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Analysis of Seat Belt Non-use

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1. Introduction

Of the various traffic accident countermeasures that exist, one of the most effective measures for preventing fatal accidents is a vehicle seat belt.

However, despite the fact that both hardware- and software-based measures have been implemented to get drivers to wear seat belts, a joint survey¹⁾ conducted by the Japan's National Police Agency and the Japan Automobile Federation (JAF) in 2020 shows that the seat belt non-use rate when driving on general roads was still at 1% and had not reached zero, and that 287 drivers not using seat belts were killed in traffic accidents in 2020 alone. Further improvements to seat belt use rates are considered indispensable in achieving the goal set forward in the 11th Basic Plan for Traffic Safety of reducing traffic accident fatalities to 2,000 or less by 2025.

Therefore, to discuss measures aimed at increasing of the seat belt use rate, we analyzed the characteristics of seat belt non-use using ITARDA's traffic accident database integrated with registered vehicle information and driver database integrated with violation and accident records.

2. Analysis 1: Characteristics of seat belt non-use drivers based on traffic accident data analysis

This section shows the results of three analyses of driver seat belt non-use (seat belt non-use is a violation of laws requiring the wearing of seat belts) using the traffic accident database integrated with registered vehicle information.

Seat belt non-use rates were calculated with the following formula and data about the seat belt use of not-at-fault drivers (including uninjured parties) of vehicles equipped with a seat belt reminder between 2015 and 2017.

$$\text{Non-use rate} = \frac{\text{Number of drivers not wearing seat belts}}{\text{Number of drivers wearing seat belts} + \text{Number of drivers not wearing seat belts}}$$

“Not-at-fault drivers” refers to secondary parties in vehicle-vehicle accidents (the primary party is the driver of the vehicle responsible for the initial collision) who did not violate laws and were not involved in a traffic accident due to factors such as their driving method or manner. The characteristics of such drivers are considered to be similar to those of general drivers.

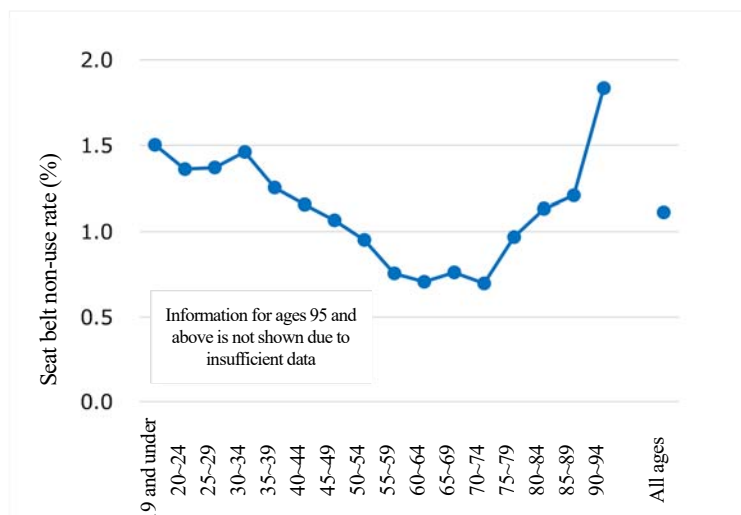


Fig. 1 - Driver seat belt non-use rate by age group

(Seat belt non-use rates were calculated based on seat belt usage between 2015 and 2017 by not-at-fault drivers of vehicle models for which seat belt reminder equipment has been required since 2005)

2-1. Age and seat belt non-use rates

Figure 1 shows seat belt non-use rates by driver age group. The seat belt non-use rate for all age groups is 1.1% and is almost the same level as the 1% from the National Police Agency/JAF Joint Survey¹⁾, meaning this method of calculating seat belt non-use rates used is considered to be appropriate. Seat belt non-use rates for drivers aged from 19 to their early 30s is high at approximately 1.4%, before decreasing with age from the late 30s. Although rates remain low at 0.8% or less from the late 50s until the early 70s (hereinafter, "middle age"), rates rise again from the late 70s and exceed 0.95% at 75 and above.

2-2. Vehicle model year and seat belt non-use rates

The equipping of a seat belt reminder which warns a driver to wear a seat belt when driving via displays or sounds became obligatory in September 2005.

With this in mind, we examined the effectiveness of this device by classifying vehicles newly registered from 2006 onwards and equipped with such devices as “new type model vehicles” and vehicles registered in 2005 and earlier and without such devices as “old model vehicles”. Although differences due to vehicle model year were low at 0.5 to 1%, by examining seat belt non-use rates by age group and vehicle model year, we were able to confirm that seat belt reminders were effective due to the low rates of seat belt non-use by drivers of

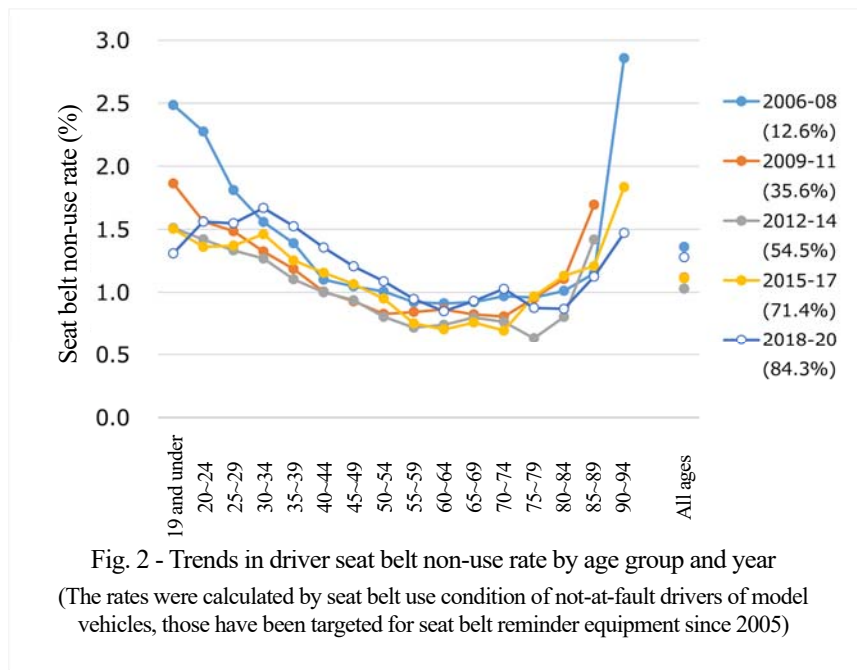
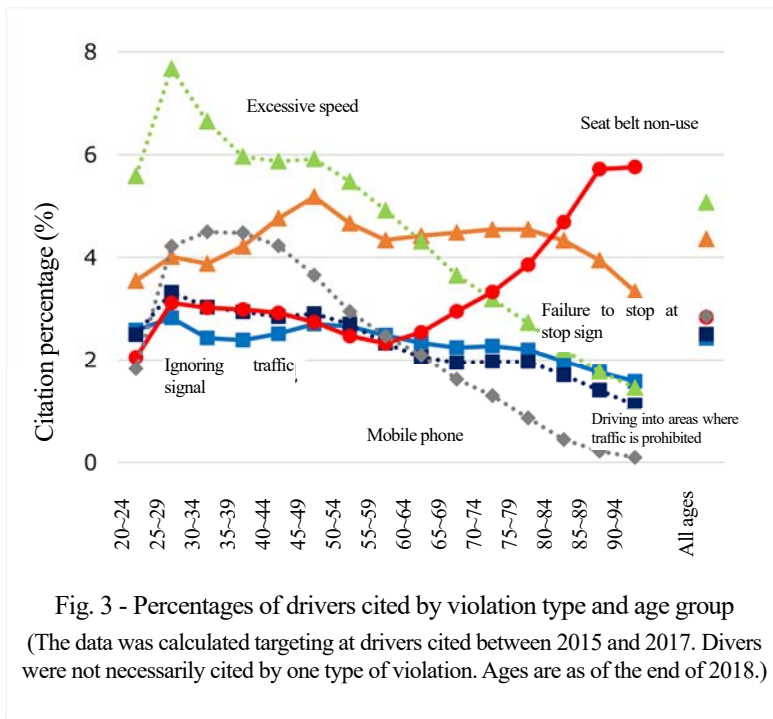


Fig. 2 - Trends in driver seat belt non-use rate by age group and year
(The rates were calculated by seat belt use condition of not-at-fault drivers of model vehicles, those have been targeted for seat belt reminder equipment since 2005)

new type model vehicles across all age groups. (This figure was not shown in this paper, but is shown as Fig. 4 in the Power Point file from the presentation session.) However, when looking at the relationship between the prevalence of vehicles equipped with seat belt reminders and seat belt non-use rates, although diffusion rates of new type model vehicles in each period as shown in the legend of Fig. 2 have increased from 12.6% in 2006-2009 to 84.3% in 2018-2020, there have been almost no recent decreases in seat belt non-use rates. In other words, the spread of warning systems (seat belt reminders) has not had any additional effects in terms of further decreases in seat belt non-use rates.

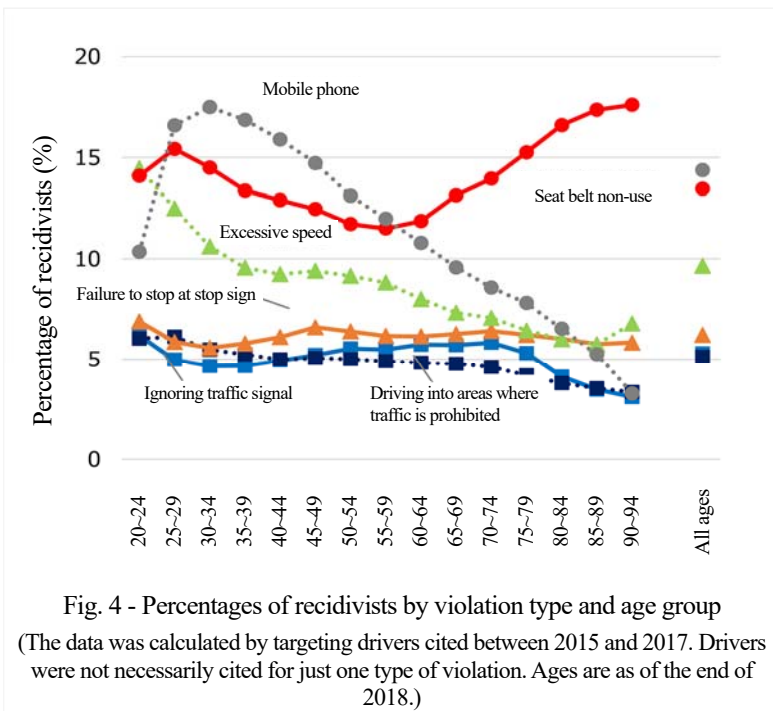
3. Analysis 2: Characteristics of seat belt non-use drivers based on traffic violation data analysis

This section shows the results of analysis performed on the relationship between age and citations for traffic violations including seat belt non-use (such non-use is a violation of laws requiring the wearing of seat belts) using ITARDA's integrated driver database with traffic accident/violation records that includes the violation data of 91 million drivers throughout Japan.



driving into areas where traffic is prohibited (■) gradually decrease as drivers after drivers pass 80 years in age. One violation for which there is little change in the percentage of drivers cited depending on the age group is failing to stop at stop signs (▲), which peaks at the late 40s and trends at approximately 4% from the 50s until the 70s. Among violations, citations for seat belt non-use (●) gradually decrease from the late 20s, but again increase from around the 60s, resulting in the largest difference with other types of violations.

Among drivers cited for traffic violations, some drivers repeat the same violation after being cited, while others learn from their citation and modify their behavior and awareness accordingly to avoid being cited again. Also, the types of violations for which drivers are most often cited are not necessarily those for which drivers are most often cited repeatedly.



3-1. Repeated violator of road traffic law

Figure 3 shows how many drivers have been cited for traffic violations, including seat belt non-use using percentages of licensed drivers cited over the past three years (hereinafter, "percentage of drivers cited") by age group. The types of traffic violations with high percentage of drivers cited differ by age group. In the 25~29 age group, the percentage of drivers cited for excessive speed (▲) is high, and nearly 8% of licensed drivers have been cited over the past three years. Young people are also often cited for mobile phone usage (◆), with percentages decreasing with age in the same manner as excessive speed violations. Ignoring traffic signals (■) and

driving into areas where traffic is prohibited (■) gradually decrease as drivers after drivers pass 80 years in age. One violation for which there is little change in the percentage of drivers cited depending on the age group is failing to stop at stop signs (▲), which peaks at the late 40s and trends at approximately 4% from the 50s until the 70s. Among violations, citations for seat belt non-use (●) gradually decrease from the late 20s, but again increase from around the 60s, resulting in the largest difference with other types of violations.

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In order to study which types of violations drivers tend to be cited repeatedly, Figure 4 shows the percentage of recidivists (drivers cited for violations two times or more) among the number of drivers in each age group cited for violations over the past three years. Although the relationship between age and the percentage of recidivists depending on the violation type is similar in some ways to driver citation rates, the ranking of these percentages is very different. Among young people, there is a higher percentage of recidivists for mobile phone usage (◆) than for excessive speed (▲). For drivers in their 60s and 70s, although the percentage of

drivers cited for failing to stop at stop signs (▲) is high, seat belt non-use (●) has a higher percentage of recidivists. Because drivers aged 60 and older have the highest percentage of seat belt non-use, seat belt non-use is a behavior for which preventing repeated citations by modifying one's behavior or awareness characteristics may be difficult for the elderly.

3-2. Traffic violations and behavioral characteristics

In general, people behave to avoid repeating failures. Furthermore, the majority of people cited for traffic violations change their method of driving or their awareness regarding traffic safety to prevent being cited for traffic violations again (particularly for the same type of traffic violation). In other words, they modify their behavioral characteristics.

Therefore, if behavioral characteristics are successfully corrected, the percentages of recidivists cited repeatedly for the same type of violation and in the same region (prefecture of residence) in a short period of time will decrease. Conversely, if the percentage of recidivists does not decrease, it is assumed that the ability of drivers to correct their methods and

awareness has become impaired. It is from this perspective of an impaired driver ability to correct such behavioral characteristics that we analyzed the percentage of recidivists who did not use seat belts.

Figure 5 shows percentages of drivers cited for seat belt non-use in their local area (prefecture of residence) by age group. Although it is thought that drivers will have decreased rates of repeated citations for the same violation in their local area if they modify their behavioral characteristics, when comparing citation percentages in the prefecture of residence from three years ago (○) with citation percentages in the prefecture of residence from two years later (●), the percentage from later (●) is high, meaning it may be difficult for the behavior of drivers who do not wear seat belts to be modified.

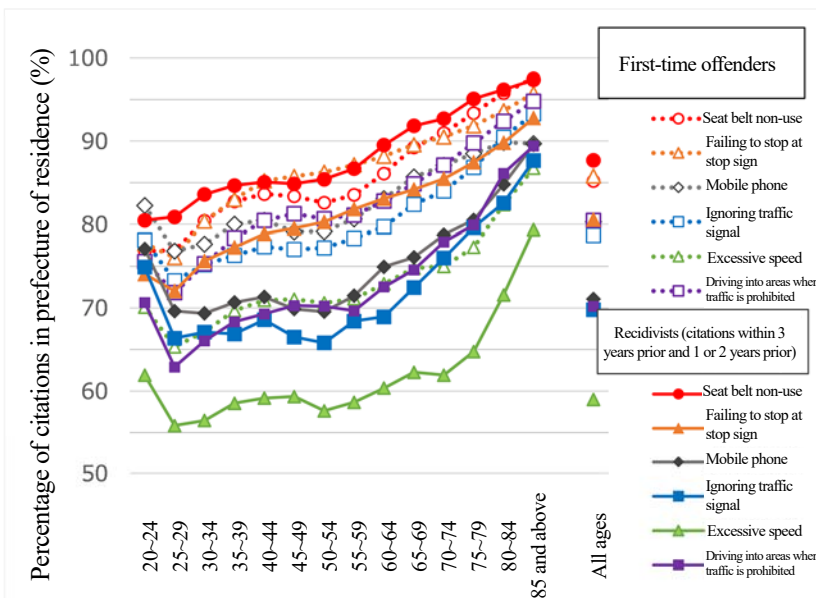


Fig. 5 - Citation percentages in the prefecture of residence by first time offenders (2015) and recidivists (drivers cited by the same type of violation in 2015 and 2016 or 2017) by violation type and age group

(The data was calculated by targeting drivers cited between 2015 and 2017. Drivers were not necessarily cited for just one type of violation. Ages are as of the end of 2018.)

Failing to stop at stop signs differs from seat belt non-use in that the percentage from later (▲) is lower than the percentage from three years ago (△), meaning it is possible that behavior or awareness were modified. The same trends as seen for failing to stop at stop signs can also be seen for mobile phone usage (◇, ◆), ignoring traffic signals (□, ■), excessive speed (△, ▲), and driving into areas where traffic is prohibited (□, ■).

In the case of first-time offenders, as with recidivists, the older the driver is, the higher of the percentage of citation in the prefecture of residence is. It is thought this is due reductions in peoples' range of behavior that often comes with aging.

4. Analysis 3: Relationship between violation/accident experience and seat belt non-use

Up to this point, we have separately discussed both seat belt non-use while driving and citation characteristics, but in this section, we will show the results of the analysis on relationships between the two variables.

4-1. Violation/accident experience and seat belt non-use

Figure 6 shows seat belt non-use rates among drivers cited for several types of violations. More specifically, it shows seat belt non-use by drivers with and without a citation record for seat belt non-use or other violation over the past three years by age group, as well as that of not-at-fault drivers.

In each age group, the percentage of drivers with a record of citation for seat belt non-use (●) was the highest, and it is assumed that many of the drivers cited for seat belt non-use will continue to drive without wearing a seat belt in the future as well. However, age groups 65~69 to 80~84 are at the same level regardless of violation record (▲, △), and the characteristics associated with traffic violation behavior may change in these age groups.

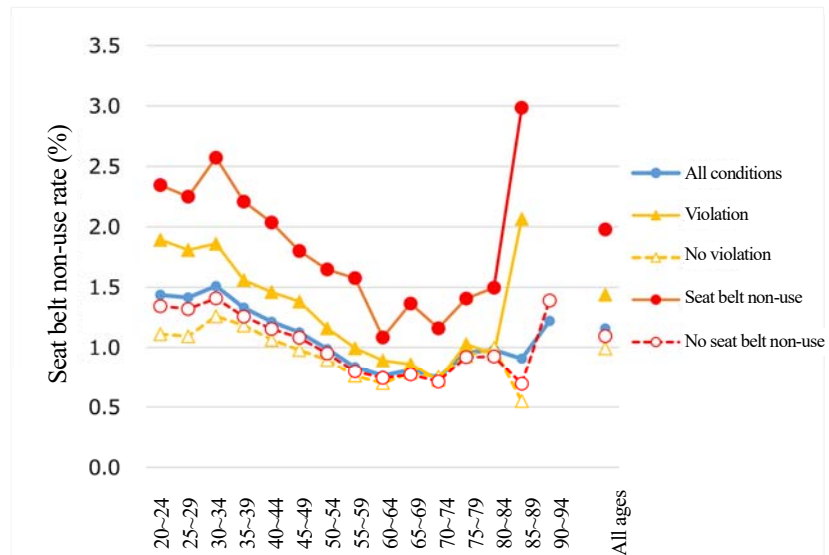


Fig. 6 - Seat belt non-use rate by three-year violation record and age group (Data was calculated by targeting at not-at-fault drivers of semi-large/medium/small sized passenger vehicles or medium/small sized goods vehicles in 2018, with the three-year violation record spanning from 2015 to 2017)

4-2. Seat belt non-use and accident rates

Table 1 shows subsequent accident rates and driving frequency of drivers cited for seat belt non-use by age group. As indicators for accident rates and driving frequency, we used accident driver ratio and quasi-induced exposure ratio as shown below.

Table 1 - Accident driver ratio and quasi-induced exposure ratio by age group and number of citations for seat belt non-use over the past three years

(In 2018, with three-year violation records spanning from 2015 to 2017)

	Accident driver ratio (%)							Quasi-induced exposure ratio (%)						
	No. of citations							No. of citations						
	No violations	1 time	2 time	3 time	4 time	5 or more times	Total	No violations	1 time	2 time	3 time	4 time	5 or more times	Total
20~24	0.8	2.0	2.7	2.7	3.9	2.9	0.8	0.3	0.9	1.1	1.5	1.6	-	0.3
25~29	0.6	1.5	2.1	2.5	1.9	4.4	0.6	0.3	0.8	1.1	1.2	1.3	1.0	0.4
30~34	0.5	1.1	1.7	1.9	1.9	1.1	0.5	0.3	0.7	0.9	0.9	0.9	-	0.3
35~39	0.4	0.9	1.4	1.5	2.3	2.0	0.4	0.3	0.6	0.9	0.9	0.9	1.0	0.3
40~44	0.4	0.9	1.3	1.5	2.4	2.6	0.4	0.3	0.6	0.7	0.9	1.2	1.0	0.3
45~49	0.4	0.9	1.4	1.7	2.3	2.3	0.4	0.3	0.5	0.6	0.7	1.3	-	0.3
50~54	0.4	0.9	1.6	1.9	1.8	2.0	0.4	0.3	0.5	0.5	0.5	-	-	0.3
55~59	0.4	0.9	1.6	1.9	2.1	1.5	0.4	0.2	0.4	0.5	0.4	1.2	-	0.2
60~64	0.4	0.9	1.4	1.5	2.2	2.1	0.4	0.2	0.3	0.4	0.5	-	-	0.2
65~69	0.4	0.9	1.3	1.6	2.0	3.7	0.4	0.2	0.3	0.4	0.3	0.3	-	0.2
70~74	0.4	0.9	1.3	2.0	2.3	2.0	0.5	0.1	0.2	0.3	0.3	-	-	0.1
75~79	0.5	1.0	1.6	2.1	2.5	2.0	0.5	0.1	0.2	0.2	0.5	-	-	0.1
80~84	0.5	0.9	1.3	1.9	2.5	1.8	0.6	0.1	0.1	0.2	0.2	-	-	0.1
85 and above	0.5	0.9	1.2	1.9	2.5	2.7	0.6	0.1	0.0	-	-	-	-	0.1
All ages	0.5	1.0	1.5	1.9	2.3	2.4	0.5	0.2	0.5	0.6	0.7	0.7	0.5	0.3

Accident driver ratio:
Percentage of drivers who were a primary party in a traffic accident during 2018 (%)

(Number of drivers who were a primary party in a traffic accident/Number of all drivers)

Quasi-induced exposure ratio: Percentage of drivers who were not-at-fault drivers in a traffic accident during 2018 (%)

(Number of not-at-fault drivers/Number of all drivers)

Across all age groups, the driving frequencies of drivers cited for seat belt non-use was higher than that of those drivers not cited, with those having more citations also having higher driving frequencies. The same trend can also be seen in the ratio of drivers who were a primary party in an accident, meaning that drivers cited for seat belt non-use can be considered drivers at a high risk of being involved in traffic accidents.

5. Discussion

5-1. Psychological characteristics of drivers who do not wear seat belts

According to the material on accidents involving novice drivers and their violation characteristics²⁾, rates of newly licensed drivers being cited for seat belt non-use (this rate takes driving frequency into consideration) decrease over time or as these drivers accumulate driving experience. From this, it is conceivable that the reason for high seat belt non-use rates among young people is that because they have no driving experience, they do not sufficiently understand the importance and usefulness of knowledge acquired during classroom lectures. Considering the fact that drivers who will potentially wear a seat belt have the characteristic of decreased seat belt non-use rates as they accumulate driving experience, it is conceivable that proactive measures such as public relations or public awareness campaigns would prove effective at encouraging novice drivers to accumulate driving experience in a short period of time and would have the same sort of effects as on-the-job training.

On the other hand, associations between impaired cognitive function and seat belt non-use as shown in the material³⁾ indicate that aging-related impairment of cognitive functions may be the cause for high seat belt non-use rates among the elderly. For this reason, instead of conventional measures that employ public relations, public awareness, or education, it may be necessary to consider measures from a medical perspective, which can be significantly more difficult to implement than measures employed for young people.

Because the above observations are based on limited analysis results, multifaceted analysis, such as of the psychological characteristics of drivers who do not wear seat belts, is required in order to enable more rigorous observations to be obtained and measures for increasing seat belt use rates.

5-2. Traffic violation behavior and traffic accident risk

Because traffic accidents are often caused by traffic violations such as excessive speed and driving into areas where traffic is prohibited, traffic control, traffic guidance, and traffic safety education are implemented from the perspective of preventing traffic accidents.

On the other hand, although many materials discuss how seat belts are effective in reducing injury in the event of a traffic accident, or how they enable drivers to maintain proper driving posture and in turn reduce fatigue and prevent operational errors, there are almost no instances of quantitative discussions highlighting the fact that drivers who do not wear seat belts are more likely to cause an accident.

The results in Table 1 show that drivers who do not wear seat belts are more likely to be involved in an accident. However,

when calculating the accident rate per unit of driving frequency (estimated using the values from Table 3 and the formula "relative accident ratio = parties concerned in accident / quasi-induced exposure ratio"), despite there being some differences depending on driver age, the difference in rate depending on number of citations is low. This fact means that a driver who has a large number of citations is not necessarily a driver whose method of driving is problematic (risky). Therefore, the reason why the accidents shown on the left side of Table 3 are more likely to occur is because the drivers with large numbers of citations shown on the right side of Table 3 have a higher driving frequency.

When studying measures for preventing accidents by drivers with a large number of citations for seat belt non-use, the fact that "drivers with high driving frequencies have a higher rate of accidents during a certain period of time", which is generally true for drivers cited for traffic violations, should be taken into consideration. This does not mean that "accidents are unavoidable because a driver's driving frequency is high", but instead that "because these drivers drive three times more often than other drivers, they need to be three times more careful than others when driving".

6. Conclusion

6-1 Summary of the analysis

Below is a summary of the analysis introduced in this paper.

Analysis 1: Characteristics of drivers who do not wear seat belts (based on traffic accident data analysis)

- Seat belt non-use rates are high for young people (under 50) and for the elderly (75 and older).
- Seat belt non-use rates are high for young people (under 50) in prefectures other than their prefecture of residence, and for the elderly (75 and older) in their prefecture of residence.
- Although seat belt reminders are effective, they have a minimal effect on increasing seat belt non-use rates.

Analysis 2: Characteristics of violators who repeat seat belt non-use (based on traffic violation data analysis)

- The relationship between percentages of drivers cited for seat belt non-use by age group (licensed drivers who have received a citation over a three-year period) and percentages of recidivists (drivers who have received two or more citations over a three-year period) varies by violation type.
- Seat belt non-use is a behavior that is difficult to modify for all age groups.

Analysis 3: Relationship between traffic violation/accident and seat belt non-use (based on traffic violation/accident data analysis)

- Seat belt non-use rates are high among drivers with a history of accidents and violations, and lowest among drivers with no history of accidents and violations (for almost every age group).
- Drivers and recidivists cited for seat belt non-use have a high rate of subsequent accidents.

6-2. Future utilization

From this research, we propose new ways of utilizing the integrated driver database with traffic accident/violation records.

(1) Analysis of non-accident drivers for accident prevention

If our target is a society without traffic accidents, it is necessary to study not only accident cases but also non-accident cases. Concerning this point, traffic accident data analysis can only provide us with information on drivers involved in accidents, but not that of drivers not involved in accidents. However, the proposed integrated driver database with traffic accident/violation records can provide both these types of information. Furthermore, a comparison study that shows the characteristics of both drivers involved in accidents and those not involved in accidents is expected to make safety driver education more effective.

(2) Systematical analysis of the effect of traffic enforcement

The effects of traffic enforcement are not always same and they sometimes appear in the short-term or long-term, or over a limited area or wide area due to the variety of methods and target groups analyzed.

Most studies on what effects traffic enforcement has on accident prevention are based on limited areas or methods, making it difficult to systematically discuss effects in terms of time and spatial points of view.

One reason for these difficulties is a lack of data to enable such systematic discussions.

The integrated database, which contains traffic violation data for all Japanese drivers (type of violation, scene, date, etc.) from over the past 20 years, as well as traffic accident data (type of collision, scene, date, etc.), makes it possible to discuss this topic from both time and spatial points of view.

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