Analysis of Accidents by Older Drivers in Japan

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Abstract

Since Japan is a rapidly aging society, ensuring the safety of older drivers is a major issue in the future. This study analyzed the number of traffic accidents by age group, and investigated the characteristics of accidents involving older drivers. It was found, for example, that regardless of age, there were more rear-end and front-to-side collisions, although older drivers had fewer rear-end collisions than front-to-side collisions. The cause of this is conjectured to be that older drivers reduce their driving speed. Driver support systems that would be useful for older drivers are systems to provide obstacle information at spots with poor visibility. In addition, since many rear-end collisions also occur, inter-vehicle distance warning devices would also be useful for older drivers.

Keywords: Accident, Older drivers, Support systems, Safety

1. Introduction

The population of Japan is gradually increasing and currently stands at 128 million people [1]. The number of traffic accidents (Fig. 1) is also showing a gradually increasing trend, with the occurrence in 2003 of approximately 948,000 accidents [2]. The number of deaths, however, is decreasing, down from 10,942 people in 1993 to 7,702 people in 2003. Meanwhile the number of injuries is increasing in proportion to the number of accidents, and the number of people injured in traffic accidents in 2003 was 1.18 million. The increasing number of people injured in traffic accidents therefore continues to be a matter for social concern in Japan.

The authors attempted a detailed investigation of the relationship between the occurrence of traffic accidents and drivers' ages. The present study considers 3 representative age groups: 16-24 years (young drivers), 40-49 years (middle-aged drivers), and 65 years or above (older drivers). The reason for starting with the age of 16 is that in Japan this is the youngest age at which people can obtain a motor scooter license (up to 50 cc). The sizes of these age groups in 2003 were 13.54 million people for the young group (10.6% of the entire population), 15.79 million people for the middle-aged group (12.4% of the entire population), and 24.31 million for the older group (19.0% of the entire population).

A look at the number of license holders by age (Fig. 2) shows that while the number of young people with a license is decreasing, the number of license holders in the old age bracket is rising dramatically. In 1993, the number of older license holders was 3.94 million, but by 2003 this had risen 2.2-fold to 8.79 million. The sharp increase in the number of older drivers is expected to continue in the future, and ensuring the safety of their driving is a major issue in Japan.

Next, the incidence of accidents was investigated by age group. Trends in accidents in which the automobile driver is the primary party (described below) are shown in

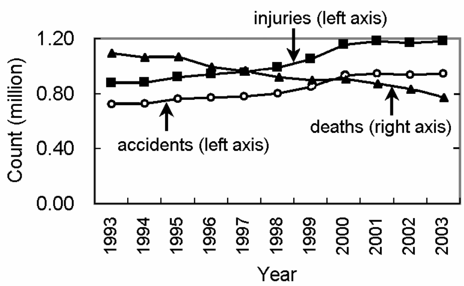

Fig.1 Trends in numbers of traffic accidents, injuries, and deaths

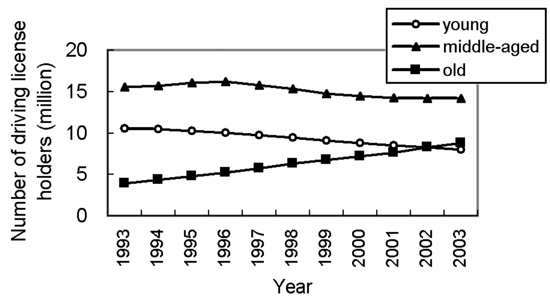

Fig.2 Trends in the number of driving license holders by age group

Fig. 3 by age group. Here, "primary party" is defined as a person having caused the most culpable failure or the least injured among parties concerned when their culpable failures are at the same level. "Vehicle" refers to passenger cars, trucks and special vehicles, not including the 2-wheeled vehicles.

While the number of accidents involving young drivers is decreasing, the number involving older drivers increased 3.1-fold from 26,663 in 1993 to 81,890 in 2003. Ensuring the safety of older drivers is

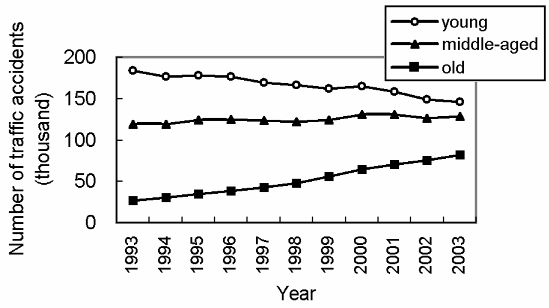

Fig.3 Trends by age group in the number of traffic accidents in which the primary party is the driver

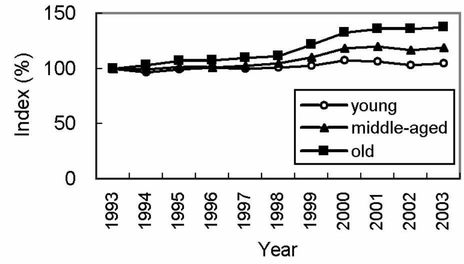

Fig.5 Changes in the number of traffic accidents per 100,000 driving license holders in each group when the primary party is the driver (1993 figures are taken to be 100.)

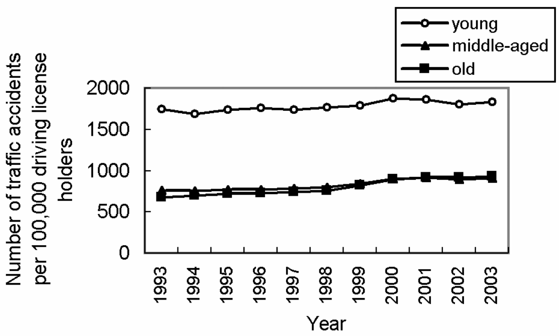

Fig.4 Number of traffic accidents per 100,000 driving license holders in each age group when the primary party is the driver

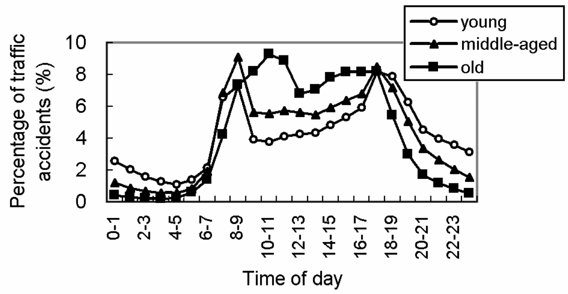

Fig.6 Percentages of the number of traffic accidents by time of day

considered to be important not only because of the increasing number of older drivers but also because of the increasing number of accidents involving these drivers.

However, a look only at the number of traffic accidents does not take into consideration the number of license holders by age bracket. It may be that an increasing number of traffic accidents is the inevitable result of a greater number of license holders. To clarify this point, the authors investigated the number of traffic accidents per 100,000 license holders for each age group (Fig. 4). Accidents examined were those in which the driver of the vehicle was the primary party. The number of accidents among young drivers was seen to be high. Although the number of accidents by older drivers is not high, it is increasing. Figure 5 shows the percentage change in the number of accidents, with the figures from 1993 taken to be 100 as an indicator. The increase in the accident rate for older drivers is particularly striking. Considering this in addition to the above, one may predict that ensuring the safety of older drivers is a problem that will have to be faced in the future.

Various commercial systems have been developed recently to support drivers, including adaptive cruise control systems, lane keeping assistant systems, vehicle stability control systems, adaptive front-lighting systems, and vision enhancement systems. For these systems to have a beneficial effect, they must be easy for drivers to adopt. Older drivers in particular may need to change their conception of driving, so support systems that actually serve to make driving more confusing for these drivers are not suitable.

The purpose of this study was to clarify the accident situation of older drivers, and based on the results to indicate the kind of support systems that would be beneficial to older drivers.

2. Analysis Results for Each Item

2.1 Analysis Methods

To clarify the accident situation involving older drivers, the number of accidents that occurred nationwide in Japan over the 3 years of 2001-2003 was analyzed.

Accidents involving older people include those involving elderly pedestrians, but since this study considers driver support systems, only accidents in which the primary party was an older driver were included.

The total number of accidents nationwide in Japan for the 3 years in which the primary party was a driver was 2,504,231. Of this number, we conducted an analysis and investigation by age bracket for 3 groups: young (16-24 years), middle-aged (40-49 years), and old (65 or more years). The number of accidents in the 3 years studied was 453,653 for the younger drivers, 385,923 for the middle-aged drivers, and 228,171 for the older drivers. The data used in these tabulations were from the Institute for Traffic Accident Research and Data Analysis (ITARDA).

2.2 Accidents by Time of Day

Figure 6 shows the proportions by time of day of the number of accidents for each age group. The percentages shown here are the number of accidents in each time period divided by the total number of accidents for each age group. Older drivers had a higher rate of accidents in the daytime, with fewer in the night hours. The reason for this is thought to be that older drivers tend not to drive at night rather than that they are less likely to cause accidents at night.

2.3 Alcohol and Driving

An investigation of drinking and driving revealed the following. The proportion of "drunk driving" incidents by day and night for each age group is shown in Fig. 7. The proportion here is the number of accidents from drunk driving in day and night divided by the total number of accidents for each age group. Daytime here means the time from sunrise until sunset. The results show a low rate of drunk driving accidents by elderly at night. This is presumed to be because older drivers do not drive much at night. These statistics indicate that drunk driving by older drivers is not a major problem.

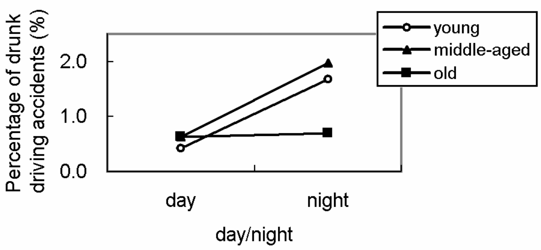

Fig.7 Percentages for day and night of number of drunk driving accidents

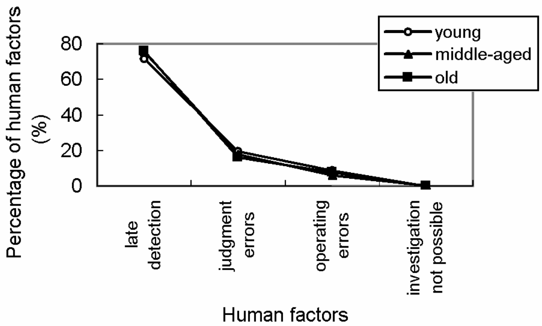

Fig.8 Percentage of traffic accidents related to human factors

2.4 Human Factors

Following are human factors that affect driving.

(1) Late detection
(2) Judgment errors
(3) Operating errors

The proportions of these factors were investigated and the results are shown in Fig. 8. Here, the proportion is the number caused by each human factor divided by the total number of accidents for each age group. Overall, it was found that no difference was recognized between all age groups and more accidents tend to be caused by late detection. Systems that assist drivers in earlier detection would therefore be beneficial.

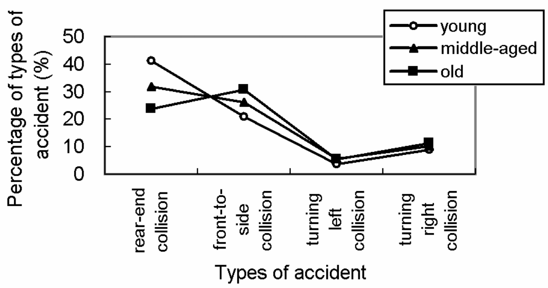

Fig.9 Percentage of traffic accidents by type of accident (4 most common types of accident)

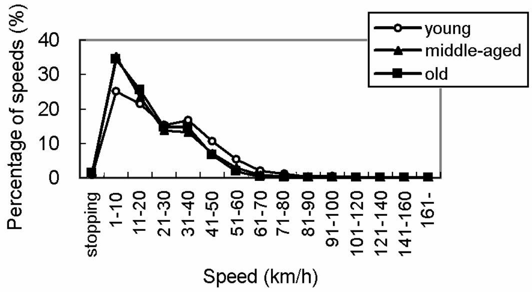

Fig.10 Comparison of hazard awareness speed by age group

2.5 Type of Accident

Among types of accident, four occurred with higher frequencies: front-to-side collisions, rear-end collisions, collisions when turning right, and collisions when turning left. The percentages of these are shown in Fig. 9. The percentages here are the number of the respective type of accident divided by the total number of accidents that occurred for each age group. Since Fig. 9 shows only these 4 types among all types of accident, the percentages in the figure do not add up to 100%. It should be remembered here that in Japan cars are driven on the left side of the road. Overall, the percentages of rear-end and front-to-side collisions are higher. A characteristic of older drivers is that they have more front-to-side accidents, while younger and middle-aged drivers have more rear-end collisions. The reasons older drivers have more front-to-side than rear-end collisions are considered in the next section.

3. Investigation of Rear-End Collisions

3.1 Driving Speed

It is generally assumed that older drivers become unconsciously aware of their slowing perception and judgment ability, and drive at a slower speed to compensate. The authors were unable to find any data showing a direct relation between each of the age groups and driving speed, but Fig. 10 shows the speed at the time the driver perceived hazard during accidents as a percentage of all accidents that occurred for each age group. This figure shows that the speed for younger drivers is higher than that for older drivers. Based on these results, the mean hazard perception speed was estimated. If, for example, the scale on the horizontal axis is 11-20 km/h, the intermediate value of 15 km/h is assumed to be the representative speed for that interval. If the mean hazard perception speed for each age group is obtained in this way, the older group is seen to have a lower value than the younger group (Table 1), at a speed of about 75% that of the younger group. This data confirms that older drivers drive at slower speeds than younger drivers.

Table 1. Comparison of hazard perception speed between age groups

	Younger drivers	Middle-aged drivers	Older drivers
Estimated mean speed (km/h)	25.2	19.8	18.9
Percentage compared with younger drivers	100%	79%	75%

Meanwhile, reference [3] gives the results of a comparison of the driving behaviors when older and non-older drivers were asked to drive following a leading car at their preferred following distance. The mean speed of older drivers was 42.8 km/h, whereas that of non-older drivers was 47.1 km/h. Thus, older drivers drove at a speed that was about 4 km/h slower. This result also indicates that older drivers drive at a slower speed than younger drivers.

3.2 Numerical Analysis

3.2.1 Numerical parameters

The effect of slow driving speed in reducing the number of traffic accidents was investigated numerically. A situation was assumed in which both younger and older drivers were following a leading vehicle, which suddenly applied its brakes.

The numerical parameters used were as follows, assumed from situations that are likely to occur in actual driving.

(1) Leading vehicle
· Speed: 30 km/h
· Deceleration during braking: 4 m/s^2
(2) Trailing vehicle with younger driver
· Speed: 30 km/h
· Distance between leading and trailing vehicle: 12.5 m (equivalent to inter-vehicle time of 1.5 sec)
· Deceleration of trailing vehicle while leading vehicle is braking: 7 m/s^2
· Brake application delay of trailing vehicle driver when leading vehicle is braking: 0.7 sec.

It will not always be the case that the driver of the trailing vehicle is looking forward with attention focused on the actions of the leading vehicle, and in fact inattentive driving is thought to lead to rear-end accidents.

Therefore,
· Calculations were made with 3 settings for time that driver's eyes are off the road: 0, 1, and 3 sec.
(3) Trailing vehicle with older driver
· Calculations were conducted with the same speed as the younger driver, plus a slower driving speed. The speed

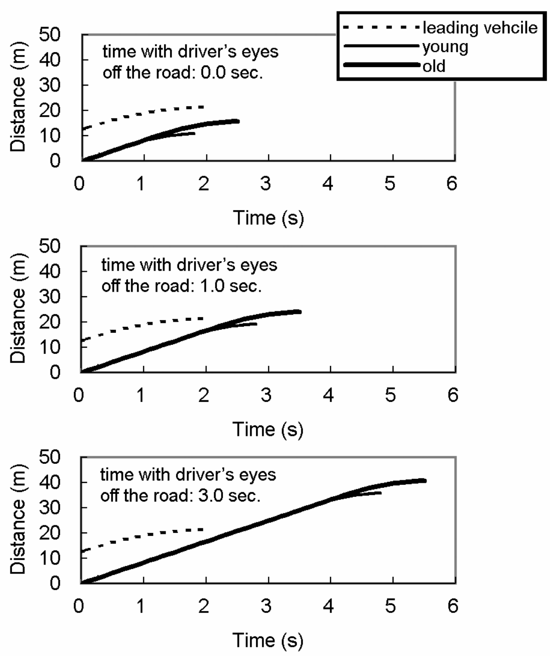

Fig.11 Numerical results for travel distance between leading and trailing vehicles
(when speed of older driver's vehicle is 1.0 times that of younger driver)

was 30 km/h when it was the same as for the younger driver.
· The deceleration of the trailing vehicle while the leading vehicle was braking was taken to be 6 m/s^2, on the assumption that older drivers would not press on the brake pedal as strongly as younger drivers.
· The brake application delay of the trailing vehicle driver when the leading vehicle was braking was taken to be 1.2 sec, assuming a greater delay than younger drivers.

In addition, assuming inattentive driving,
· Calculations were made with 3 settings for time with driver's eyes off the road: 0, 1, and 3 sec.

3.2.2 Calculation results

The numerical results are shown in Fig. 11. The horizontal axis shows the time course, with the point at which the leading vehicle brakes are first applied as time 0. The vertical axis shows the driving distance from the time the leading vehicle starts to apply its brakes, with the position of the trailing vehicle at that time as 0. At time 0, the distance to the leading vehicle shown on the vertical axis is the initial inter-vehicle distance of 12.5 m.

The numerical results indicate that the leading vehicle would stop in about 8.7 m (a position of 21.2 m from the initial position of the trailing vehicle). The trailing vehicle begins to decelerate with application of the brakes at a delay behind the application of the leading vehicle's brakes of 0.7 sec for younger drivers, and 1.2 sec for older drivers.

If the time the trailing driver's eyes are off the road is 0 sec (Fig.11, upper), the trailing vehicle can stop without colliding with the leading vehicle. According to the calculations, the younger drivers stop at 10.8 m

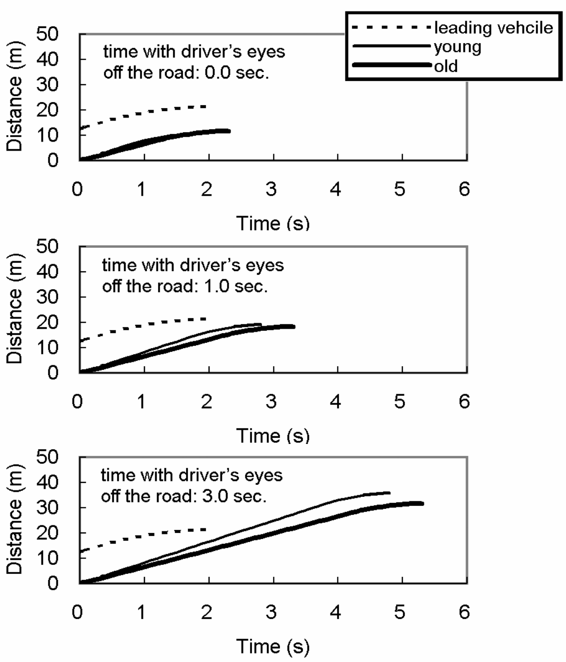

Fig.12 Numerical results for travel distance between leading and trailing vehicles (when speed of older driver's vehicle is 0.8 times that of younger driver)

whereas the older drivers reach a distance of 15.8 m before stopping. However, as the time the trailing driver's eyes are off the road increases, the distance before the trailing vehicle stops grows longer. When eyes are off the road for 1 sec (middle in the figure), the younger drivers do not collide (stopping distance of 19.1 m) but the older drivers do collide (stopping distance of 24.1 m). When the time the trailing driver's eyes are off the road is 3 seconds (bottom in the figure), both the younger and older drivers collide with the leading vehicle.

Next let us consider the case when the older driver has a reduced driving speed. Calculations with the same parameters as those above were conducted for the case in which older drivers drove at a speed 0.8 times (in this case 24 km/h) that of younger drivers. The results are shown in Fig. 12. Since the parameters were the same, the results for the younger drivers were the same as in Fig. 11. Since the speed of the older drivers was slower, the stopping distance was shorter than when they were driving at 30 km/h.

Furthermore, the final stopping distance of the older drivers becomes shorter than that of the younger drivers as the length of time the eyes are off the road becomes longer. In other words, although the driver is not applying the brakes when his eyes are off the road, the distance traveled during that time is shorter because of the slower speed. As a result, the final stopping distance is shorter, and it is assumed to be less likely that a rear-end collision will occur. Older drivers are thought to unconsciously reduce rear-end collisions by lowering driving speed. To reduce collisions even further a support system to warn of abnormal inter-vehicle distances may be effective.

Front-to-side collisions, on the other hand, are related not to traveling distance while the driver's eyes are off the road, but to reaction time in emergencies. Because older drivers have slower response times than younger drivers, they are unlikely to reduce this type of accident by driving at slower speeds. Systems that would somehow compensate for slower response times would therefore be useful for older drivers. For example, a system that would warn older drivers in advance of dangerous situations at intersections with poor visibility would be beneficial.

4. Characteristics of Communities with Large Elderly Populations

Japan is divided into 47 prefectures. Some regions are highly developed urban areas, and others are rural. Looking at the distribution of elderly people it is seen that the percentage of elderly people differs according to prefecture. Figure 13 shows the proportion of elderly people against the entire population of each prefecture in 2002. The prefecture with the highest proportion of elderly people (elderly rate) has 26.0% elderly, while that with the lowest has 14.2%. Five prefectures with high elderly rates were selected for an investigation of whether the occurrence of accidents in those prefectures differed from the situation nationwide.

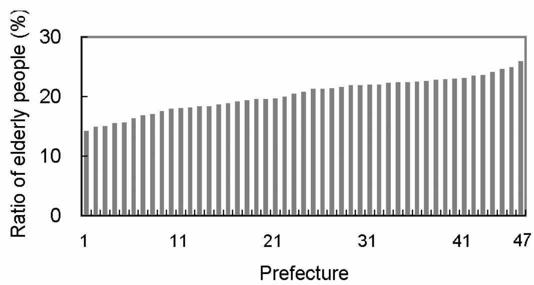

Fig.13 Proportion of over 65 years old people in the population by prefecture in Japan

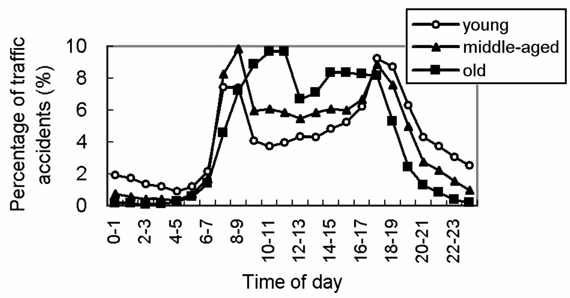

Fig.14 Percentages of the number of traffic accidents by time of day

By time of day (Fig. 14), there were more accidents with older drivers in those prefectures during the day, which was nearly the same as the trend nationwide (Fig. 6).

Looking at human factors (Fig. 15), although the rate of errors in judgment was somewhat high, the trend did not differ significantly from the national trend (Fig. 8).

The results for the top 4 types of accident (Fig. 16) showed greater numbers of rear-end and front-to-side collisions, and on this point were no different than the national trend (Fig. 9). The same trend for older drivers was seen in which there were more front-to-side collisions than rear-end collisions.

With other factors as well the number of accidents in districts with high elderly populations did not differ greatly from the national trends.

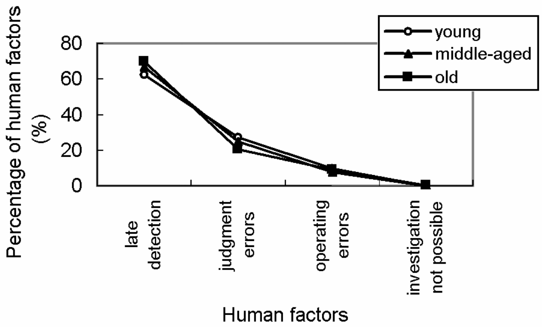

Fig.15 Percentage of traffic accidents related to human factors

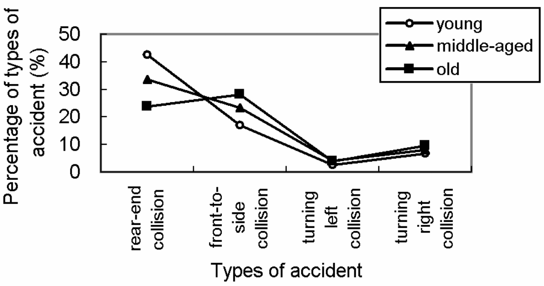

Fig.16 Percentage of traffic accidents by type of accident (4 most common types of accident)

5. Support Systems for Older Drivers

Some examples of support systems for drivers are adaptive front-lighting systems (AFS), vision enhancement systems, systems to provide information on obstacles in places with poor visibility, drunk driving prevention technology, inter-vehicle distance warning devices, lane keeping assistant systems, and sleep warning devices.

Since the number of nighttime accidents with older drivers is low, at present the introduction of nighttime support systems such as AFS and vision enhancement system is not predicted to have a considerable effect. However, if the introduction of such systems would increase the opportunities for older drivers to drive at night, these kinds of support systems would be useful. Similarly, drunk driving prevention technologies would not be particularly useful for older drivers at present. These conclusions are made considering overall trends, but considering individual accidents nighttime support systems would obviously be useful in certain cases.

Front-to-side collisions are thought to be caused by slow reaction speeds, and considering the high number of these collisions, support systems to provide information on obstacles in spots with poor visibility would be useful for older drivers. However, since rear-end accidents also occur in high numbers, inter-vehicle distance warning devices would also be useful for older drivers.

The utility of lane keeping assistant systems and sleep warning systems could not be determined from this analysis of accidents.

6. Conclusion

This study analyzed the number of traffic accidents by age group, and investigated the characteristics of accidents involving older drivers. It was found that the number of accidents caused by older drivers at night was small, and accordingly they had few drunk driving accidents. Regardless of age, there were more rear-end and front-to-side collisions, although older drivers had fewer rear-end collisions than front-to-side collisions. The cause of this is conjectured to be that older drivers reduce their driving speed.

Driver support systems that would be useful for older drivers are systems to provide obstacle information at spots with poor visibility. In addition, since many rear-end collisions also occur, inter-vehicle distance warning devices would also be useful for older drivers.

Acknowledgments

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References

[1] Statistics of Japan, Ministry of Internal Affairs and Communications, http://www.stat.go.jp/data/nihon/index.htm

[2] Statistics of National Police Agency, http://www.npa.go.jp/toukei/#koutsuu

[3] T. Matsuura, I. Sugawara, "Driving behaviours of aged drivers in vehicle following," *Report of National Research Institute of Police Science*, Vol. 33, No. 1, pp.23-29,1992 (in Japanese)