

New Trial Analysis of Characteristics of Accidents and Traffic Violations by Elderly Drivers in Japan

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ABSTRACT

The number of elderly drivers is increasing in Japan and ensuring the safety of elderly drivers is becoming an important issue. The authors previously conducted an analysis of the characteristics of accidents and traffic violations by elderly drivers based on the number of accidents in which they were rear-ended. This method was used in order to exclude the influence of driving frequency. As a result of that analysis, it was found that the likelihood of violations committed by elderly drivers was not particularly higher than in other age groups, while the likelihood of accidents caused by them was higher. The risk of causing an accident was judged to be about two times higher in elderly drivers than in the 35-44 year age group. However, the methodology presupposed that collisions in which a driver is rear-ended are accidents that occur randomly, and that they occur with the same probability in each age group. To verify the results of that study, we attempted a new analytical method that uses the number of stop sign violations, which are considered to occur with the same probability among age groups, as an indicator of driving frequency in place of accidents in which a driver is hit from behind (rear-end collisions). In the new analysis the risk of causing an accident was judged to be 1.24 times higher in elderly drivers than in the 35-44 year age group. In general, the risk of accidents caused by elderly drivers is estimated to be lower than in the previous study.

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INTRODUCTION

In 2012 the number of traffic fatalities in Japan was 4411 according to data from the Institute for Traffic Accident Research and Data Analysis (ITARDA) [1]. (Deaths within 24 hours of an accident are counted as traffic fatalities in Japan.)

Something that needs to be considered today is the increase in elderly drivers that has come with the overall aging of Japanese society. Figure 1 shows the trends in the number of driving license holders and the number of traffic accidents between the 2003 and 2012 calendar years, in which drivers were the 1st party. Here, "1st party" refers to the person responsible for the most culpable failure or who is the least injured among parties concerned when their culpable failures are at the same level. Data of traffic accidents are collected by the police, who classify the data based on their own criteria, for example, regarding which party is the 1st party.

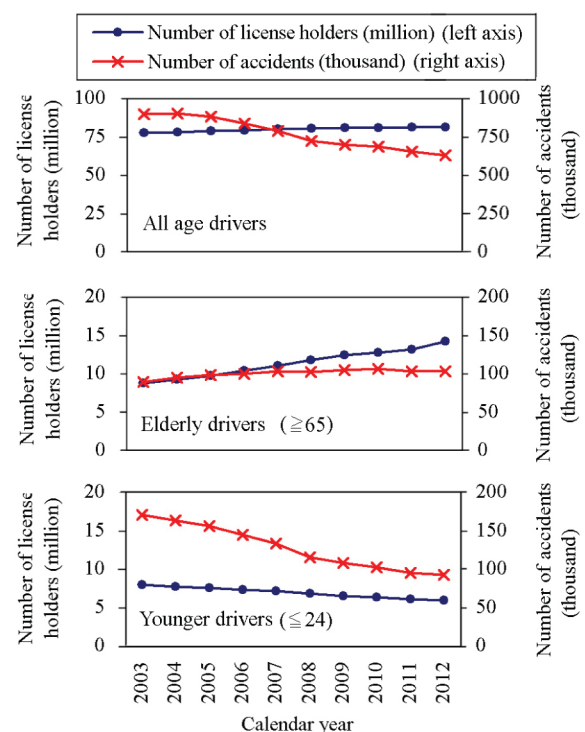


Figure 1. Trends in number of driving license holders and traffic accidents (2003-2012)

The upper graph in the figure is the trend for drivers of all ages, the middle graph for elderly drivers (equal or over 65 years old), and the lower graph for younger drivers (24 years old or younger). We can see that for all age drivers the number of license holders is almost constant, although the number of traffic accidents is gradually decreasing. This is the recent trend in Japan. For elderly drivers the number of license holders is increasing and the number of the traffic accidents is increasing slightly, whereas for younger drivers the number of the license holders is gradually decreasing and the number of the traffic accidents is decreasing rapidly. Therefore, considering the slight increasing trend in the number of the traffic accidents for elderly drivers, in spite of the decreasing trend for all age groups, we can conclude that there is a need to ensure the safe driving of elderly drivers.

Reducing traffic accidents involving elderly drivers is an issue shared by all countries. Many studies have been conducted to ensure the safety of their driving [2,3,4,5,6]. Some people view elderly drivers as a risk and more likely to cause accidents because of their deteriorating abilities [7,8,9,10], such as visual search, useful field of view, working memory, situational awareness, decision-making, reaction time, and contrast sensitivity. An opposing view is that they are less likely to be involved in accidents because of their greater caution [11,12].

To reveal the risk level of elderly drivers, we previously analyzed the accident and violation data [13]. Since there is a general tendency for elderly drivers to have less opportunity to drive than younger drivers [14], it was necessary to consider driving frequency when making comparisons among age groups. We therefore calculated the normalized ratio (odds ratio) based on the number of accidents in which a driver is rear-ended, which were assumed to occur with the same frequency in all age groups. This was done in order to exclude the influence of driving frequency. As a result of the analysis, it was found that the likelihood of violations committed by elderly drivers was not particularly higher than for younger drivers, while the likelihood of accidents caused by elderly drivers was higher. The risk of causing an accident was judged to be 2.11 times higher in elderly drivers than in the 35-44 year age group [13]. The age groups used were five 10-year cohorts: 25-34, 35-44, 45-54, 55-64, and 65-74 years old. Since our aim in the analysis was to clarify the characteristics of elderly drivers, we did not include the age group of people around 20 years who had recently obtained driving licenses.

In that analysis, the methodology presupposed that collisions in which a driver is rear-ended are accidents that occur randomly, and that such accidents occur with the same probability in each age group. However, the presupposition that accidents in which a driver is rear-ended occur with the same probability for all age groups was not strictly verified. Therefore, we wrote in the Conclusion of the previous paper [13], "Finally, the methodology adopted in this study presupposes that the proportional ratio of Ω to the number of rear-ended collisions is constant for all age groups since

rear-ended collisions occur by chance. This hypothesis is not strictly verified at present and needs to be resolved in the future".

To resolve the above question, in this paper we tried adopting another intermediary, which is considered to occur at the same rate in each age group, as an indicator of driving frequency.

PREVIOUS ANALYSIS OF LIKELIHOOD OF ACCIDENTS AND VIOLATIONS

As we pointed out in our previous report [13], driving frequency needs to be considered when comparing the accident and violation characteristics of elderly drivers with those of other age groups. Even if elderly drivers cause fewer accidents, this may be due simply to lower driving frequency. Consequently, in order to analyze whether or not accidents and violations actually occur at a higher rate in any group, we must adopt a method of analysis that considers driving frequency. For this reason we conducted our analysis in the previous study with number of collisions in which a driver was rear-ended as an intermediary.

Among the various kinds of rear-ended collisions that may occur, we selected as the intermediary in the analysis those limited to the following conditions: a car in a stationary state (e.g. stopped at a traffic signal or parked), and not violating any traffic rules, such as stationary violations, is hit from the rear. This means the driver was hit by chance, without any fault on his or her part. Therefore, we considered these data were appropriate as an intermediary.

Our thinking is shown in the following.

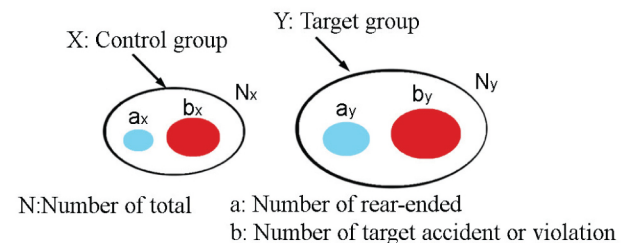


Figure 2. Analysis concept based on number of collisions in which a driver was rear-ended

Collisions in which a driver was rear-ended were taken to be a_x and a_y , respectively, for the control group (X) and analysis group (Y) shown in Figure 2. The occurrence of accidents or violations was taken to be b_x and b_y , respectively. It should be noted that driving frequency may differ between groups X and Y. If a group of drivers taken as X includes many people who have driving licenses but do not actually drive (drivers on paper only), the probability of this group having accidents will be low since the drivers on paper only basically do not drive. The number of accidents or violations shown with b_x may be extremely small relative to the total number X. Therefore, we cannot analyze the accident or violation rate simply with the

number of b_x and b_y alone. It is necessary to consider the likelihood of an accident or violation occurring in relation to driving frequency.

The exposure rate related to driving frequency is taken here to be ε_x and ε_y . When the respective total numbers in groups X and Y are taken to be N_x and N_y , respectively, they are apparent parameters but not parameters related to accidents or violations. Group parameters that consider the exposure rate ε_x and ε_y are taken to be Ω_x and Ω_y , which can be named "true total number," as shown in the following.

$$\Omega_i = N_i \times \varepsilon_i \quad (i = x, y) \quad (1)$$

Here, N_x and N_y are known from aggregation of accident data, but Ω_x , Ω_y , ε_x , and ε_y are unknown. The exposure rate is considered to be different for each group.

In the previous study, we assumed that collisions in which a driver is rear-ended were accidents that occur with the same probability for X and Y. This assumption yields the following equation:

$$\frac{a_x}{\Omega_x} = \frac{a_y}{\Omega_y} \quad (2)$$

In this case, the problem is whether

$$\frac{b_x}{\Omega_x} = \frac{b_y}{\Omega_y} \quad (3)$$

holds for other types of accident or violation.

If the right side of the equation is greater than the left side, accidents or violations may be said to be more likely in group Y. Here, a_x , a_y , b_x , and b_y are number of occurrences, and so their values are known.

To perform this analysis, ε must be considered. The following equation is derived from equations (1)-(2):

$$\frac{\Omega_y}{\Omega_x} = \frac{a_y}{a_x} = \frac{N_y \varepsilon_y}{N_x \varepsilon_x} \quad (4)$$

and thus becomes:

$$\frac{\varepsilon_y}{\varepsilon_x} = \frac{a_y}{a_x} \frac{N_x}{N_y} \quad (5)$$

Assuming now that the ratio alone is considered and that $\varepsilon_x = 1$, this becomes

$$\varepsilon_y = \frac{a_y}{a_x} \frac{N_x}{N_y} \quad (6)$$

and ε_y is obtained. Since Ω_x and Ω_y can be obtained from this, we investigated the magnitude relationship of b_x/Ω_x and b_y/Ω_y . When b_y/Ω_y was greater than b_x/Ω_x , it was concluded that accidents or violations are more likely to occur in group Y.

Alternatively, a_y/a_x and b_y/b_x may also be compared. Thus, the value obtained by the following equation is called the normalized ratio, which corresponds to an odds ratio, and whether or not this value is greater than 1 is determined. We also calculated the 95% confidence interval using the method of Woolf.

$$r = \frac{\frac{b_y}{\Omega_y}}{\frac{b_x}{\Omega_x}} = \frac{\frac{b_y}{b_x}}{\frac{a_y}{a_x}} \quad (7)$$

In the previous study we focused on elderly drivers and conducted an analysis of whether or not they are truly more likely to be involved in traffic accidents. We estimated that elderly drivers tend to cause 2.11 times more traffic accidents than the 35-44-year-old age group [13]. In the analysis we used the following parameters for examples:

For the control group of 35-44-year-olds: $a_x=44,641$, $b_x=116,265$, and for the elderly group: $a_y=12,443$, $b_y=68,453$.

For reference, the number of license holders for analysis is $N_x=17,133,757$ for the control group and $N_y=10,208,715$ for the elderly group. The values of Ω_x , Ω_y , ε_x , and ε_y are unknown, as we mentioned above.

Here, the accident data used were from ITARDA. The data on traffic violations used were driving license data from the same institute. Concerning the traffic violations, drivers are often ticketed and fined for minor violations by the police. The citation levels are not thought to differ depending on the driver's age. In this analysis, we paid ITARDA to aggregate data in the first stage, then we ourselves conducted a detailed examination based on these aggregated data. In the previous analysis we examined the data from the year 2009 that were available to us.