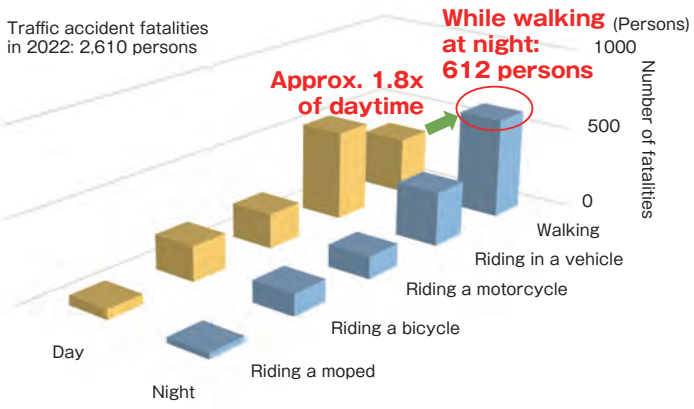

Fig. 2 Number of fatalities by day/night and by circumstance (2022)

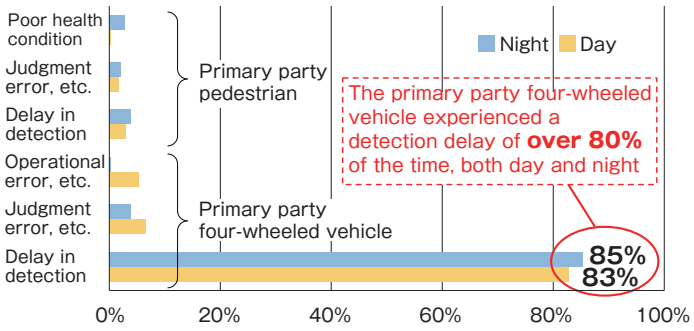

Fig. 3 Percentage of human factors by day and night in fatal pedestrian accidents involving pedestrians and four-wheeled vehicles (2022)

In 2022, 93% of traffic fatalities involving pedestrians at night occurred in collisions with four-wheeled vehicles. Hereafter, we will focus on accidents between pedestrians and four-wheeled vehicles.

Let's examine the human factors associated with the primary party (the party demonstrating greater negligence or sustaining lesser damage if both parties are equally at fault) in these accidents (see Fig. 3).

The most prevalent factor is the **driver's delay in detection**. While this factor is not exclusive to nighttime accidents, it is responsible for over 80% of all accidents and is regarded as the leading cause of pedestrian fatalities.

Next, we will analyze data on vehicle speed. Figure 4 illustrates the number of fatalities and injuries (in the left graph) and the number of fatalities (in the right graph) in pedestrian-to-four-wheeled vehicle accidents during both day and night in relation to the hazard recognition speed of the vehicle (the speed at which the driver became aware of the danger).

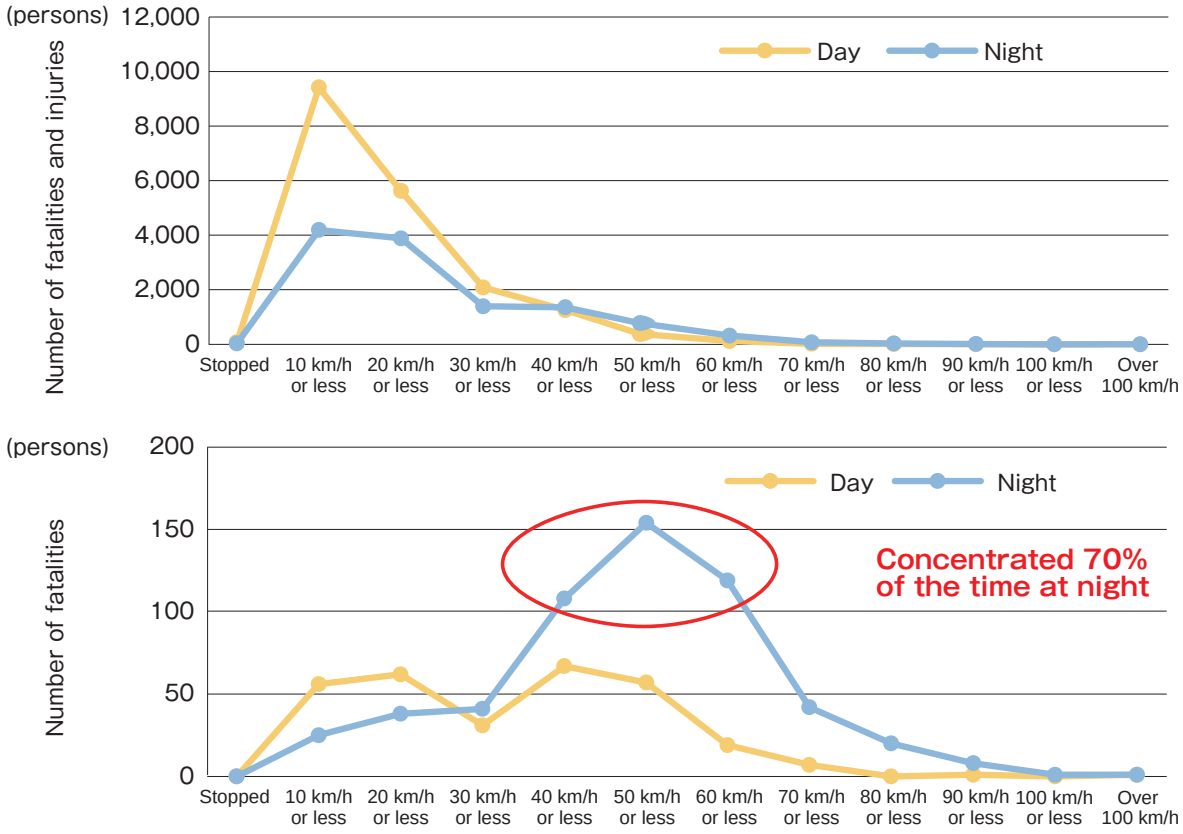

Fig. 4 Number of pedestrian fatalities and injuries (top chart) and number of pedestrian fatalities (bottom chart) by day/night and hazard recognition speed (2022)

The majority of pedestrian fatalities and injuries occur at low speeds, specifically 20 km/h or less, both during the day and at night. However, approximately 70% of nighttime fatalities happen at speeds between 40 km/h and 60 km/h. This indicates that fatal pedestrian accidents are characterized by **"frequent delay in detection"** and that **"speeds are higher"** at night than during the day.

3 Presence of high-performance headlights and the number of pedestrian fatalities

What causes delays in detecting pedestrians during nighttime accidents? As stated at the beginning of this article, over the past 10 years, it has been observed that in approximately 95% of fatal pedestrian accidents, the headlights were directed downward[2]. The range of illumination for the low beam is 40 meters, while the high beam can illuminate up to 100 meters. If you are driving at 40 km/h with the low beam and notice a pedestrian 40 meters ahead as the light begins to illuminate the area, reaching the pedestrian will take 3.6 seconds. At a 60 km/h speed, this time reduces to approximately 2.4 seconds. Have you ever experienced driving at speeds between 40 to 60 km/h at night and looking away for a few seconds? If you glance away just as your headlights are about to reach a pedestrian, you will collide with the pedestrian as soon as you turn your attention back 2-3 seconds later. Now, let us consider the scenario with a high beam. When using the high beam, if you spot a pedestrian 100 meters ahead, it would take 9 seconds to reach them at 40 km/h and 6 seconds at 60 km/h. It is unlikely for someone to look away for such an extended period. Even if a driver were momentarily distracted, they would typically regain their focus in time to see the pedestrian and respond appropriately.

The effective use of high beams has been highlighted on the National Police Agency website[1]. In 2017, the "Partial Revision of Traffic Rules (Concerning Nighttime Lighting Methods)" was implemented. However, driving with a high beam is not always advisable. If you encounter an oncoming vehicle or a vehicle ahead of you, you must immediately switch to a low beam to avoid dazzling other drivers. This can be a safety concern, particularly when switching between high and low beams while steering around a curve is difficult. To address this issue, high-performance headlights were introduced as an optional feature around 2011. These headlights utilize cameras and other sensors to detect oncoming and preceding vehicles, automatically switching between high and low beams as needed—this feature is known as automatic high beams (AHB). These automatic switching systems are especially effective on dark roads with low traffic. Additionally, there has been an increase in the availability of advanced automatic anti-glare headlights. This technology is known as Adaptive Driving Beam (ADB). It utilizes a high beam while automatically dimming only the areas with preceding or oncoming vehicles. This means that the front of the vehicle remains brightly lit even when passing by another vehicle, which enhances visibility for spotting pedestrians and obstacles, even on heavily trafficked roads (see Fig. 5). As shown in Figure 1, the equipped rate of high-performance headlights has increased significantly since the revision of traffic regulations in 2017 and the introduction of evaluations by the Japan New Vehicle Assessment Program (JNCAP)[4] in 2018. Consequently, many vehicles, including small-sized vehicles, are now standard-equipped[5] with these high-performance headlights. With a growing number of vehicles utilizing these headlights, we may see a decrease in fatal pedestrian accidents at night. Thus, we investigated the relationship between the presence of this equipment and the number of pedestrian fatalities.

The National Agency for Automotive Safety and Victims' Aid (NASVA) supervises JNCAP and has published a detailed list of safety features in each vehicle[5]. Using this list and the owners' manuals of various vehicles, we compared passenger vehicles manufactured by domestic companies that are standard-equipped with high-performance headlights to those that do not include this feature. Please note that due to the limited information available, our analysis will be focused specifically on domestic passenger vehicles (including small-sized vehicles).

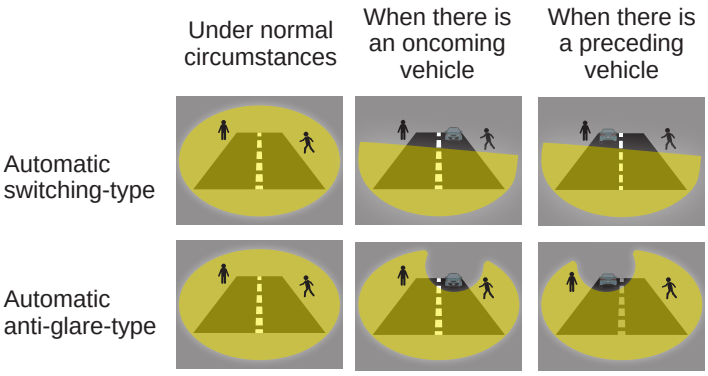

Fig. 5 Image of high-performance headlight illumination

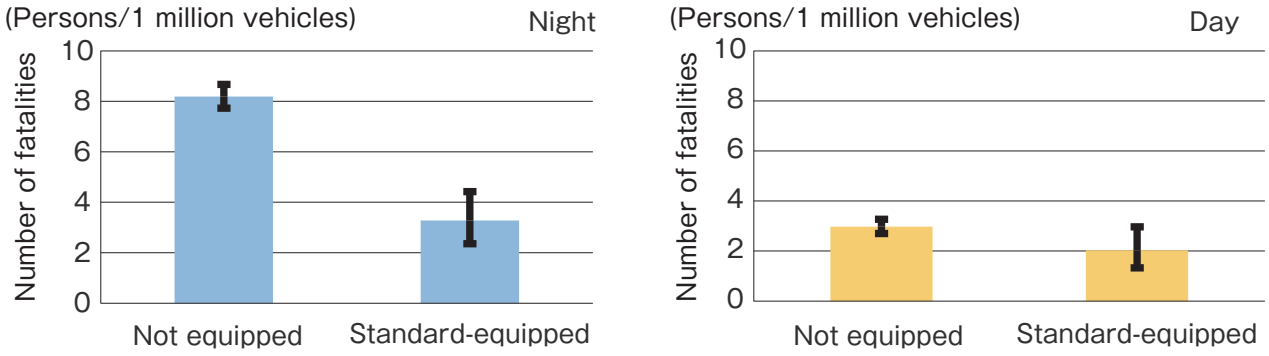

Fig. 6 Number of fatalities per one million registered vehicles in pedestrian-to-four-wheeled vehicle fatal pedestrian accidents
(Left figure: Night; Right figure: Day)

Figure 6 presents the number of pedestrian fatalities in accidents involving pedestrians and four-wheeled vehicles per one million registered vehicles from 2019 to 2022. It compares vehicles without high-performance headlights to those equipped with them, both at night (left) and during the day (right). The black vertical bars in the figure represent 95% confidence intervals. The data indicates that vehicles standard-equipped with high-performance headlights experience fewer pedestrian fatalities at night than those without them. During daytime, however, the confidence intervals overlap, suggesting that while there is a difference, it is not statistically significant. The number of fatalities per one million registered vehicles will continue to be used through Figure 7 below*.

* From 2019 to 2022, approximately 12.82 million registered vehicles (5%) were standard-equipped with high-performance headlights. In contrast, about 142.93 million vehicles (62%) did not have this feature. The remaining 33% of vehicles were non-standard-equipped, including options or vehicles that transitioned to standard-equipped during the model run. We have omitted details about this group, which showed intermediate characteristics, from the discussion to simplify the data presented.

Figure 7 illustrates the ratio of fatalities between standard-equipped vehicles and non-equipped vehicles during both day and night. At night, the number of fatalities for standard-equipped vehicles is 60% lower than for non-equipped vehicles.The question arises: why is the number of fatalities during the day 30% lower? High-performance headlights operate only when turned on, suggesting another factor may be at play. Non-equipped vehicles are often older, and many lack automatic emergency braking (AEB). Suppose we attribute the daytime reduction in fatalities to AEB and assume that AEB is equally effective day and night. In that case, the difference in fatalities between nighttime and daytime can be attributed solely to high-performance headlights. This analysis found that between 2019 and 2022, vehicles standard-equipped with high-performance headlights experienced 60% fewer pedestrian fatalities at night per registered vehicle than non-equipped vehicles. Additionally, even when accounting for factors such as AEB, there were still 28% fewer pedestrian fatalities.

Since this data is based on a per-vehicle comparison, we anticipate that as the proportion of vehicles standard-equipped with high-performance headlights increases in the future, the overall number of fatalities is likely to decrease further.

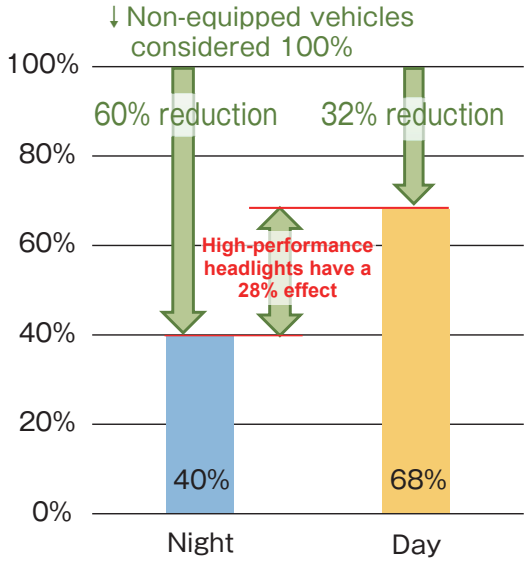

Fig. 7 Ratio of fatalities (Standard-equipped/Non-equipped)

4 Case examples of fatal pedestrian accidents at night and the potential for avoidance with high-performance headlights

In this section, we will examine two pedestrian fatality cases from ITARDA's in-depth accident case studies and assess the effectiveness of high-performance headlights in preventing accidents.

[Case example 1] (Fig. 8) Shortly after 9 p.m. in April, Mr. A drove down a straight road with two lanes and a sidewalk on the right side. His headlights were aimed downward when he collided with Mr. B, who was walking in the same direction while pushing a bicycle on the road ahead of him. The speed limit on this road was 50 km/h. The speed at the collision was estimated to be 55 km/h. Mr. A was driving absent-mindedly due to the low traffic and fatigue from work, and by the time he realized it, the collision had already occurred. Upon reviewing the dashcam footage, it was observed that the surroundings were very dark and that an oncoming vehicle was far ahead. If Mr. A had used his high beam appropriately, he might have been able to see Mr. B earlier and avoid the collision. It is believed that high-performance headlights equipped with automatic switching and anti-glare features may have effectively mitigated the risk of this accident.

[Case example 2] (Fig. 9) After 6 p.m. in February, during light rain, Mr. A was driving straight on a two-lane road that had sidewalks on both sides. His headlights were angled downwards when he collided with Mr. B, who was crossing the crosswalk from right to left. The speed limit on this road was 50 km/h, but at the time of the collision, Mr. A's speed was estimated to be 40 km/h. A review of the dashcam video shows that Mr. B was faintly visible when he began crossing the crosswalk just after a preceding vehicle passed. However, the crosswalk was difficult to see due to the reflection from the wet road surface and the glare from the headlights of an oncoming vehicle. Given these conditions, Mr. A should have slowed down and driven more cautiously. In this situation, there was an oncoming vehicle, meaning high beams could not be used. Consequently, the automatic switching feature was unable to prevent this issue. However, if the vehicle had been equipped with an automatic anti-glare system, the headlights might have illuminated Mr. B as he started to cross, allowing Mr. A to notice him and potentially stop in time. Alternatively, the light from the headlights might have alerted Mr. B to the approaching vehicle, enabling him to assess its speed and decide whether it was safe to cross.

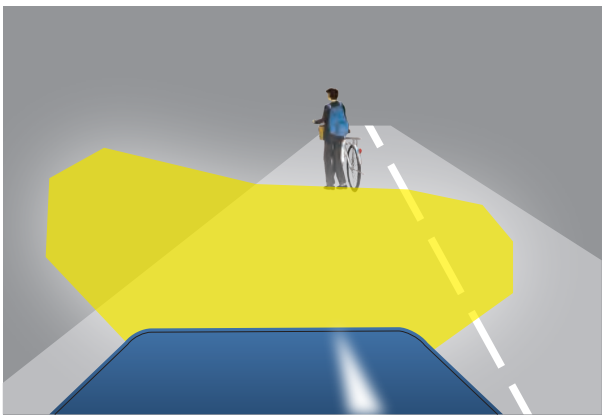

Fig. 8 A case example of a rear-end collision with a pedestrian pushing a bicycle

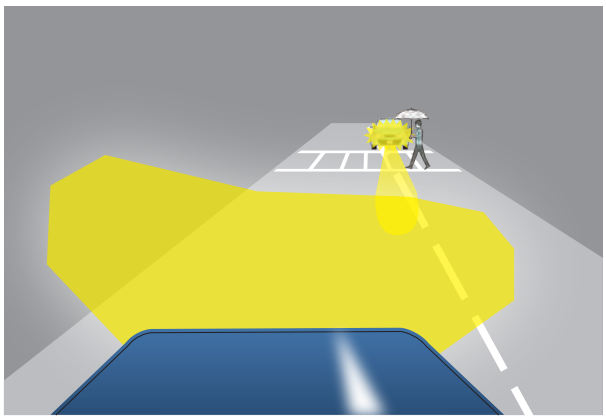

Fig. 9 A case example of collision with a pedestrian crossing from the right

5 Challenges associated with automotive lighting technology

High-performance headlights can potentially reduce fatal pedestrian accidents at night but also come with certain challenges.

- Challenges with the operation method
  - High-performance headlights require the driver to manually switch between the ON and OFF settings, which may discourage some drivers from using them.
  - In some models, the function activates when the high beam/low beam switching lever ("lever") is in the high position. Therefore, drivers typically using the low beam setting may not utilize this feature.
  - Different vehicle manufacturers and models have varying operation methods, confusing drivers when switching vehicles.

To address these issues, we reviewed several online instruction manuals from various vehicle manufacturers. We classified the operation methods for high-performance headlights from domestic vehicle companies, as illustrated in Figure 10. The columns in the figure distinguish between the presence or absence of a dedicated switch and whether the high-performance headlight function remains active when the vehicle is restarted (either when the engine is restarted or when the power switch is turned off and on again). The rows in the figure identify the position of the headlight lever at which the function is activated. Each letter in the figure corresponds to a specific vehicle company, while the branch number indicates the model, with a larger number in the direction of the arrow indicating a newer model.

Please note that this survey is not comprehensive; it does not cover all vehicle companies or models, and the classification is based solely on the author's interpretation.

- Presence or absence of a dedicated switch

(1) With a dedicated switch

- Switch must be turned ON every time (left column of Figure 10): When starting the vehicle, the dedicated switch must be turned ON again to activate the high-performance headlights.
- Function is maintained (middle column of Figure 10): Once the dedicated switch is turned ON, the high-performance headlights will function the next time the vehicle is started without needing to activate the switch again. In the G2 and G3 models illustrated in the figure, the high-performance headlights are initially set to function without any special operation when the vehicle is started. (Users can change the settings to turn off this automatic activation.) The models in the "Switch at the tip of the lever" frame allow for safe switching between operation (ON) and manual (OFF) without requiring the driver to look away from the road.

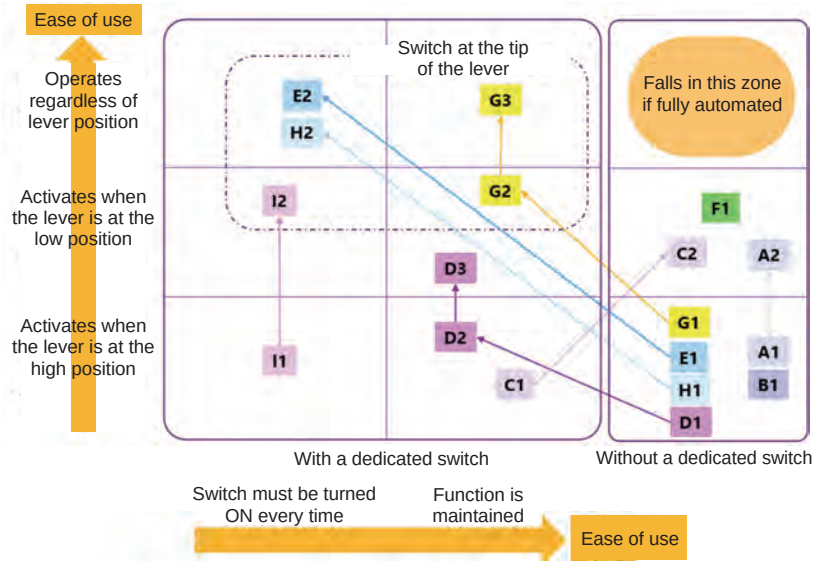

Fig. 10 Differences and alterations in the operation method of high-performance headlights; Ease of use

(2) Without a dedicated switch (right column of Figure 10): Many vehicles without a dedicated switch also incorporate auto light functions, which turn the headlights ON in the automatic position and OFF in the manual position.

- Lever position

In most early models, this function was designed to operate only when the lever was set to the high position (as shown in the lower part of Figure 10, primarily for branch number 1). Drivers often perceive this operation as similar to manual operation, making the switching process less uncomfortable. However, those who typically drive with low beams may not fully utilize this feature. In recent years, there has been a rise in the number of models that allow the function to work when the lever is in the standard (low) position (illustrated in the middle row of Figure 10) and models that function regardless of the lever position (depicted in the top row of Figure 10). This shift is expected to increase the percentage of vehicles with this function in an activated (ON) state.

On the other hand, high-performance headlights are an evolving technology and are not entirely automatic. For instance, these headlights cannot automatically dim for pedestrians or cyclists approaching from the opposite direction, so drivers must manually adjust their headlights to prevent dazzling these individuals. Furthermore, drivers who struggle with switching between the high and low beams must also learn how to alternate between automatic and manual modes, which could feel like an additional burden.

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Other challenges include:

- The response time for lowering the high-performance headlights is slow.
- When the headlight function unexpectedly shifts from high beam to low beam, drivers may find it difficult to see what they want to see due to the significant contrast between light and dark caused by the brightness of the headlights.
- Additionally, the driver may feel that the operation of the headlights does not align with their sensibilities.
- After manual operation, there is a possibility of forgetting to revert to automatic mode.
- Although automatic anti-glare headlights are nearly ideal, they tend to be expensive due to their complex design.

Nonetheless, we hope these issues will be addressed as automatic anti-glare technology improves and becomes more widespread.

6 Conclusion

Analysis of fatal pedestrian accidents involving four-wheel vehicles at night indicates that vehicles standard-equipped with high-performance headlights experience 60% fewer fatalities per one million registered vehicles compared to non-equipped vehicles. Even when excluding the effects of automatic emergency braking (AEB) and other factors, the fatalities were still about 30% lower. However, it is essential to note that high-performance headlights present certain operational challenges, as illustrated in Figure 10, along with several other related issues. Nonetheless, if all existing vehicles with high-performance headlights were utilized properly, fatal pedestrian accidents could have potentially decreased by more than 60%. To help reduce the number of fatal pedestrian accidents, we encourage drivers of vehicles equipped with high-performance headlights to make sure they are using them. If you have previously tried using them but found them uncomfortable, consider testing a newer vehicle, especially one equipped with automatic anti-glare technology. If you still find it challenging to use, please engage the high beam manually when appropriate.

AEB relies on a camera as a sensor, but similar to the human eye, it can struggle to detect pedestrians outside the range of low beam illumination accurately. When driving with only low beam headlights, detection is limited. In contrast, if high-performance headlights—particularly those with automatic anti-glare features—are always activated, AEB can identify pedestrians earlier. This can significantly reduce the risk of accidents through a synergistic effect. For this reason, we advocate for vehicles equipped with AEB to utilize high-performance headlights. We hope that future vehicles will see enhanced reliability in these headlights, allowing them to be used at all times. Until such advancements are achieved, we encourage drivers to adopt a calm, relaxed attitude. If you notice a pedestrian or bicycle approaching at night, please slow down and switch to low beam headlights.

(Shinta Arai)

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2) ITARDA website, 26th Presentation Session for Traffic Accident Investigations, Analysis, and Research 2023, "Fatal Accidents involving four-wheeled vehicles and pedestrians and high-performance headlights," Figure 4, "Distributed materials on the day," p. 13 https://www.itarda.or.jp/presentation/26
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5) “Download materials” on the same website: https://www.nasva.go.jp/mamoru/download/car_download.html “List of Safety Equipment Equipping Statuses (as of the end of December 2023)” in the middle section.

●Itarda Information Inquiries
●For inquiries regarding the contents of ITARDA Information: Public Relations Section TEL 03-5577-3973; EMAIL: koho@itarda.or.jp
●For changing the delivery address and the number of copies of ITARDA Information: Ad Assist Co., Ltd. Email nakamura@ad-assist.bis

Institute for Traffic Accident Research and Data Analysis

●URL https://www.itarda.or.jp/

ITARDA Tokyo Office
Sumitomo Suidobashi Bldg.,
2-7-8 Kandasarugakucho, Chiyodaku, Tokyo 101-0064, Japan
Phone:+81-3-5577-3977 Fax:+81-3-5577-3980

Tsukuba Traffic Accident Investigation Office
c/o Japan Automobile Research Institute, Inc.
641-1 Nishi Ohashi, Tsukuba, Ibaraki 305-0831, Japan
Phone:+81-29-855-9021 Fax:+81-29-855-9131

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2-7-8 Kandasarugakucho, Chiyodaku, Tokyo 101-0064, Japan