イタルダ インフォメーション
ITARDA INFORMATION
交通事故分析レポート No.131

Special feature

Are elementary school students being made to wear their seatbelts properly?

~ Protecting elementary school student passengers in cars from accidents ~

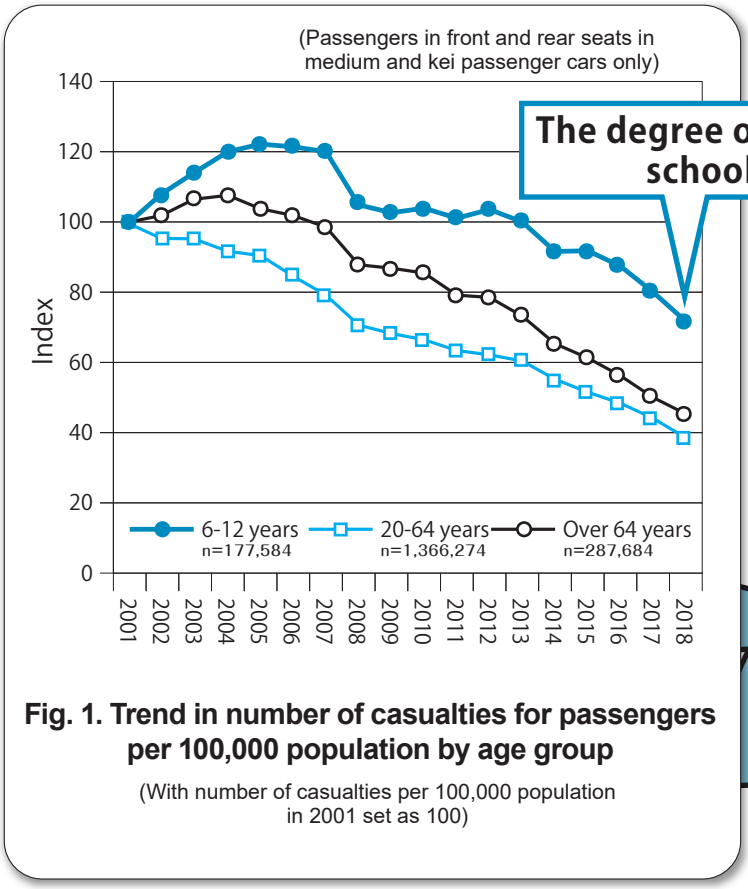


Fig. 1. Trend in number of casualties for passengers per 100,000 population by age group

(With number of casualties per 100,000 population in 2001 set as 100)

1 Introduction

The number of casualties resulting from traffic accidents that occurred in 2018 was 529,378. In the 10th Traffic Safety Basic Plan, the Japanese government has set forth a goal of reducing the annual number of casualties to below 500,000 by 2020, and has been carrying out various measures in this regard. Pedestrians, children, and elderly persons, or so-called "vulnerable road users," account for high percentage of the casualties, and as such, focused initiatives for these groups are needed. How are various initiatives changing the numbers of casualties from traffic accidents among children and elderly persons?

Fig. 1 on the cover page shows the trend in the number of casualties per 100,000 population[1)] for passengers in front and rear seats in medium and kei passenger cars (primary and secondary-party cars directly involved in traffic accidents) by age group. It appears that in all age groups, various measures have been effective in continuously decreasing the number of casualties.

Meanwhile, in the case of passengers of age 6 to 12 years, the degree of decline in the number of casualties per 100,000 population has been smaller than that of other age groups, and thus the trend of decline appears to differ from one age group to another. Similarly, in Fig. 2, which shows the trend in the number of fatalities or serious injuries, it can be seen that in the case of the number of fatalities or serious injuries per 100,000 population, the degree of decline among passengers of age 6 to 12 years is on par with that of elderly persons, and less than that of 20 to 64 years. Thus, it seems that measures to protect passengers of age 6 to 12 years from traffic accidents have been slow to take effect compared to those for other age groups. What makes this group different from other age groups?

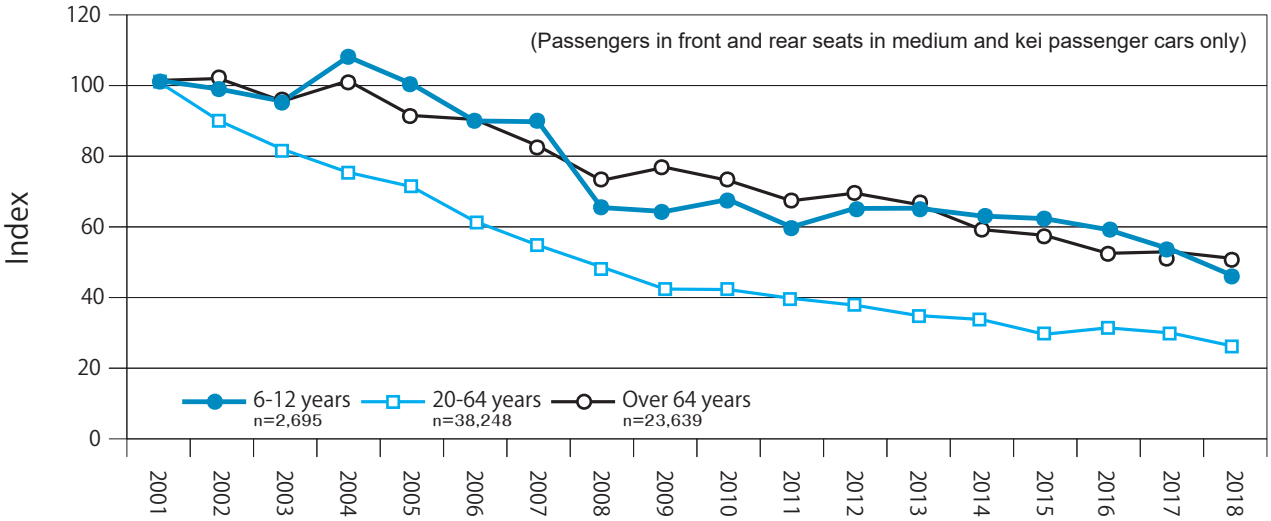


Fig. 2. Trend in number of fatalities or serious injuries for passengers per 100,000 population by age group

(With number of fatalities or serious injuries per 100,000 population in 2001 set as 100)

Since most 6 to 12-year-old children are elementary school students, passengers of age 6 to 12 years are hereinafter referred to as "elementary school students," and analysis is carried out placing a focus on accidents involving this group of passengers. Furthermore, since use/non-use of seatbelt is deeply related to whether injuries were sustained and the seriousness of injuries sustained during accidents, consideration will be given to the characteristics of, and issues related to fatality or serious injury accidents by use/non-use of seatbelt, and elementary school students will be compared with 20 to 64-year-old non-elderly adults (hereinafter "adults") in the context of such accidents.

2 Problem of many "seatbelt non-use" cases in rear seats among elementary school students

■ Status of seatbelt use among elementary school students

Let us first of all take a look at the status of seatbelt use with regard to fatalities or serious injuries among elementary school students.

Table 1 shows: Ⓐ the riding ratio in front passenger seat and rear seat, Ⓑ the rate of seatbelt non-use by front passenger seat and rear seat, and Ⓒ the rate of seatbelt non-use by front passenger seat and rear seat according to the riding ratio, in 2001 through 2018. The definitions of these are as follows.

Ⓐ Riding ratio = number of fatalities or serious injuries in front passenger seats versus number of fatalities or serious injuries in rear seats

Ⓑ Rate of seatbelt non-use by front passenger seat and rear seat (%)
= number of fatalities or serious injuries in "seatbelt non-use" cases in relevant seat ÷ number of fatalities or serious injuries in relevant seat × 100

Ⓒ Rate of seatbelt non-use by front passenger seat and rear seat according to riding ratio (%)
= Ⓐ × Ⓑ = number of fatalities or serious injuries in "seatbelt non-use" cases in relevant seat ÷ number of fatalities or serious injuries in all passenger seats × 100

(This calculation is based on the number of fatalities or serious injuries and thus differs from the actual riding ratios and rate of seatbelt non-use.)

Table 1. Rate of seatbelt non-use during accidents in medium and kei passenger cars

(Based on total number of fatalities or serious injuries in 2001 through 2018)

	Ⓐ Riding ratio	Ⓑ Rate of seatbelt non-use by front passenger seat and rear seat	Ⓒ Rate of seatbelt non-use by front passenger seat and rear seat according to riding ratio (Ⓐ × Ⓑ)
Elementary school students (6-12 years)	71% versus 29%	71% versus 27%	50% versus 8%
Adults (20-64 years)	38% versus 62%	74% versus 18%	28% versus 11%

Ⓐ in Table 1 shows that a higher ratio of elementary school students were riding in rear seats than front passenger seats (71% versus 29%). Ⓑ shows that the rates of seatbelt non-use in rear seats were about the same for elementary school students and adults, at roughly 70%.
As is shown in Ⓒ, while the rates of seatbelt non-use in rear seats were about the same for elementary school students and adults when an elementary school student was riding in the car, because it was more common for elementary school students to ride in rear seats, elementary school students accounted for a significantly higher percentage of cases for seatbelt non-use in rear seats (50%) than adults (28%).

■ Trend in number of fatalities or serious injuries in "seatbelt non-use" cases per 100,000 population when elementary school students were riding in "rear seats"

As such, it has been shown that elementary school student passengers account for "a high rate of seatbelt non-use cases in rear seats." Thus, we will next take a look at the trend in the number of fatalities or serious injuries in "seatbelt non-use" cases per 100,000 population when the passenger is riding in a "rear seat." Fig. 3 shows the trend by front passenger seat and rear seat in and after 2001.

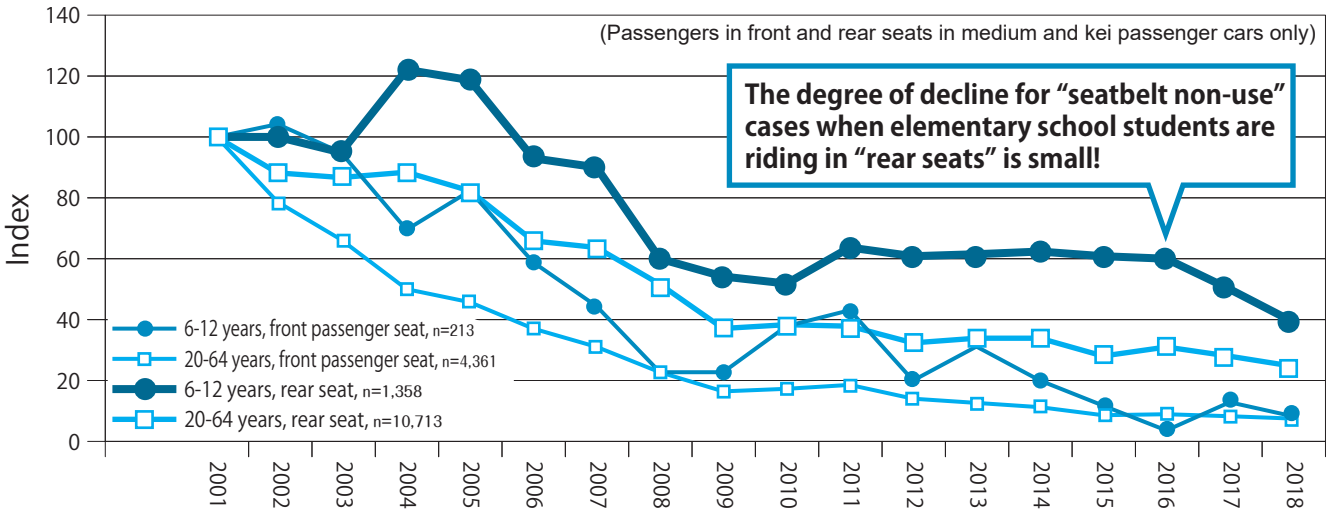


Fig. 3. Trend in number of fatalities or serious injuries in "seatbelt non-use" cases per 100,000 population for elementary school students and adults by front passenger seat and rear seat

(With number of fatalities or serious injuries per 100,000 population in 2001 set as 100)

Fig. 3 shows that for both elementary school students and adults, the degree of decline in the number of fatalities or serious injuries in “seatbelt non-use” cases per 100,000 population is smaller in “rear seats” than front passenger seats, and the degree of decline is the smallest for elementary school students in “rear seats.”
As for reasons why the decline in the number of fatalities or serious injuries has been relatively slow in the case of “rear seats”, looking at the history of initiatives related to car safety measures such as the installment of SRS airbags and reinforcement of car bodies, safety measures for the driver’s seat and front passenger seat appear to have been carried out in advance of those for the “rear seats,” and this seems to have had an effect.
Among elementary school students, there appears to be a problem in which the decrease in the number of fatalities or serious injuries in “seatbelt non-use” cases per 100,000 population has been slow in “rear seats.”

■ Trend in number of fatalities or serious injuries in “seatbelt non-use” cases per 100,000 population among elementary school students

The analysis thus far has shown that “elementary school students account for a high percentage of seatbelt non-use cases in rear seats,” and that “in the case of elementary school students, the decrease in the number of fatalities or serious injuries in ‘seatbelt non-use’ cases per 100,000 population has been slow in ‘rear seats.’”
We will now take a look at the overall trend in the number of fatalities or serious injuries in “seatbelt non-use” cases per 100,000 population, which also includes cases in which elementary school students are riding in the front passenger seat. Fig. 4 shows this trend in and after 2001.

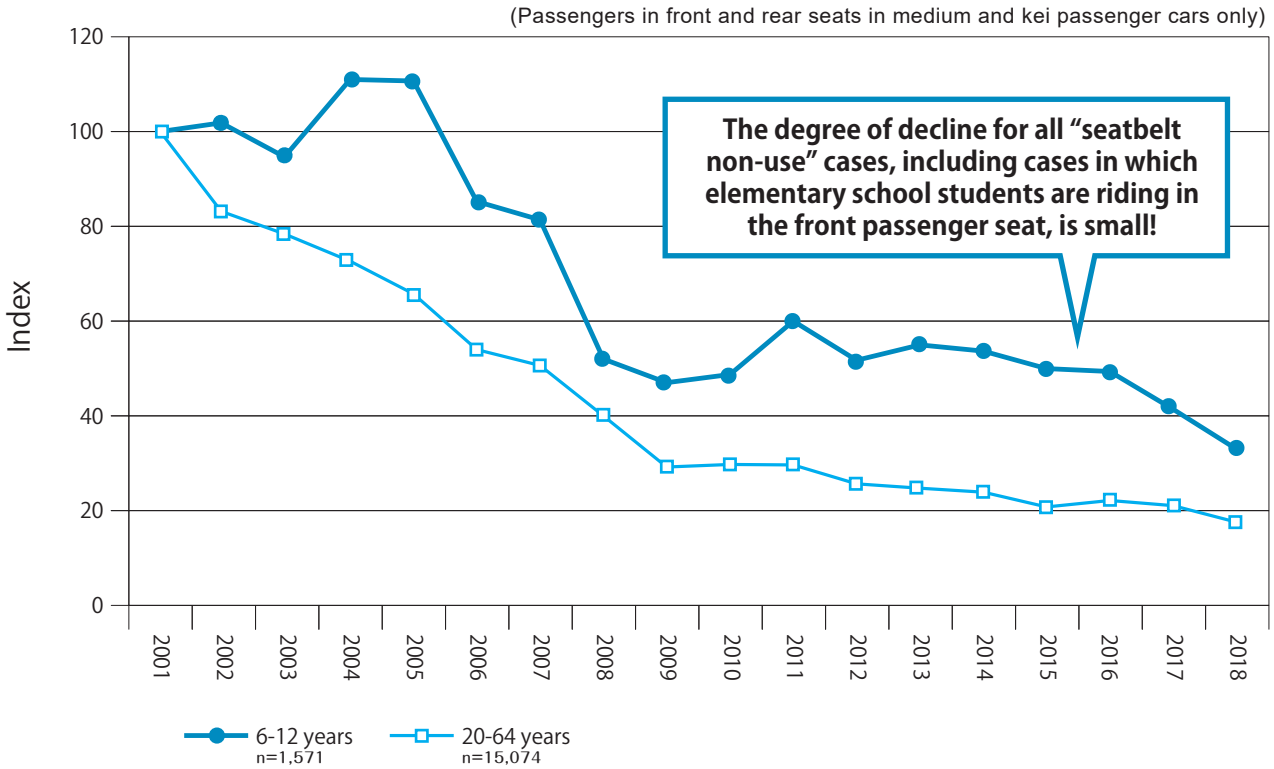


Fig. 4. Trend in number of fatalities or serious injuries in “seatbelt non-use cases” per 100,000 population among elementary school students and adults

(With number of fatalities or serious injuries per 100,000 population in 2001 set as 100)

Based on Fig. 4, it is apparent that the decrease in the overall number of fatalities or serious injuries in “seatbelt non-use” cases per 100,000 population, which includes cases in which elementary school students are riding in the front passenger seat, has been slow. This trend seems to be one reason why the decrease in the overall number of fatalities or serious injuries among elementary school students, which is shown in Fig. 2, has been slow.
One should not get the mistaken impression that riding in a “rear seat” is the problem. The problem is that there are many “seatbelt non-use” cases when the riding position is a rear seat. “Seatbelt non-use” cases are dangerous situations that can lead to serious injuries. In order to decrease the number of fatalities or serious injuries, thorough use of seatbelts must first of all be carried out.

❸ Even in “seatbelt use” cases, effects of seatbelt use are sometimes not being sufficiently obtained among elementary school students

■ Trend in the number of fatalities or serious injuries in “seatbelt use” cases per 100,000 population among elementary school students

We will now perform an analysis regarding the number of fatalities or serious injuries in “seatbelt use” cases. First, take a look at the trend in the number of fatalities or serious injuries in “seatbelt use” cases per 100,000 population among elementary school students. Fig. 5 shows this trend in and after 2001.

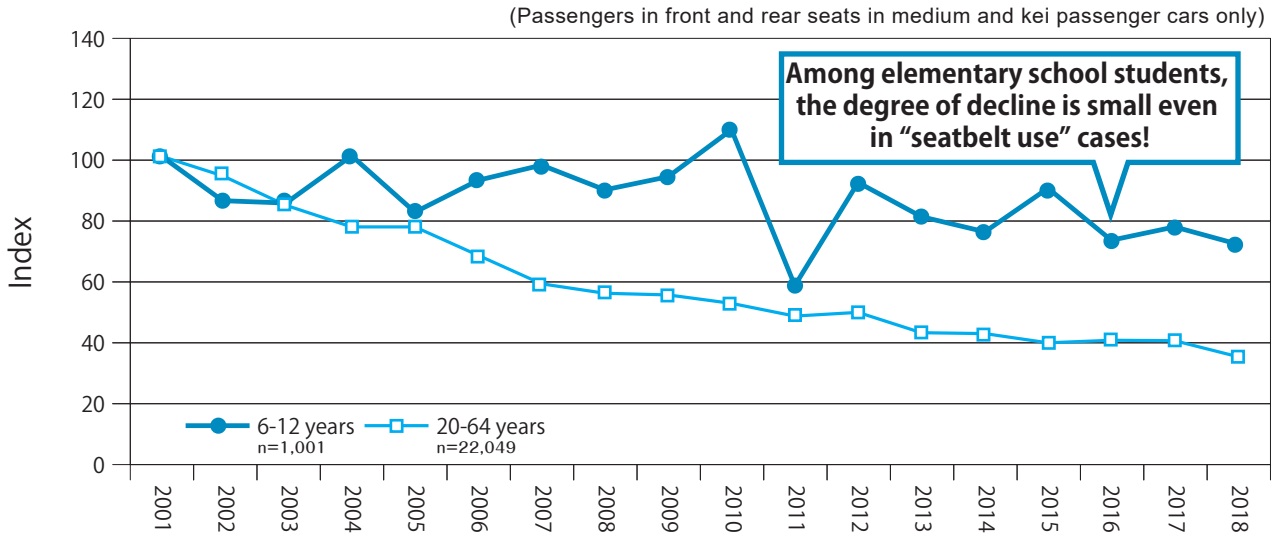


Fig. 5. Trend in number of fatalities or serious injuries in “seatbelt use” cases per 100,000 population among elementary school students and adults

(With number of fatalities or serious injuries per 100,000 population in 2001 set as 100)

Based on Fig. 5, it is apparent that among elementary school students, “the decrease in the number of fatalities or serious injuries in ‘seatbelt use’ cases per 100,000 population has been slow.” As with the slow decrease regarding “seatbelt non-use” cases, the slow decrease regarding “seatbelt use” cases seems to be a factor behind why the overall decrease in the number of fatalities or serious injuries among elementary school students, which is shown in Fig. 2, has been slow.

Why has the decrease in the number of fatalities or serious injuries been slow even in “seatbelt use” cases?

■ Injured body part in “seatbelt use” cases

We would now like to take a look at the “injured body part” and analyze this as a factor related to why the decrease in the number of fatalities or serious injuries in “seatbelt use” cases per 100,000 population has been slow. Here, “injured body part” refers to the part of the body that sustained the principle damage leading to the fatality or serious injury. Fig. 6 shows a comparison of the composition rates of injured body parts in fatalities or serious injuries in “seatbelt use” and “seatbelt non-use” cases in 2001 through 2018.

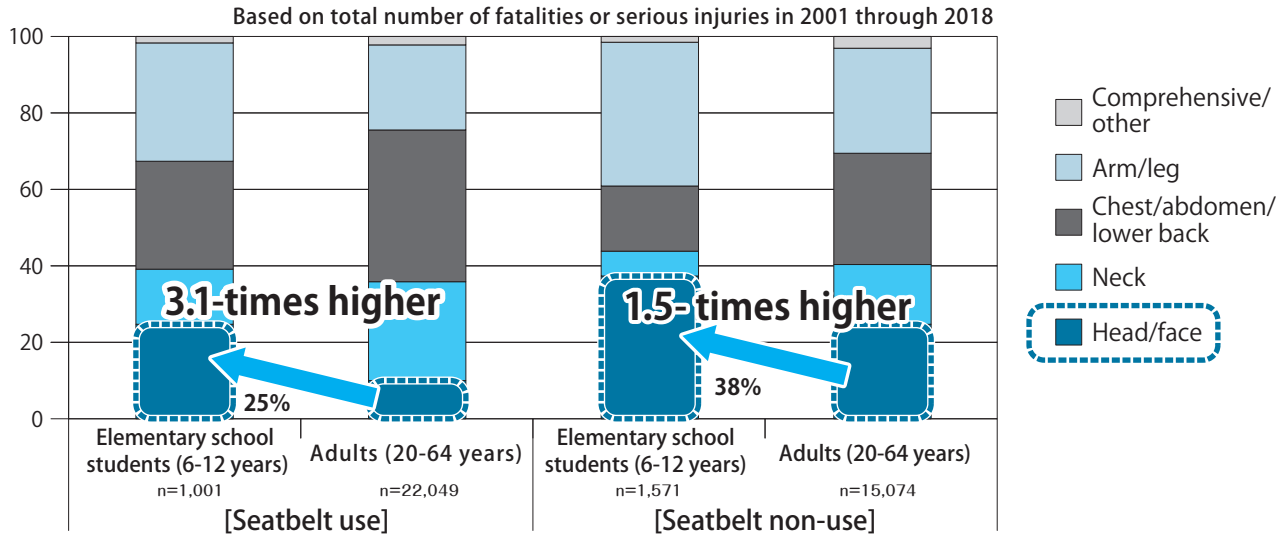


Fig. 6. Composition rates of injured body parts in fatalities or serious injuries

Fig. 6 first of all shows that the rate for the injured body part "head/face" is higher for elementary school students than for adults. It is generally said that in the case of children, there is a tendency for the upper body to tilt forward at the time of an impact since the head is large relative to the size of the rest of the body and the center of gravity is high[2]. As a result, the "head/face" part comes in contact with the inside of the car cabin and sustains injuries more frequently compared with adults.
Also, it is clear that when seatbelt is worn, the rate for the injured body part "head/face" is lower compared with "seatbelt non-use" cases (38% → 25%), and that seatbelt use has the effect of reducing the number of cases in which the "head/face" comes in contact with the car.
Meanwhile, the rate for the injured body part "head/face" was 1.5-times higher for elementary school students than for adults in "seatbelt non-use" cases and 3.1-times higher for elementary school students than for adults in "seatbelt use" cases.

■ Mechanisms of injury in "seatbelt use" cases based on injured body parts and injury-inflicting car parts

In the case that elementary school students and adults are restrained to their seats in a similar manner in seatbelt use cases, elementary school students, which have about half the body weight and height of adults, are thrown from car seats less frequently during accident impacts. It seems that the reason the rate for the injured body part "head/face" is higher among elementary school students in spite of this logic is that "elementary school students might actually not be receiving the same restraining force from seatbelts as adults."
We will consider this based on the injured body part and the part of the car that inflicted the injury (injury-inflicting car part). Tables 2-1 and 2-2 show the composition rates (%) of the injured body part and injury-inflicting car part combinations in fatalities or serious injuries in "seatbelt use" cases. The size of the dots on the table corresponds to the size of the composition rate.

Table 2-1. Composition rates (%) of injured body parts and injury-inflicting car parts in fatalities or serious injuries in "seatbelt use" cases among elementary school students

(n=1,001)

	Ejected from car	Steering wheel	Windshield	Dashboard area	Door/ window	Pillar	Roof	Seat (2)	Other parts of car interior	Parts of car exterior, etc.
Head/face	(1)		●	●	●	●	●	6	9	●
Neck								11	●	
Chest/abdomen/ lower back				●	●			11	11	●
Arm/leg				●	5	●		10	10	●
Other								●		

(Based on the total number of fatalities or serious injuries in 2001 through 2018.
When 0 when rounded down to nearest whole number: blank space; when 1 to below 5: ● only.)

Table 2-2. Composition rates (%) of injured body parts and injury-inflicting car parts in fatalities or serious injuries in "seatbelt use" cases among adults

(n=22,049)

	Ejected from car	Steering wheel	Windshield	Dashboard area	Door/ window	Pillar	Roof	Seat (2)	Other parts of car interior	Parts of car exterior, etc.
Head/face	(1)		●	●	●			●	●	
Neck								19	●	●
Chest/abdomen/ lower back				●	5			14	15	●
Arm/leg				●	●			5	9	●
Other								●	●	

(Based on the total number of fatalities or serious injuries in 2001 through 2018.
When 0 when rounded down to nearest whole number: blank space; when 1 to below 5: ● only.)

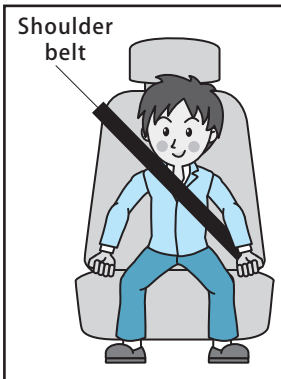
By comparing Tables 2-1 and 2-2, the characteristics of (1) and (2) on the tables become apparent. Based on (1), it is clear that the "head/face" part comes into contact with many car parts in the case of elementary school students compared to adults. In other words, "there is a higher frequency of being thrown from the seat even in seatbelt use" cases.
Looking at the injury-inflicting car parts “seat” and “other parts of car interior” in (2), more than 70% injuries are being inflicted by these parts. Seatbelts are also concerned with these injury-inflicting car parts. Since passengers are restrained to their “seat” with a seatbelt, seatbelts have some effect on this car part. “Other parts of car interior” consists of the injury-inflicting car parts such as console box, shift lever, and so on, and it also includes seatbelts.
Under (2), the injured body parts for adults are mainly concentrated at the trunk of the body in the “neck” and “chest/abdomen/lower back” parts. This seems to be due to the fact that the seatbelt is restraining the passenger in an effective manner, so many of the injuries that are sustained are from pressure from the seatbelt itself, and shaking and whiplashing of the body while it is restrained to the seat with the seatbelt.
Meanwhile, in the case of elementary school students, the injured body parts are mainly “head/face” and “arm/leg” and relatively few injuries are sustained in “neck” and “chest/abdomen/lower back.” In other words, unlike adults, many injuries are sustained at parts of the body that are slightly away from the trunk, and thus it seems that “relatively few injuries are sustained from the seatbelt itself and restraining of the body to the seat with the seatbelt.” Thus, as suspected, there seems be a “possibility that seatbelts are not restraining as effectively as they are with adults.”
Therefore, it appears that the decrease in the number of fatalities or serious injuries in “seatbelt use” cases has been slow because the effects of seatbelt use are not sufficient.
Why has it not been possible to obtain a sufficient level of effects from seatbelt use?

4 Why effects of seatbelt use are not being sufficiently obtained among elementary school students

It is generally said that seatbelts are effective when the passenger’s height is 140 cm or above, and thus seatbelts sometimes do not fit the passenger’s body frame until the passenger is around 10 years old. There are survey results showing that child passengers wear seatbelts in a variety of ways when riding in cars[3)-4)]. As shown in Table 3, these include wearing the seatbelt at a shifted angle or with poor body posture (sprawling, etc.) due to feeling that the correct position is uncomfortable, and having the shoulder belt become misaligned due to steering maneuvers of the driver for avoiding obstacles and so on. It seems that when accidents occur while seatbelts are being worn in such ways, there are many cases in which injuries are sustained because effects from seatbelt use are not obtained.

Table 3. Examples of ways shoulder belts are worn by child passengers

(Information on lap belt omitted from figure.)

			
Worn correctly	Worn at shifted angle	Worn with poor body posture	Misalignment of child’s shoulder belt resulting from steering maneuver of driver

In order for the effects of seatbelt use to be obtained, the following is required. “The seatbelt must be worn properly while maintaining the correct body posture based on eliminating discomfort related to the seatbelt. This is achieved by adjusting the height of the shoulder belt and height of the seat (in the case of a front passenger seat), or using a child safety seat for school-age children (which is sometimes referred to as a “booster seat”), which market analysis of accidents in the United States has shown to be effective for reducing the risk of serious injuries[5)-6)], etc.”

5 Conclusion

In this special feature, since most fatality or serious injury accidents among 6 to 12-year-old children involve elementary school students, we referred to these as “fatality or serious injury accidents among elementary school students,” and we analyzed these from the perspectives of “seatbelt non-use” and “seatbelt use” cases.

For elementary school students,

- While the rate of seatbelt non-use cases in rear seats is about the same as that for adults, because it is more common for elementary school students to ride in rear seats, elementary school students account for a higher “rate of seatbelt non-use cases in rear seats” than adults. Due to this and the fact that the decrease in the number of fatalities or serious injuries per 100,000 population when the riding position is “rear seat” has been slow, the overall decrease in the number of fatalities or serious injuries in “seatbelt non-use” cases per 100,000 population has been slow.
- The overall decrease in the number of fatalities or serious injuries per 100,000 population has been slow in “seatbelt use” cases as well. This is because during impacts in accidents, the effects of seatbelt use are not being sufficiently obtained as the result of improper use of seatbelts or body posture.

As a result of the above:

- Since the decrease in the number of fatalities or serious injuries per 100,000 population has been slow in both “seatbelt non-use” and “seatbelt use” cases, the overall decrease in the number of fatalities or serious injuries per 100,000 population has been slow.

When elementary school students are riding together, they should be made to ride in a rear seat as much as possible, and always be made to wear a seatbelt. Please make sure that they are sitting squarely in their seat and are able to sit comfortably when riding in the car, and also please check to make sure that the lap belt is near the pelvis. If the seatbelt position does not fit the child, please make adjustments by using a child safety seat for school-age children, etc.

There is a need for guardians to be more thorough about carrying out the above in order to protect elementary school students from being harmed in accidents.

(Masanori Taniguchi)

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＜お詫びと訂正＞

イタルダ・インフォメーションNo.130に誤記がありました。正しくは下記になります。お詫びして訂正します。

表紙下部の【死者数の多い県】で　(誤)埼玉都　➡　(正)埼玉県

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