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Traffic Violation Records, Results of the Cognitive Assessment, and Traffic Accidents among Elderly Drivers

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1. Introduction

In recent years, the number of fatalities caused by traffic accidents has been steadily declining because a variety of traffic safety measures have been instituted. However, the number of elderly driver's license holders has been increasing, and the share of fatal accidents in which a driver aged 75 or older was the primary party has been trending upwards year by year. As a result, tragic accidents caused by elderly drivers have continued to occur, attracting the attention of not only traffic officials in charge of traffic safety but also the general public.

At present, when elderly drivers aged 75 or older renew their driver's license, they are required to take the Cognitive Assessment prior to the training for elderly drivers. With respect to the relationship between the results of the Cognitive Assessment and accidents, Kosuge[1] reported on a study titled "An analysis of cognitive function in elderly drivers and traffic accidents" at ITARDA's 22nd Presentation Session for Traffic Accident Investigations, Analysis, and Research in 2018.

In this study, the relationship between traffic violation experience before the Cognitive Assessment and traffic accidents after the assessment was analyzed based on Kosuge's study using the Integrated Driver Database containing traffic accident and violation records established by ITARDA.

2. Background

2.1 Overview of Kosuge's study (2018)

(1) A multivariate analysis was performed using variables such as scores of subtests of the Cognitive Assessment (temporal orientation, cued recall, and drawing a clock), traffic accidents recidivism, age, and gender. The results of the study indicated that traffic accidents recidivism and age had an effect on the accident driver ratio for elderly drivers.

(2) The relationship between the accident driver ratio and the results of the Cognitive Assessment (Class 1, 2 and 3) was analyzed for elderly driver's license holders. The results showed no significant difference between the ratio of drivers classified as Class 1 and that of drivers classified as Class 2 or 3 (hereafter Class 1, 2 or 3 drivers), whereas the ratio of Class 2 drivers was significantly higher than that of Class 3 drivers.

2.2 Overview of the Cognitive Assessment for Elderly Drivers

According to a notice from the National Police Agency[2], drivers aged 75 or older as of the expiry date of their driver's license must take the Cognitive Assessment prior to the training for elderly drivers. The assessment can also be taken starting from six months prior to the expiry date of their driver's license.

The Cognitive Assessment is a test to measure the adequacy of a driver's cognitive function for driving. It categorizes the test takers into the following three classes based on the total scores of the subtests (temporal orientation, cued recall, and the drawing a clock). These are: Class 1: "Memory and judgment ability is impaired (possibility of dementia)," Class 2: "Memory and judgment ability is slightly impaired (possibility that cognitive function has declined)," and Class 3: "Memory and judgment ability is not impaired (no possibility that cognitive function has declined)."

2.3 Database used in the study

The Integrated Driver Database containing traffic accident and violation records used for this study was established by ITARDA to analyze the characteristics of traffic accidents and violations in a long-term manner. The database consists of driver management data and traffic accident statistical data provided by the National Police Agency.

Since 2018 the scores of the Cognitive Assessment (refer to 2.2) for elderly drivers have been provided to ITARDA, making it possible to analyze the relationship between cognitive function and traffic accident/violation characteristics for elderly drivers.

3. Analyses

3.1 Two analyses

The following two analyses were carried out in this study.

· Analysis 1: Relationship between traffic violation characteristics before the Cognitive Assessment and traffic accident characteristics after the assessment

· Analysis 2: Changes in the results of the Cognitive Assessment

3.2 Analyzed data

(1) Analysis 1

The analyzed drivers were those born between 1937 and 1940 who took the Cognitive Assessment in 2014 and renewed their driver's license between 2014 and 2015, as well as drivers born between 1938 and 1941 who took the Cognitive Assessment in 2015 and renewed their driver's license between 2015 and 2016 (each group was between the ages of 74 and 77 when they took the assessment). The number of drivers was 942,737.

The analyzed data included traffic violation records over the two-year period prior to the Cognitive Assessment (from 2012 to 2013 or from 2013 to 2014), and data on casualty accidents in which the drivers were the primary party over a two-year period after the Cognitive Assessment (from 2015 to 2016 or from 2016 to 2017).

The traffic violations and casualty accidents for the analysis were caused by drivers of a four-wheel vehicle.

(2) Analysis 2

The analyzed drivers were those born between 1937 and 1940 who took the Cognitive Assessment in 2014 and 2017 and renewed their driver's license between 2014 and 2015 (between the ages of 74 and 77 at the time of the test).

3.3 Evaluation indexes

The following three indexes[3] have been used to discuss the accident characteristics of drivers.

· Accident driver ratio (A)   : The share of drivers who caused traffic accidents over a certain fixed period out of the target group.

(the number of primary party drivers / the total number of driver's license holders)

· Relative accident ratio (R): The accident ratio per unit of quasi-induced exposure. This corresponds to the accident ratio per unit of driving frequency, such as kilometers traveled

(the number of primary party drivers / the number of secondary party drivers involved in vehicle-vehicle accidents without any violation)

· Quasi-induced exposure (Q): The share of drivers involved in traffic accidents which they were not at fault for over a fixed period out of the target group. This indicator corresponds to frequency of road use.

(the number of secondary party drivers involved in vehicle-vehicle accidents without any violation / the total number of driver's license holders)

The following relationship exists between these three indexes:

Accident driver ratio (A) = Quasi-induced exposure (Q) $\times$ Relative accident ratio (R)

The size of data used for this study was so small that the calculation errors of quasi-induced exposure and relative accident ratio are too large to discuss the accident characteristics in detail. Therefore, only the accident driver ratio was used for this study.

4. Results and discussion

4.1 Analysis 1. Correlation between traffic violation characteristics before the Cognitive Assessment and those after the assessment

(1) Accident driver ratio by violation experience and the results of the Cognitive Assessment

Fig. 1 and Fig. 2 show the accident driver ratio by violation experience and the results of the Cognitive Assessment (refer to 2.2) with a confidence interval of 95%.

"Non-transgressor" refers to drivers who have no traffic violation record, and "transgressor" refers to drivers with one or more traffic violation records. For these, "one-time transgressor" refers to drivers with a single traffic violation record, while "repeat transgressor" refers to drivers with two or more traffic violation records. The accident driver ratio of transgressors is significantly higher (significance level of 5%; the same hereafter) than that of non-transgressors among all classes (Fig. 1). Concerning non-transgressors, the accident driver ratio of non-transgressors of Class 2 drivers is significantly higher than that of Class 3 drivers. Concerning transgressors, the ratio of Class 2 was significantly higher than that of Class 1 or 3. In other words, Class 2 drivers with traffic violation records presumably had a greater tendency to become the primary party of an accident, compared with drivers of any other class with a traffic violation record.

Fig. 2 compares the accident driver ratios of one-time transgressors and repeat transgressors who have multiple records. The figure indicates that for Classes 2 and 3 drivers who had repeatedly committed two or more violations had a significantly higher accident driver ratio than one-time transgressors.
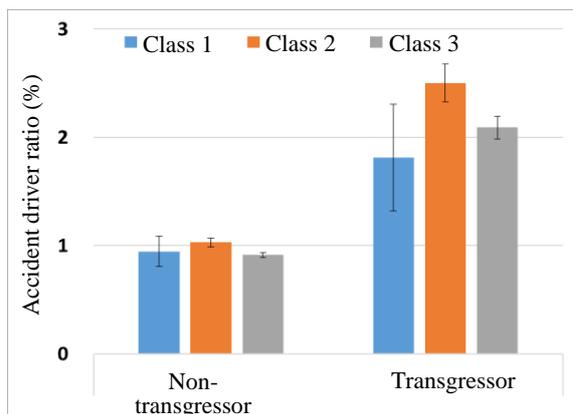
Fig. 1. Accident driver ratio by violation experience
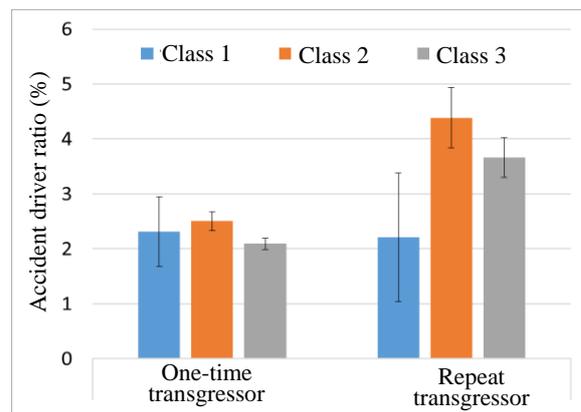
Fig. 2. Accident driver ratio by number of violation records

(2) Accident driver ratio by type of violation

The previous section discussed the accident driver ratio by violation experience and the results of the Cognitive Assessment without considering type of violation. This section presents an analysis of the accident driver ratio based on the types of violations in order to discuss the difference in the accident driver ratio by type of violation. Fig. 3 shows the accident driver ratio by type of violation with a confidence interval of 95%. The result that drivers with violation records had a higher accident driver ratio than drivers without a violation record is consistent with Fig. 1. Fig. 3 lists the accident driver ratio of the top seven violations by the number of violators. The three violations of ignoring traffic signals, driving in prohibited areas and failing to stop were included among the 18 types of violations that require drivers to take the Special Cognitive Assessment. This rule has been applied to all drivers aged 75 and older in the event that they have committed a traffic violation since 2017. However, the other four types of violations are not included in the 18 types of violations.

Those with violations involving mobile phones had the highest accident driver ratio of 3.8, while those with

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violations such as ignoring traffic signals, driving in prohibited areas and parking had roughly equivalent accident driver ratios of 2.7, and those with violations such as failing to stop, not wearing a seat belt and speeding had accident driver ratios of 2.2–2.3.
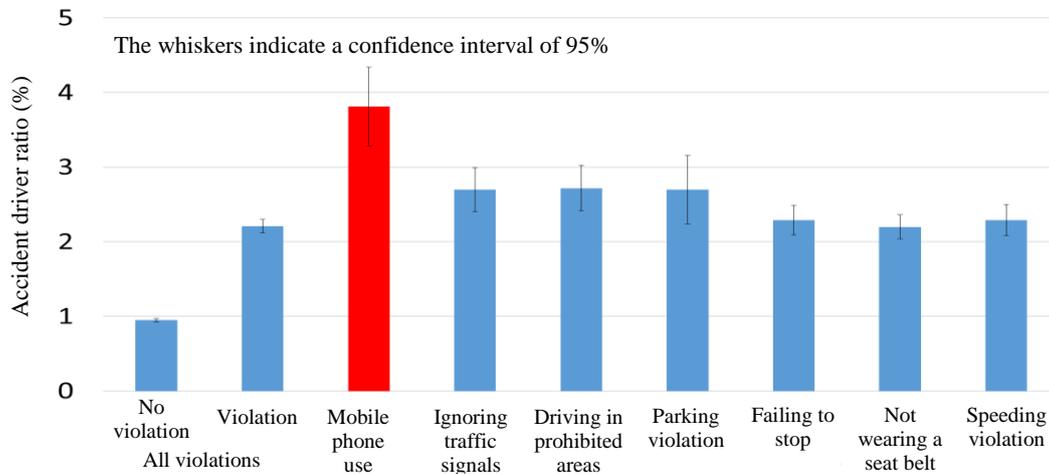

Fig. 3. Accident driver ratio by type of violation

(3) Accident driver ratio by type of violation and the results of the Cognitive Assessment

Fig. 4 and Fig. 5 show the accident driver ratio by type of violation and the results of the Cognitive Assessment (refer to 2.2) with a 95% confidence interval.

Concerning mobile phone use violations, there was no significant difference between the accident driver ratio of Class 2 drivers and that of Class 3 drivers.

Comparing ignoring traffic signals, driving in prohibited areas and illegal parking, which have roughly equal accident driver ratios of 2.7, for driving in prohibited areas there is no significant difference between the accident driver ratio of Class 2 and that of Class 3, while for ignoring traffic signals and illegal parking the accident driver ratio of Class 2 is higher than that of Class 3 (significance level of around 10%).

In the same way, comparing failing to stop, not wearing a seat belt and speeding, which exhibited roughly equal accident driver ratios of 2.2–2.3, for failing to stop there is no significant difference between the accident driver ratio of Class 2 and that of Class 3, while for not wearing a seat belt and speeding the accident driver ratio of Class 2 is higher than that of Class 3 (significance level of around 10%).
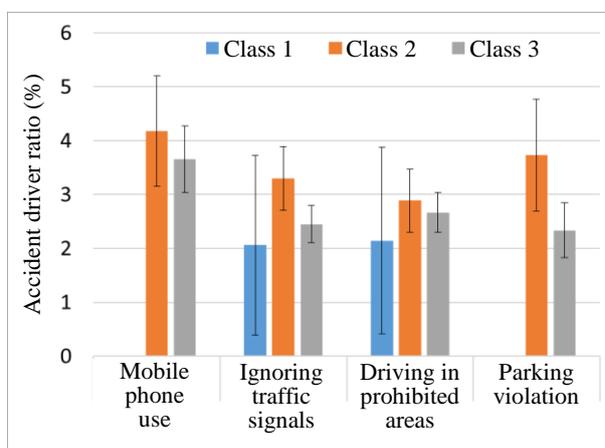

Fig. 4. Accident driver ratio by
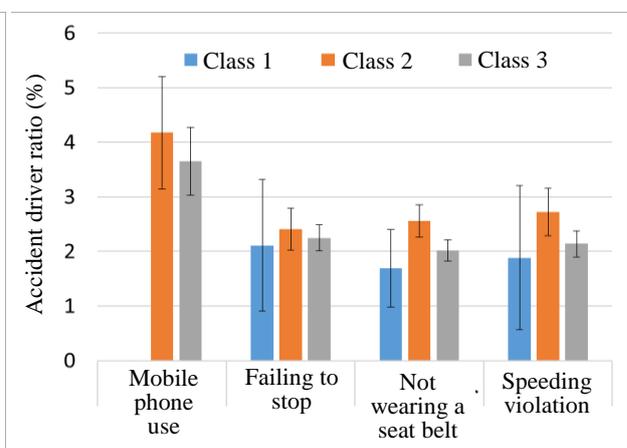
Fig. 5. Accident driver ratio by

type of violation and class   **type of violation and class**

(4) Conclusion

The main results from Analysis 1 are as follows.

- The accident driver ratio of drivers with traffic violation records is higher than that of drivers without a traffic violation record.
- Considering the results of the Cognitive Assessment, the accident driver ratio of Class 2 drivers with traffic violation records was significantly higher than that of Class 3 drivers (significance level of 5% or around 10%).
- Considering seat belt violations, the accident driver ratio of Class 2 drivers is significantly higher than that of Class 3 drivers.

Based on these results, it would be possible to discuss drivers' subsequent declines in ability to drive safely (difference in the accident driver ratio) in more detail by focusing not only on the results of the Cognitive Assessment, but also on traffic violation experiences and type of violation.

4.2 Analysis 2. Changes in the results of the Cognitive Assessment

(1) Changes in the results of the Cognitive Assessment

There is a significant difference between the driver's license renewal rate of Class 1 drivers and that of other classes of drivers. Of the 4,089 drivers who renewed their driver's license after being classified as Class 1 in the Cognitive Assessment in 2014, 2,352 (approximately 58%) renewed their driver's license three years later. Similarly, approximately 80% of those who renewed their license after being classified as Class 2 or 3 renewed again three years later.

Table 1. Trends in the results of cognitive function tests

2014		2017	
		Renewed license	Did not renew license
Class 1 4,089	3 years later	2,352 (57.5%)	1,737 (42.5%)
Class 2 119,883		92,354 (77.0%)	27,529 (23.0%)
Class 3 343,931		271,669 (79.0%)	72,262 (21.0%)

ITARDA Information No. 109 "Renewal characteristics of elderly male driver's license holders" discussed the matter of voluntary surrender of one's driver's license from the perspective of the relationship with accident and violation experience.

As shown in Fig. 6, the shares of voluntary surrenders of those who had caused traffic accidents in the previous three years (hereafter, those with accident experience, ■, □) were higher than that of those who had never caused a traffic accident (hereafter, those without accident experience, ●, ○), and rises dramatically over the age of 78 years. Therefore, it is conceivable that accident experience increases the share of voluntary surrenders. On the other hand, the shares of voluntary surrenders of those who had been penalized for traffic violations in the previous three years (hereafter, with violation experience, ■, ●) were lower than that of those who had been not penalized for traffic violations in the previous three years (hereafter, without violation experience, □, ○) respectively; this suggests that violation experience has a smaller impact on drivers surrendering their license compared to those with accident experience.

Approximately 40% of Class 1 drivers refrained from renewing their driver's license, so being judged as Class 1 may provide an excellent opportunity to prompt them to consider voluntary surrender.
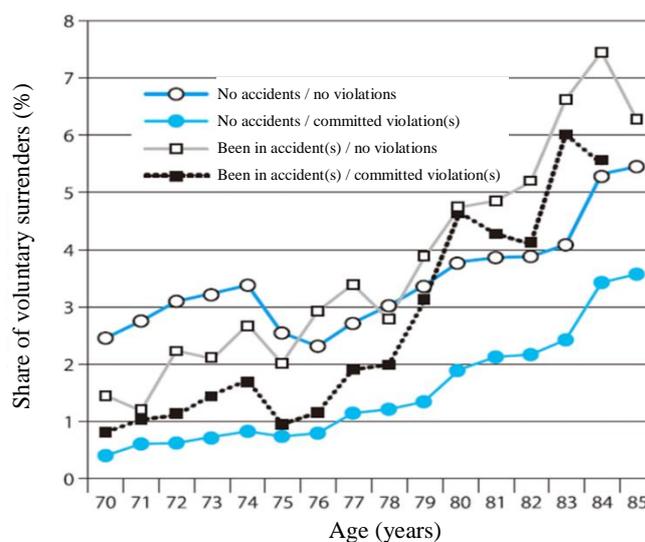
Fig. 6. Share of driver's license voluntary surrenders by age and whether or not they have had accidents or violations[4)]

(Note: Share of voluntary surrenders from 2011–2012 among male drivers who refrained from renewing in 2012)

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(2) Conclusions and discussion

The main results from Analysis 2 are as follows.

・ The driver's license renewal rate of Class 1 drivers three years later, 58%, was lower than that of drivers of other classes.

・ There was no significant difference between the driver's license renewal rates between Class 2 and Class 3 drivers.

It is highly likely that Class 2 and 3 drivers will continue to drive (Analysis 2), and that those with violation experience will have a higher driver's license renewal rate compared with those with accident experience (prior study[4]). The results of Analysis 1 indicated that Class 2 drivers with violation experience have a higher subsequent accident driver ratio.

These results suggest that an effective way to prevent traffic accidents would be to encourage Class 2 drivers with violation experience to surrender their licenses voluntarily.

5. Conclusion and future challenges

This study revealed that drivers with traffic violation records had a higher accident driver ratio than those without a traffic violation record. Especially, the accident driver ratio of Class 2 drivers was higher than that of Class 1 or 3 drivers (Analysis 1). Those drivers classified as Class 2 by the Cognitive Assessment tended to renew their driver's licenses and continue driving thereafter (Analysis 2).

A remarkable correlation between traffic violation records and accident driver ratio was not shown in the prior study. Considering the results of this study, it is presumably necessary to provide those drivers with past traffic violation records (even those classified as Class 2) with information about the subsequent increase in accident driver ratios among them, and to encourage them to surrender their driver's license voluntarily.

Conversely, curtailing the driving of the elderly, who have a high accident ratio, would presumably be effective for preventing traffic accidents. However, there are also elderly drivers who must continue to drive in order to maintain their quality of life, depending on the region. There are no simple solutions to the problems related to elderly drivers; more analyses and discussions must be carried out from a variety of perspectives. For this reason, the Integrated Driver Database containing traffic accident and violation records established by ITARDA, which makes it possible to analyze the risk of accidents of elderly drivers in a long-term and multi-dimensional manner, is enormously useful.

References

1) Hanae KOSUGE: An analysis of cognitive function and traffic accidents in elderly drivers (in Japanese), the 21st ITARDA Presentation Session for Traffic Accident Investigations, Analysis, and Research 2018, http://www.itarda.or.jp/ws/pdf/h30/21_04elderly.pdf

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3) Yasushi NISHIDA: Road Traffic Accident Analysis considering Driver's Accident and Violation Records (in Japanese), Report of the Japan Research Center or Transportation Policy A-591, 2014, http://www.nikkoken.or.jp/pdf/project/2012/2012_01.pdf

4) Yasushi NISHIDA and Masahide HONDA: Renewal characteristics of elderly male driver's license holders, ITARDA Information #109, 2015 http://www.itarda.or.jp/itardainfomation/info109.pdf