Characteristics of and countermeasures to fatal accidents caused by later-stage elderly people driving kei-passenger cars

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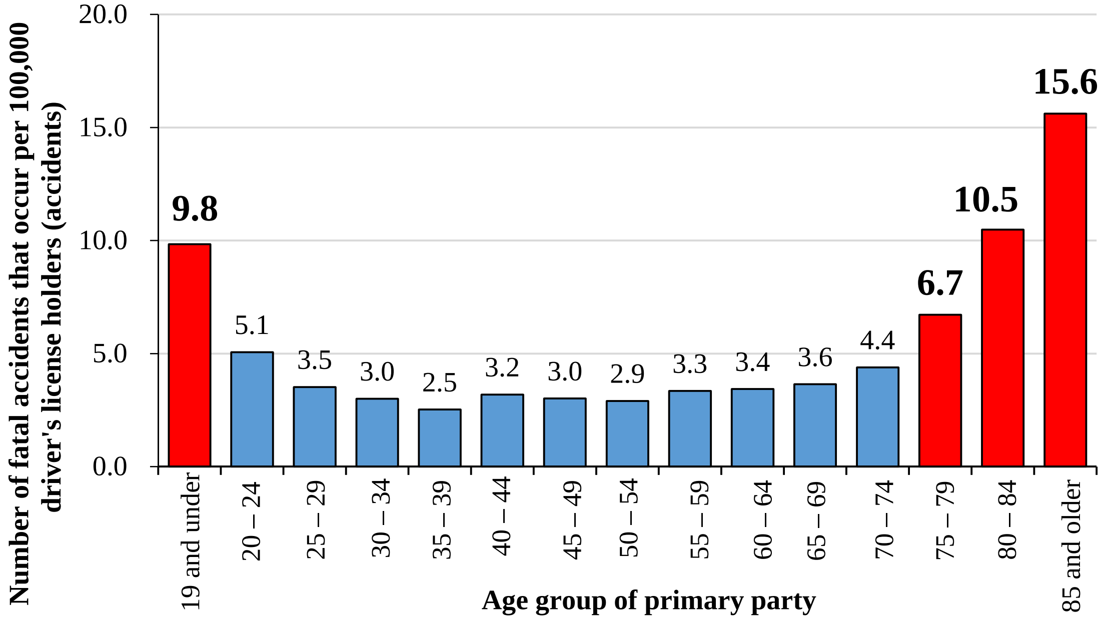
Overview

There has been a rise in the number of elderly people driving kei-passenger cars (small-sized passenger cars in Japan) in recent years due to the fact that they are highly economical and convenient. This has resulted in the number of fatal accidents caused by later-stage elderly (elderly people age 75 or older) driving kei-passenger cars increasing by approximately 2.3-fold over the ten-year period from 2007 to 2016. The share accounted for by such accidents out of the total number of fatal accidents caused by later-stage elderly driving four-wheel vehicles has risen to the point where it is roughly equal to that for medium-sized passenger cars.

Therefore, this study will focus on later-stage elderly driving kei-passenger cars to perform a comparative analysis with medium-sized passenger cars. Through this, it will clarify the characteristic format of fatal accidents while also offering recommendations on effective countermeasures for preventing such accidents via an analysis of their actual conditions.

1. Background and goals

Fig. 1 shows a graph whereby the number of fatal accidents in which the primary party was the driver of a passenger car or truck in 2016 has been converted to a base of 100,000 license holders by age group. This is a technique that is commonly used in order to show the tendencies of drivers of different age groups to cause fatal accidents. However, this does not take into consideration factors like the license holder’s driving frequency or distance travelled, so it must be kept in mind that this does not necessarily represent the fatal accident rate per volume of traffic on actual roads. Looking at this reveals a U-shape, with high rates among young people age 19 and under and later-stage elderly age 75 and over, with the figures increasing the older people get. Conversely, it can be noted that early-stage elderly between the ages of 65 and 74, while also classified as elderly, are not significantly different from the other age groups in terms of their number of such accidents. Looking at this graph reveals that young people and later-stage elderly have a particularly pronounced tendency to cause fatal accidents, which is a phenomenon that merits close scrutiny.



(Passenger cars + trucks, 2016)

Fig. 1. Number of fatal accidents by age group of the primary party driver (2016)

Next, the rise or fall in the number of fatal accidents will be shown for each age group. Fig. 2 is a graph showing the trend over the past ten-year period from 2007 to 2016 regarding the number of fatal accidents where the primary party was the driver of a passenger car or truck. Here, the reader should focus on the fact that while the number of fatal accidents among nearly every age group (including the young) is dropping, only among the later-stage elderly has this risen from 316 to 395 accidents. As a result, the composition rate of accidents accounted for by the later-stage elderly has risen from 7.0% to 13.5%, nearly doubling over the past ten years. This is presumably significantly impacted by the rise in the population of later-stage elderly drivers. Since the population of later-stage elderly drivers is projected to rise in the future, it will be extremely important that countermeasures against fatal accidents by these drivers be taken in order to continue reducing the overall number of fatal accidents still further.

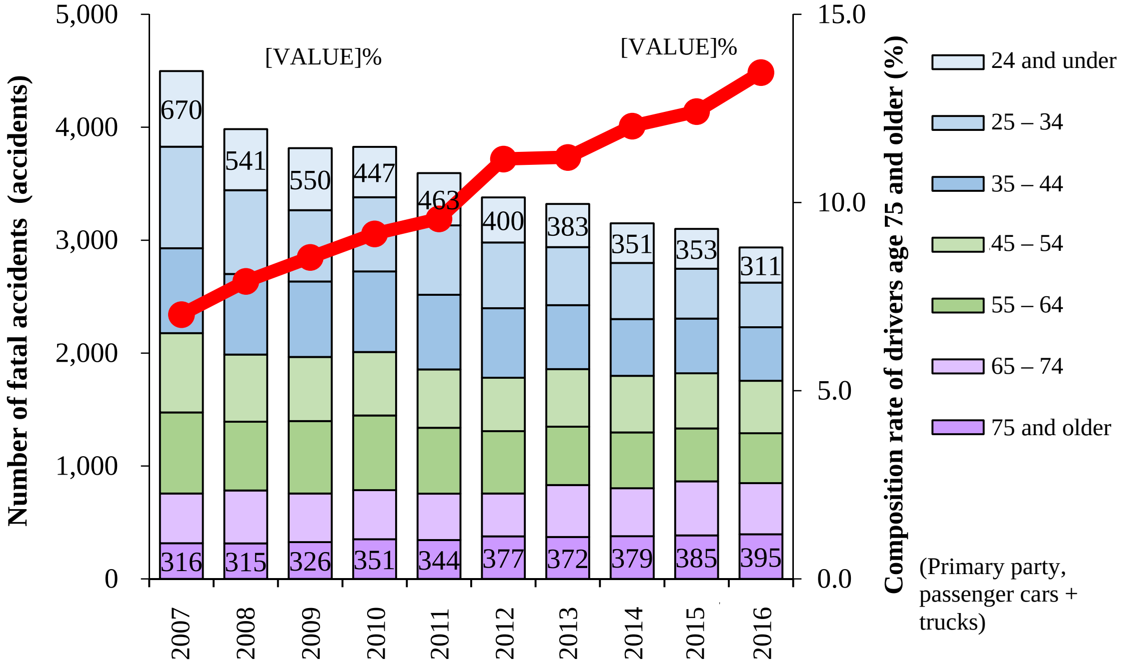


Fig. 2. Number of fatal accidents by age group of the primary party driver (2016)

Next, the trends in the number of fatal accidents will be shown by focusing on the vehicle type to indicate what later-stage elderly were driving when they caused a fatal accident. Fig. 3 is a graph that indicates the trends over the past ten-year period from 2007 to 2016 regarding the number of fatal accidents in which a later-stage elderly driver was the primary party by vehicle type. Apparently, there has been a substantial increase in just the number of fatal accidents involving kei-passenger cars, which rose by approximately 2.3-fold over this ten-year period. The number involving medium-sized passenger cars and kei-trucks (small-sized trucks in Japan) have held largely steady, and so as a result the share of accidents accounted for by kei-passenger cars has increased. In recent years the shares from medium-sized passenger cars and kei-trucks have been largely identical. The reason for this is not because kei-passenger cars have suddenly become more dangerous, but rather because the number of later-stage elderly people driving kei-passenger cars has increased. In other words, this can be thought of as having come about due to an increase in this parameter.

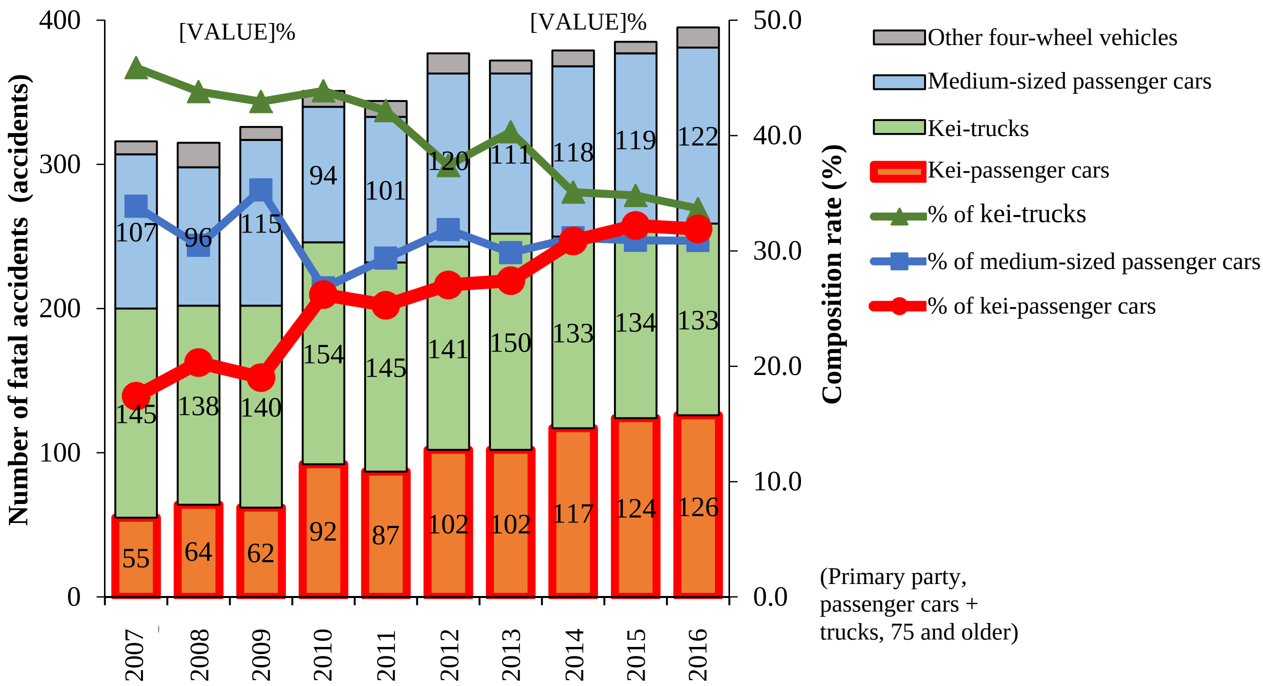


Fig. 3. Trends in the number of fatal accidents for later-stage elderly as the primary party by vehicle type

Data that suggests this will be introduced here. Fig. 4 shows the trend in the number of owners of four-wheel vehicles over the past ten years from 2007 to 2016.[1)] Whereas there has been a slight decrease in the number of medium-sized passenger cars and kei-trucks over the past ten years, the number of kei-passenger cars alone has risen by roughly 1.4-fold. There are a number of conceivable reasons backing this, such as kei-passenger cars' inexpensive maintenance costs and excellent maneuverability, while it is also believed to have come about as a result of car manufacturers releasing superior products. Fig. 5 shows the composition by age group for kei-passenger car drivers for the years 2007 and 2015.[2)] Apparently, the proportion accounted for by people in their 70s or older has increased, with the average age also shifting upwards from 46 to 53 years old. Based on this data we can see that the number of owners of kei-passenger cars is increasing in and of itself, and that in addition the proportion of later-stage elderly drivers within this is also increasing. As a result, the number of later-stage elderly driving kei-passenger cars is rising at a rapid pace. Calculating the number of kei-passenger cars being driven by elderly people to the extent that this can be inferred from this data yields the following results. In 2007 people in their 70s and older owned 7% of the 15.93 million kei-passenger cars owned, while in 2015 they owned 12% of the total of 21.85 million. This means that the number of kei-passenger cars owned by people in their 70s and older rose from 1.12 million vehicles in 2007 to 2.62 million vehicles in 2015. This corresponds to an increase of approximately 2.3-fold over ten years, which is largely consistent with the pace at which the number of fatal accidents involving kei-passenger cars driven by later-stage elderly is rising. It is predicted that in the future this will increase at a greater pace than ever before as people in their 60s, a group that includes the baby boom generation, continue aging.

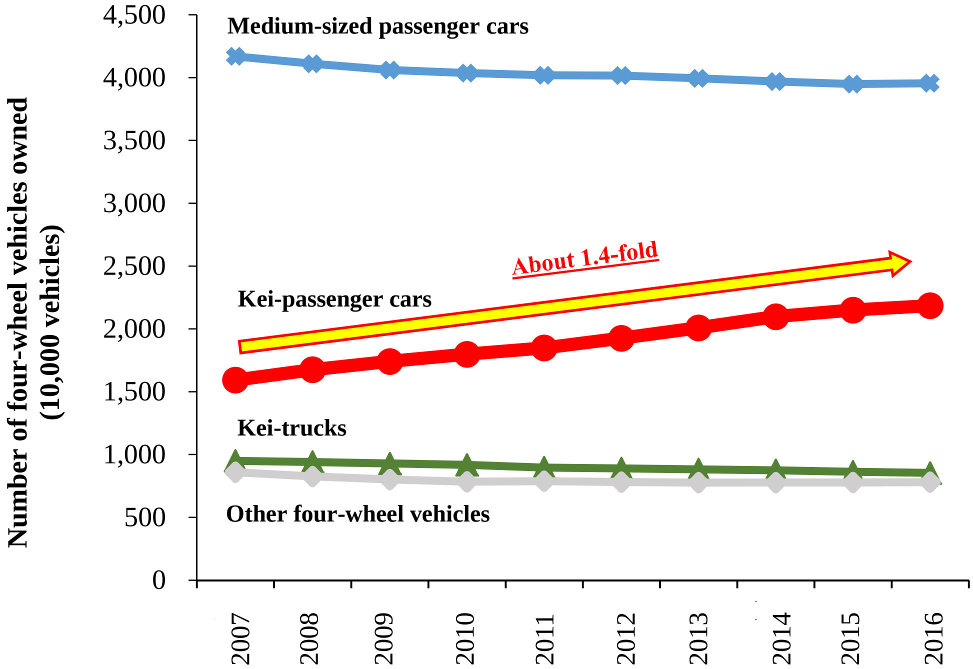


Fig. 4. Trends in the number of owners of four-wheel vehicles

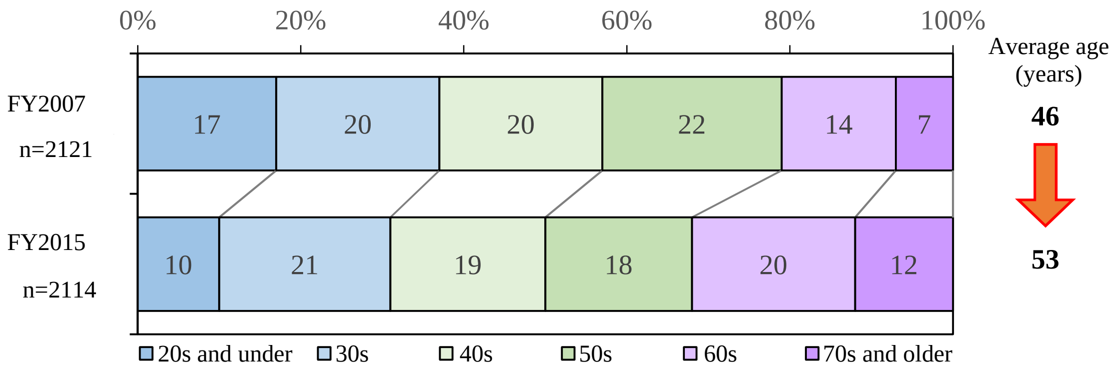


Fig. 5. Changes in kei-passenger car drivers by age group

Given this background, it is possible that the number of fatal accidents caused by later-stage elderly driving kei-passenger cars will rise even more. Therefore, it will be difficult to further reduce the number of fatal accidents unless countermeasures tailored to the characteristics of said accidents are taken.

Therefore, this study will clarify the characteristic format of fatal accidents among elderly drivers of kei-passenger cars and analyze their details in order to offer recommendations on the countermeasures required for reducing the number of fatal accidents in the future.

2. Analysis of the characteristic format of fatal accidents among later-stage elderly driving kei-passenger cars

(1) Characteristics of fatal accidents by later-stage elderly driving kei-passenger cars by type of accident

Fig. 6 shows the composition rate of fatal accidents by type of accident for each type of primary party. The horizontal axis shows the number of accidents by each respective primary party driver type, while the bar graphs show the ratio of each type of accident in a color-coded manner. First off, this graph reveals characteristics of accidents by later-stage elderly by comparing later-stage elderly with all of the age groups when driving the same vehicle type. Compared with all of the age groups, later-stage elderly people are characterized by having a lower share of fatal pedestrian-vehicle accidents regardless of the type of vehicle, but a higher share of fatal accidents from head-on collisions and collisions with roadside structures. The reason behind this is believed to be because later-stage elderly themselves are more prone to dying when accidents occur due to their reduced impact tolerance, with this becoming more pronounced with accidents where the damage to the driver is particularly severe. Next, when we compare later-stage elderly driving kei-passenger cars with those driving medium-sized passenger cars, a number of characteristics become apparent. These include the high percentage of head-on collisions with kei-passenger cars, while at the same time there is virtually no change in the share of collisions with roadside structures and the share of pedestrian-vehicle accidents is low. In terms of the underlying reason for why these sorts of differences arise, it is possible that this is impacted by differences in vehicle structure and the drivers' driving style. But the precise reason for this is unclear, and further detailed analysis is needed on this. When we compare the total number of casualty accidents in the same manner, we see that there is virtually no change in the share of head-on collisions owing to the vehicle type. Therefore, it is not the case that later-stage elderly driving kei-passenger cars are particularly prone to causing head-on collisions, but rather when they do cause a head-on collision it is highly likely to result in a fatal accident. Moving forward, further analysis will be performed on characteristic fatal head-on collision accidents involving kei-passenger cars driven by later-stage elderly.

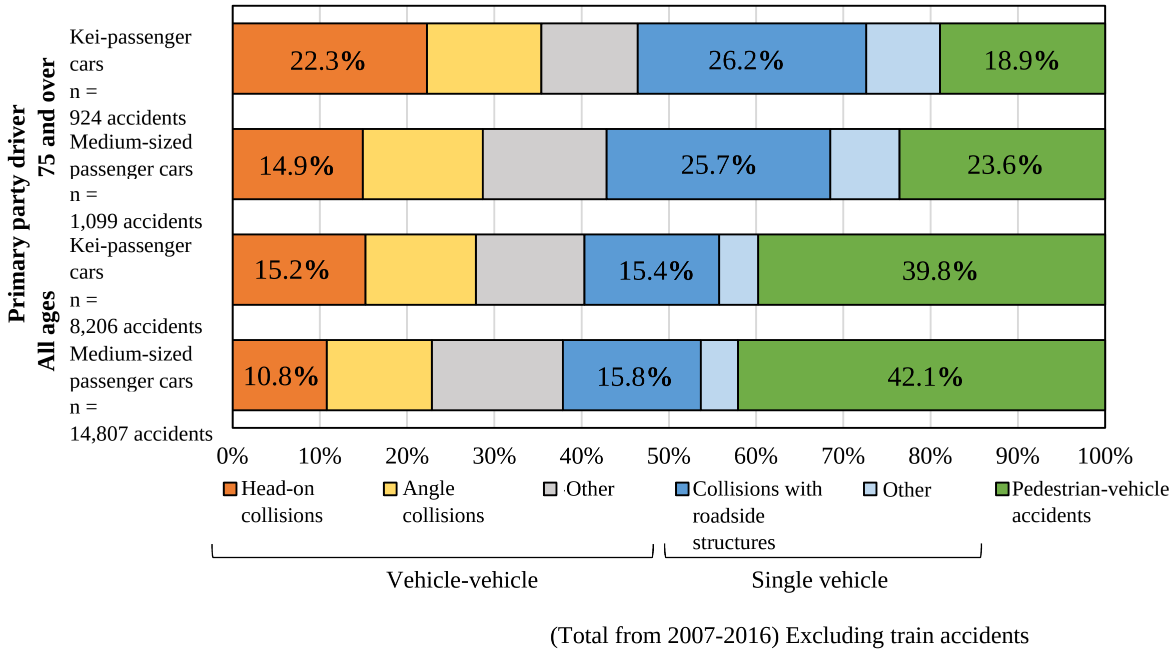
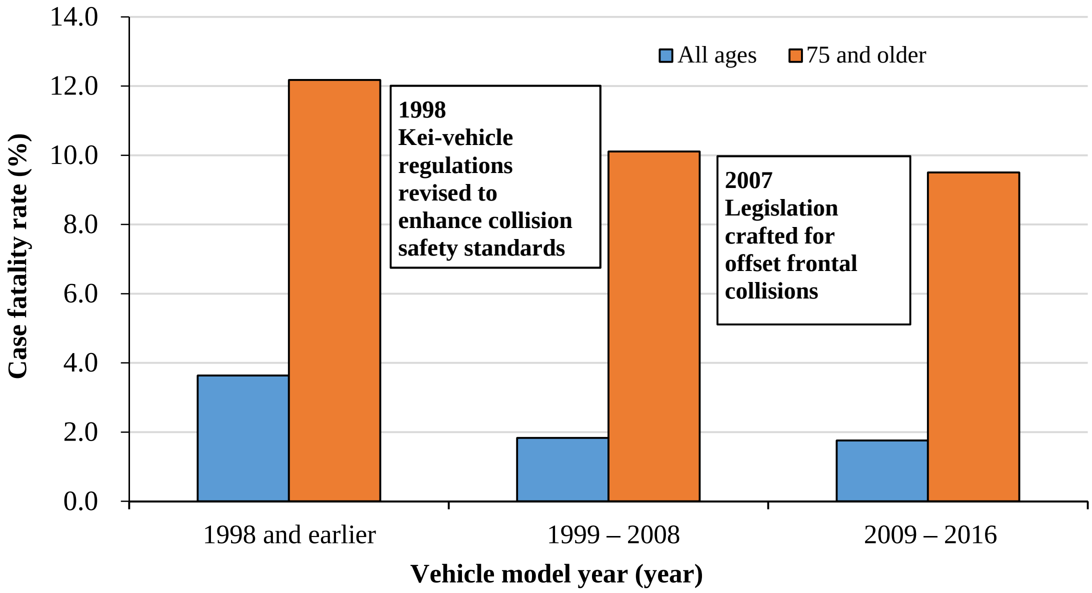


Fig. 6. Composition rate of fatal accidents by type of accident and type of primary party

(2) Case fatality rates for head-on collisions by model year of kei-passenger cars

To offer a glimpse of the changes in collision safety for kei-passenger cars during head-on collisions, Fig. 7 shows the case fatality rates for drivers as viewed by different kei-passenger car model years for head-on collisions. Here, the case fatality rate will be defined as the ratio of the number of fatalities to the number of casualties out of the total number of drivers who got into an accident. The bar graphs each show the case fatality rates for all ages and for people age 75 and older, with the horizontal axis showing the vehicle model year. This has been divided up into three periods: 1998 and earlier, 1999 – 2008, and 2009 – 2016. In general, the case fatality rate tends to be lower the newer the model year becomes. A variety of different measures have been taken to bolster the collision safety performance of kei-passenger cars, such as enhancing their collision safety standards via regulatory revisions and crafting legislation for offset frontal collisions. Therefore, it can be surmised that the results of these are surfacing. Yet the case fatality rate remains higher among later-stage elderly compared with that for all ages. The hope is that further improvements will be made when it comes to collision safety. But it will still be no easy feat to protect later-stage elderly, who have relatively low impact tolerance when accidents do occur. Therefore, it will become increasingly important to enhance preventative safety measures for preventing collisions in the future.



* Case fatality rate = No. of fatalities ÷ No. of casualties ×100%

(Primary + secondary parties, wearing seatbelt, total from 2007-2016)

Fig. 7. Case fatality rates by vehicle model year for kei-passenger car drivers (head-on collisions)

(3) Analysis of the actual conditions of fatal head-on collision accidents caused by later-stage elderly driving kei-passenger cars

In this section, analyses will be performed on when, where, and why later-stage elderly driving kei-passenger cars caused fatal head-on collision accidents in the interest of prevention and safety. For the analyses, the total figures for the number of fatal accidents over the past ten years was used in which the primary party was a kei-passenger car driver aged 75 and older and drivers of the same in all ages for purposes of comparison, as well as drivers of a medium-sized passenger car age 75 and older and drivers of the same in all ages, with a four-wheel vehicle as the secondary party.

[1] When do fatal head-on collision accidents occur?

Fig. 8 shows the composition rate of fatal head-on collision accidents by time period. When you compare accidents between two drivers age 75 and older and between two drivers of all ages, there is virtually no difference in the trends for any of these based on the type of vehicle. Conversely, when drivers age 75 and older are compared with drivers of all ages their trends diverge, with those age 75 and older getting into an extremely large number of accidents in the daytime and a small number in the early morning and at night compared with all of the age groups. The reason for this is because with drivers of all ages there is variance in the time periods in which accidents occur as a result of people commuting to and from school and work in the morning and evening, as well as driving at night. As opposed to this, it is conjectured that later-stage elderly people have few opportunities to go out by car in the early morning and at night, with their driving concentrated in the daytime. This is not limited to just head-on collisions, but is a trend that is noted with accidents in general caused by later-stage elderly drivers.

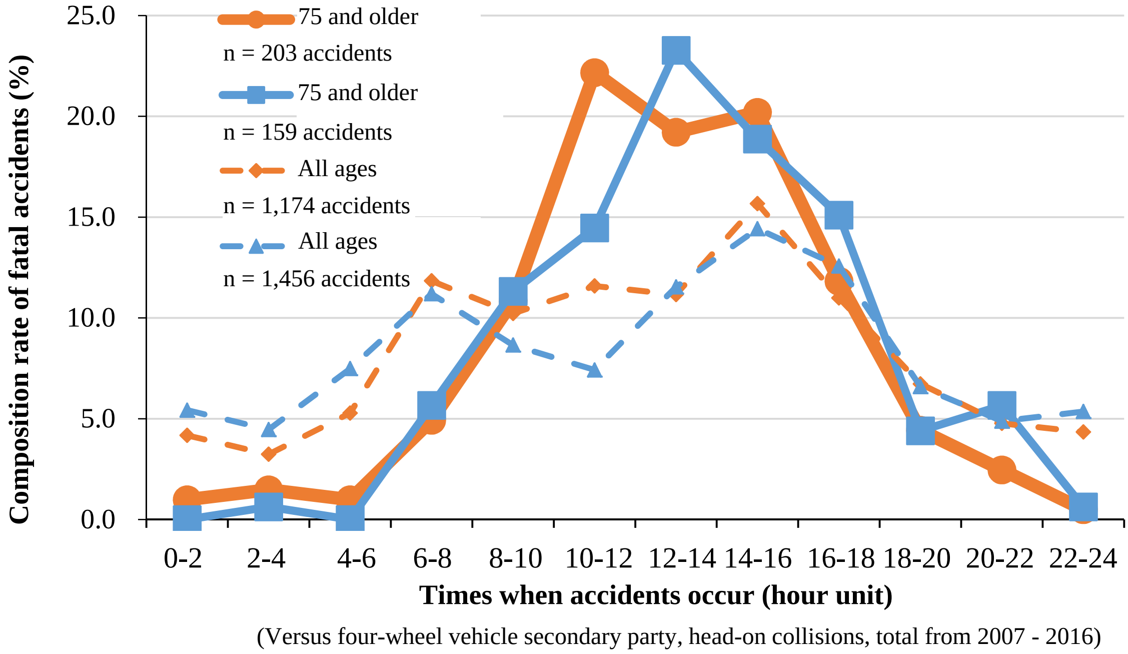


Fig. 8. Composition rate of fatal accidents by time period (head-on collisions)

[2] Where do fatal head-on collision accidents occur?

Next, the types of locations where fatal head-on collision accidents occurred will be analyzed. Fig. 9 shows the composition rate of fatal head-on collision accidents by topography. There are virtually no differences in the trends shown in the graph by type of vehicle or age, but it does show that nearly 80% occur in non-urban areas where there are few homes and structures. There are some cases where differences arise by topography based on the type of accident, but since there is no difference with this for head-on collisions it is possible that these occur in similar sorts of locations for all drivers. Fig. 10 shows the composition rate of fatal head-on collision accidents based on the collision site. Collision sites have been divided up into those occurring within the oncoming traffic lane and other, with “other” here taken to include those in Lane 1, at intersections, in parking lots, and so on. There are virtually no differences in the trends shown in the graph by type of vehicle or age, but it does show that more than 70% of the collisions took place in the oncoming traffic lane. Since collisions in the oncoming traffic lane can only occur if a driver goes over the center line, these presumably must have all involved a driver deviating from their lane. Moreover, viewing a breakdown of this by road alignment within the oncoming traffic lane ultimately showed that a slightly larger number occurred along curved road sections for all drivers. Therefore, the typical head-on collision could be said to be a case in which there is a collision with an oncoming vehicle resulting from a driver deviating from their lane at a curved road section.

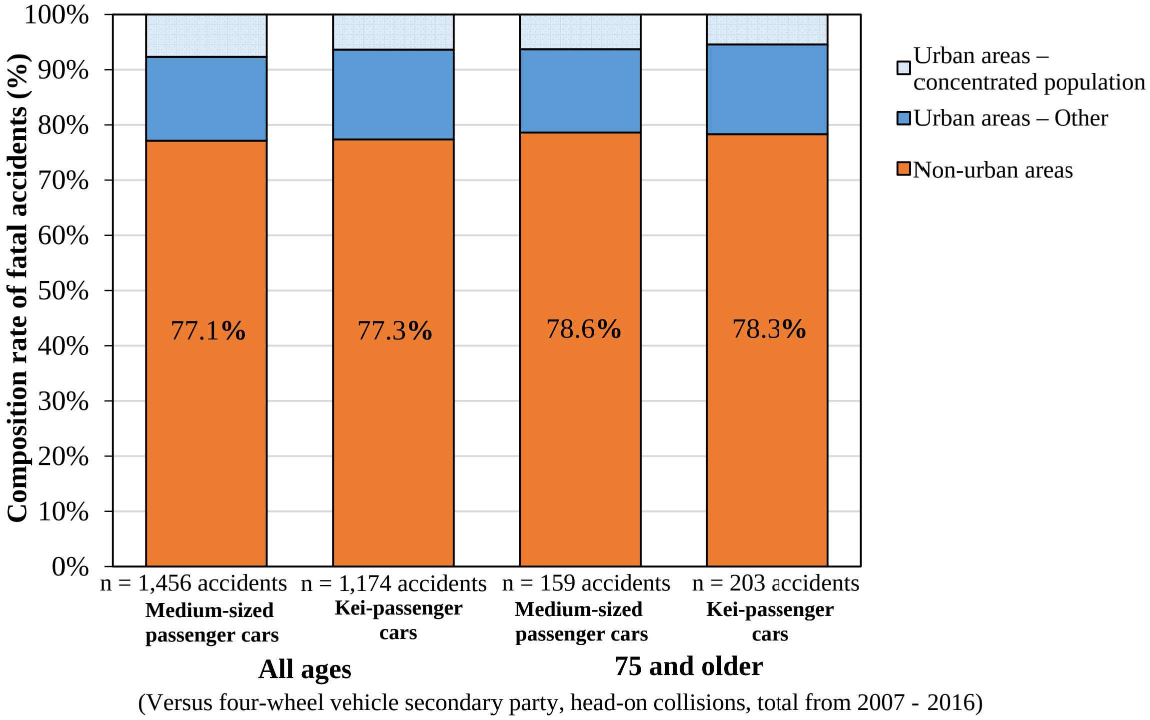


Fig. 9. Composition rate of fatal accidents by topography (head-on collisions)

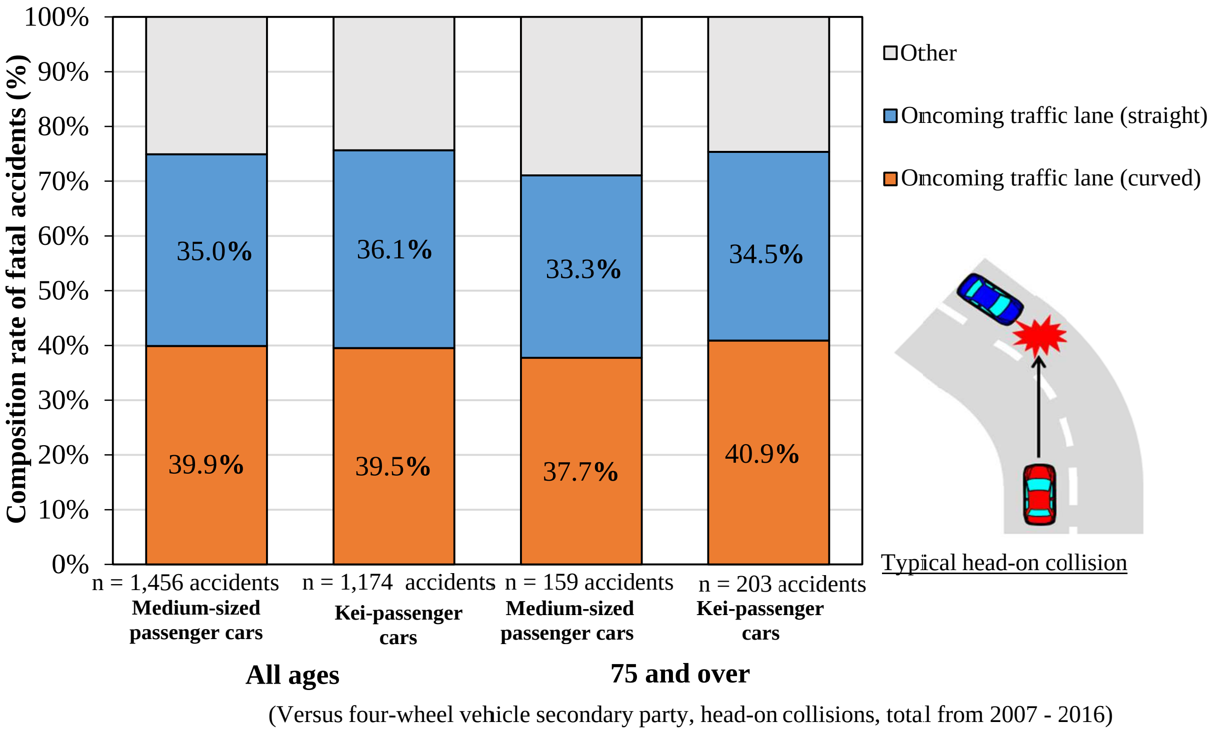


Fig. 10. Composition rate of fatal accidents by collision site (head-on collisions)

Next, the sorts of roadways on which fatal head-on collision accidents occurred will be indicated. Fig. 11 indicates the composition rate of fatal head-on collision accidents involving a kei-passenger car where the primary party is a driver age 75 or older by road width and route type. Apparently, such accidents are concentrated on non-intersection roads between 5.5m and 9m, as well as main roadways such as national highways and principal local roads (but excluding expressways). Moreover, when road width / size and the trends with collision sites mentioned above are taken into consideration, then presumably the majority of these accidents occurred along general roadways with single-lane in one direction. What is not shown here, however, is that since similar tendencies are seen with other drivers this is considered to be a characteristic of head-on collision accidents in general.

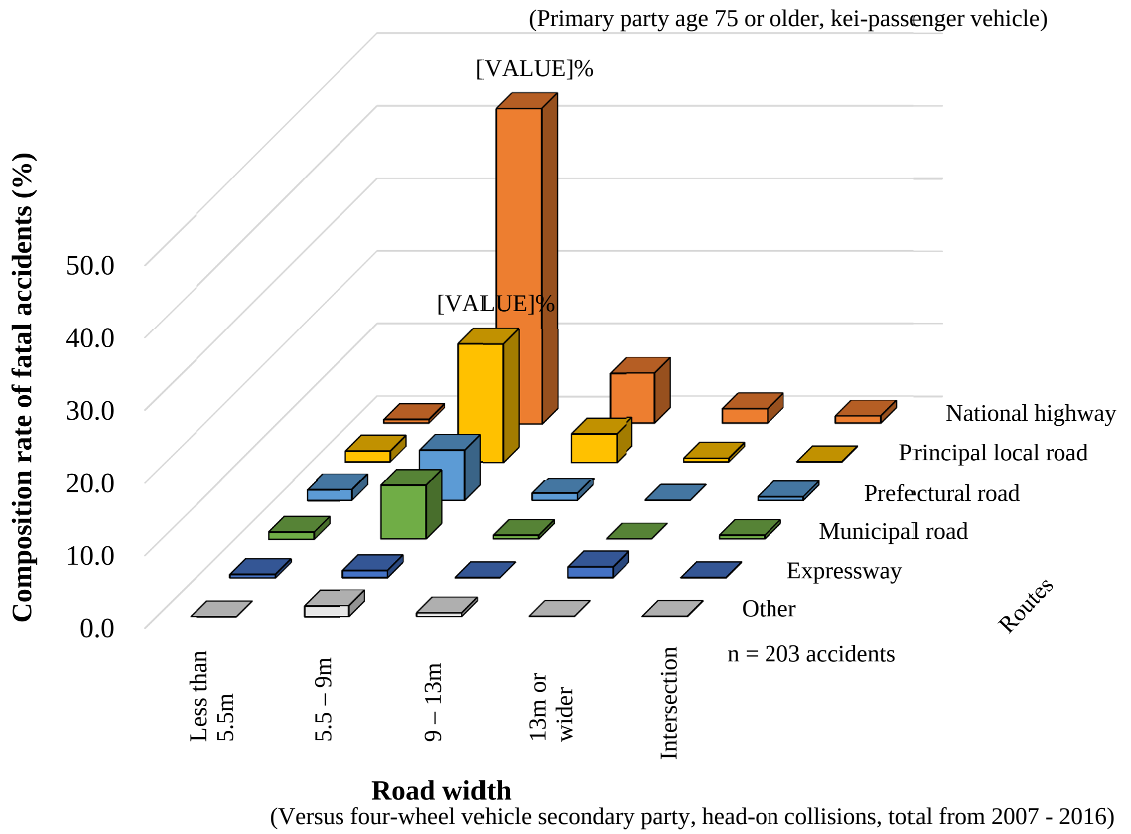


Fig. 11. Composition rate of fatal accidents by road width × route type (head-on collisions)

[3] Why do fatal head-on collision accidents occur?

Next, the causes behind the occurrence of fatal head-on collision accidents will be analyzed from the perspective of human factors. Fig. 12 shows the composition rate of fatal head-on collision accidents by human factor. According to the graph, steering error accounts for roughly 20%, judgement errors account for roughly 15%, and failure to pay attention forward (which includes distracted driving, adjusting radio / chatting, dozing off, being lost in thought, etc.), account for about 50%. At the same time, the breakdown for the failure to pay attention forward category varies by driver. The tendency observed with drivers age 75 and older over all ages, as well as with those in kei-passenger cars more so than those in medium-sized passenger cars, was for a lower proportion of drivers dozing off while driving and a higher proportion that engaged in aimless driving, such as by getting lost in thought. This is nothing more than conjecture, but this could conceivably be because later-stage elderly driving kei-passenger cars in particular have frequent occasion to drive down roads they are used to traveling down for relatively short periods of time, so while they do not reach the point of dozing off they do tend to engage in absentminded driving.

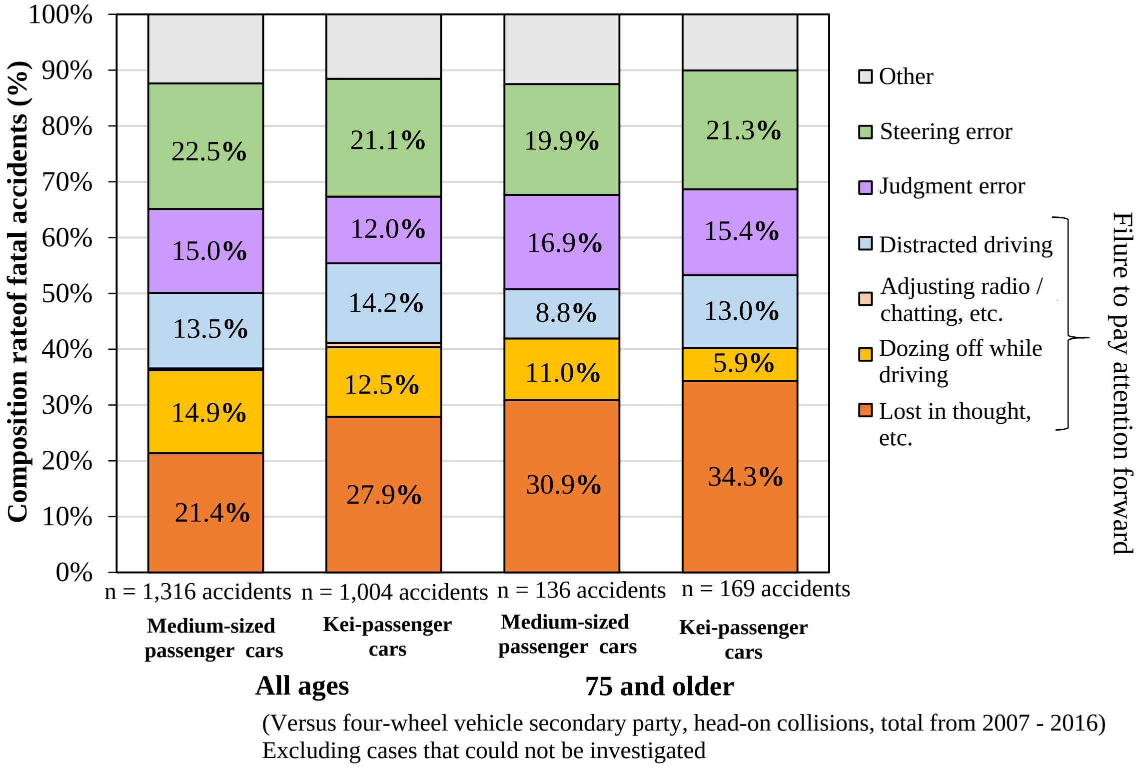


Fig. 12. Composition rate of fatal accidents by road width × route type (head-on collisions)

[4] Summary of the analyses of actual conditions

Based on the results of the analyses thus far, we have learned that a high percentage of fatal head-on collision accidents are characterized by involving a later-stage elderly driver driving a kei-passenger car. However, looking at the largest number of cases of when accidents occur indicates that while characteristic differences for later-stage elderly can be seen based on the time period, there is no noticeable difference between them and others in terms of where accidents occur, their collision site, or their cause. As such, it appears that any driver can cause a fatal head-on collision accident in similar sorts of settings. Therefore, the assumption is that satisfactory results with reducing accidents can be expected by further enhancing commonly-envisaged preventative measures for head-on collision accidents.

3. Considering examples of precautionary measures for head-on collisions

[1] Examples of infrastructure-based precautionary measures for head-on collisions

Based on the analytical results, the effectiveness of a number of general preventative measures for head-on collision accidents will be considered. To start with, examples of infrastructure-based countermeasures to these will be shown. Fig. 13 shows an example of a high visibility road marking. Since these road markings contain intermittent protrusions, they are believed to be effective at preventing drivers from deviating from their lane due to failure to pay attention forward by producing a noise or vibration when tires pass over them. These road markings were originally developed with the goal of improving visibility at night and during rainy weather by using glass beads within the paint film itself to set up protrusions so that they are not submerged when it rains. For this reason, such road markings are described as "high visibility." On the other hand, Fig. 14 shows a center line that is called a rumble strip.[3)] The aim with these is to effectively prevent drivers from deviating from their lane in a similar manner through the installation of indents in the road rather than protrusions. Having protrusions like those in Fig. 13 presents an obstacle for snow removal, and so these have primarily been adopted mainly in regions that experience snowfall. Soundly installing and managing these sorts of center lines will serve as an important countermeasure against accidents, particularly for major roadways with single-lane in one direction in non-urban areas.

Fig. 13. A high visibility road marking

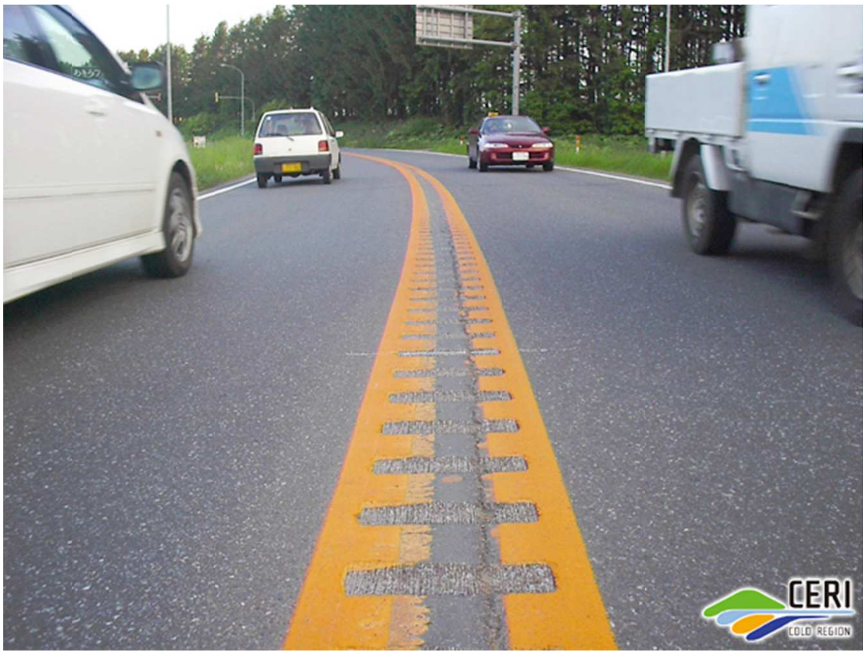


Fig. 14. A rumble strip

[2] Examples of vehicle-based preventative measures for head-on collision accidents

Next, vehicle-based preventative measures for head-on collision accidents will be shown. Fig. 15 is an image of a lane-deviation warning system. These are systems that mainly use cameras mounted on the vehicle to detect lanes and issue a warning when it looks like the vehicle is about to deviate from its lane. According to a survey on the dissemination status of Advanced Safety Vehicle Technology, in 2015 such systems were equipped on approximately 18% of new vehicles,[4)] showing that they are gradually becoming more widespread. In addition, in recent years systems that not only make a noise but also cause the steering wheel to vibrate at the same time have begun to be practically implemented. Meanwhile, Fig. 16 is an image of a lane-deviation control system. The major difference between these and the warning systems is that these systems will intervene in the steering and braking in order to assist the driver in returning to their original lane. It is surmised that these sorts of systems will be effective at combatting accidents caused by operating errors.

These systems were still only equipped on a small number of vehicle models as of 2017. But in recent years systems that come equipped on compact cars and kei-motor vehicles have begun to appear, with the expectation being that they will spread still further.

Yet there are cases where both of these systems fail to function normally on account of the conditions, so caution is required. For example, it is known that in cases like when the weather is bad or when the center line is blurry it can make it difficult for the camera to detect this. Moreover, it is envisioned that these sorts of systems will ordinarily operate when travelling at high speeds, and so at times they fail to operate during low-speed travel.

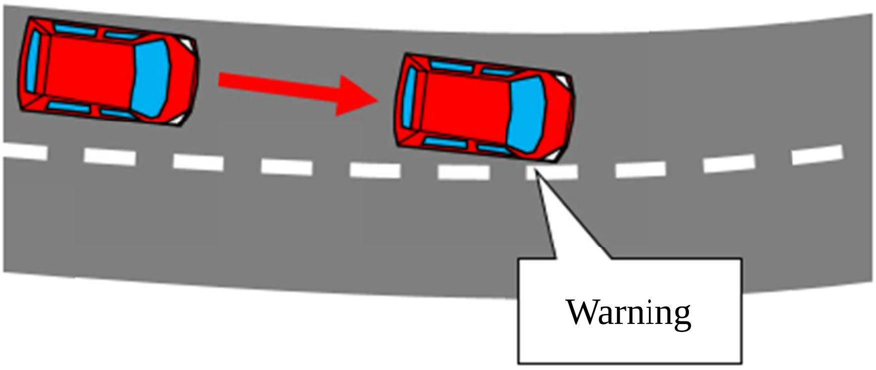


Fig. 15. Image of a lane-deviation warning system

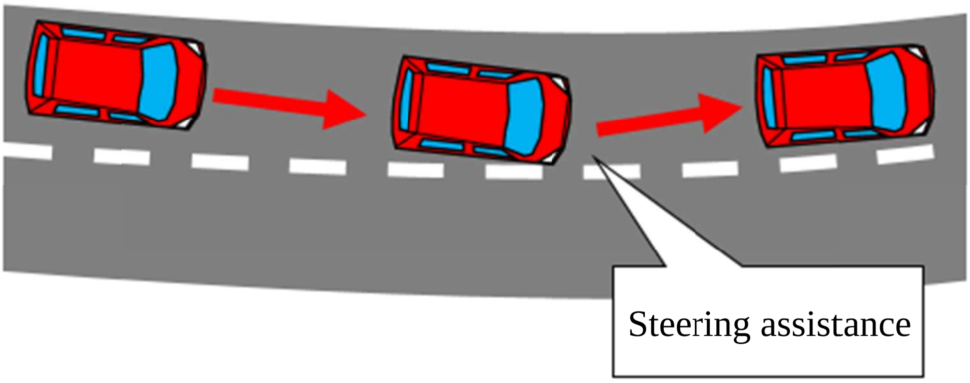


Fig. 16. Image of a lane-deviation control system

[3] Proposed improvements for lane-deviation prevention devices

Described below is a way to improve these lane-deviation prevention devices based on the precautions raised above. Fig. 17 shows the composition rate of fatal accidents by the danger perception speed of the primary party. It reveals that most of these accidents occur at speeds of less than 60km/h, regardless of the vehicle type or driver’s age. For kei-passenger cars driven by drivers age 75 or older in particular, the responses peak in the 40km/h-range at about 43%, followed by the 30km/h-range at about 25%, with these concentrated at moderate to low speeds. For this reason, installing systems that operate not just at high speeds, but at moderate and low speeds of less than 60km/h, in order to prevent head-on collision accidents could potentially reduce an even greater number of fatal accidents.

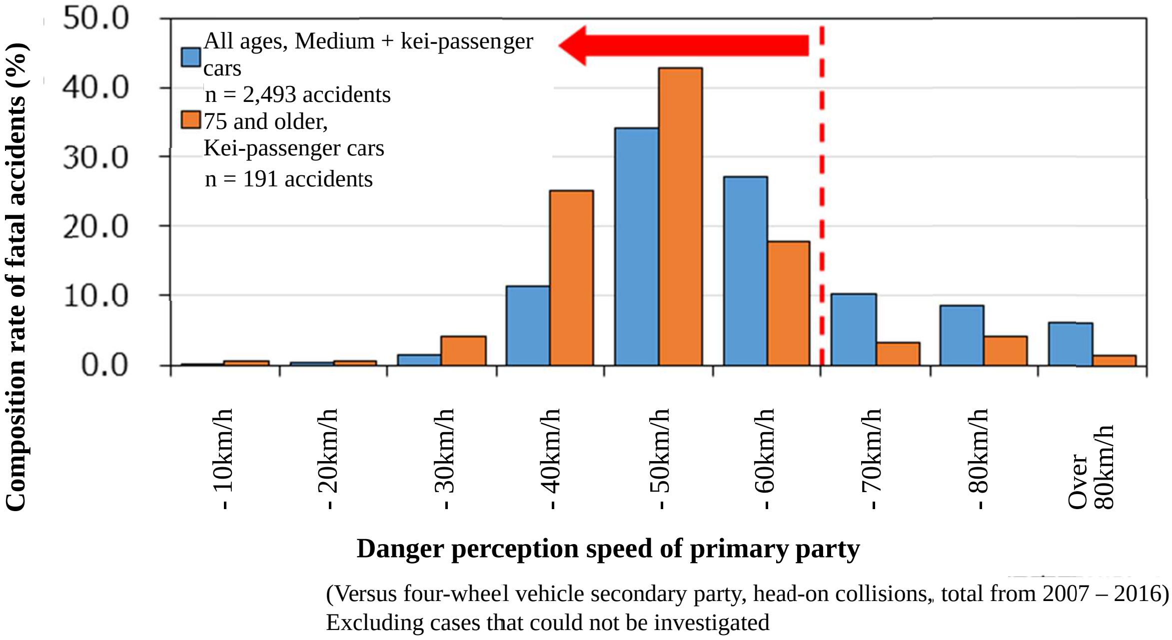


Fig. 17. Composition rate of fatal accidents by danger perception speed of the primary party (head-on collisions)

4. Conclusion

This analysis revealed that countermeasures against head-on collision accidents involving kei-passenger cars, especially preventing deviations from one's lane, are important for the sake of reducing the number of fatal accidents caused by later-stage elderly drivers. The hope is that road administrators will maintain and manage center lines and road shoulders in order to accomplish this. There are two main reasons for this: because having uneven surface conditions will prevent drivers from deviating from their lanes, and because it will boost detection by onboard cameras. For car manufacturers, it is hoped that they will popularize and enhance lane-deviation prevention devices equipped on all of their vehicle models, including kei-passenger cars. It is also hoped that systems that operate even at moderate and low speeds of less than 60km/h will be further enhanced in the future.

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