

ITARDA INFORMATION

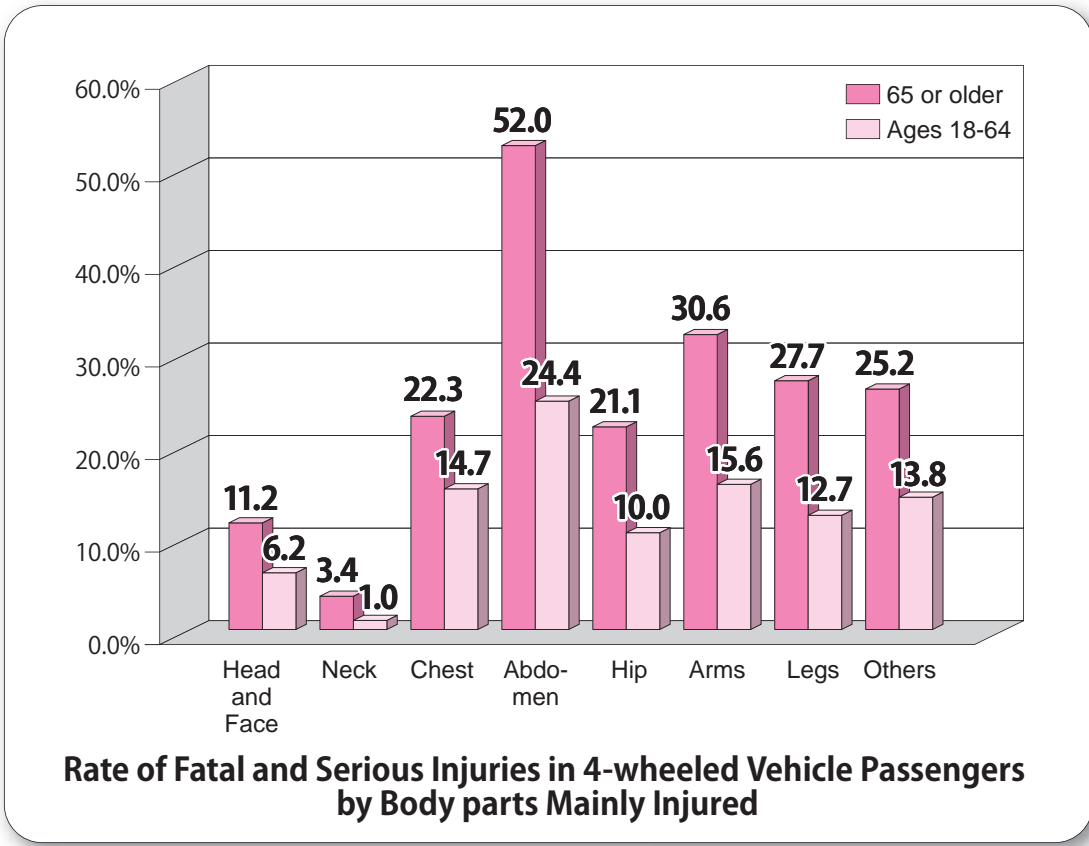
交通事故分析レポート

No.104

Special feature

Injuries to Older Passengers in Traffic Accidents

~How can we reduce the risk of fatalities and serious injuries?~



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1 Introduction

Elderly population of Japan is increasing by the year and so are older drivers and older passengers. So far, many of our reports were centered on injuries in older drivers of 4-wheeled vehicles; however in this issue we shall focus on older passengers and analyze the situations that cause them serious injuries or fatalities while they are occupying 4-wheeled vehicles followed by ways to reduce such risks.

2 Injuries to older passengers

Fig.1 and Fig.2 show respectively the trend in casualties and fatal and serious injuries caused to the front and rear seat passengers of 4-wheeled vehicles (limited to passenger cars, light passenger cars and light trucks) based on our Traffic Accident Research Database from 2002 through 2012. Passengers aged 65 and older (hereafter "older passengers") account for more fatal and serious injuries and less casualties as compared to those aged 18-64 (hereafter "younger passengers") indicating that older people are more likely to die or sustain severe injuries when met with accidents. The comparison is based on casualties per 0.1 million population.

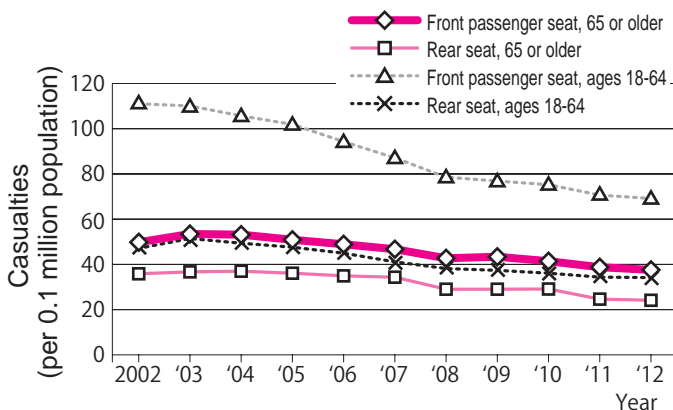


Fig.1 Trend in casualties of 4-wheeled vehicle passengers (per 0.1 million population)

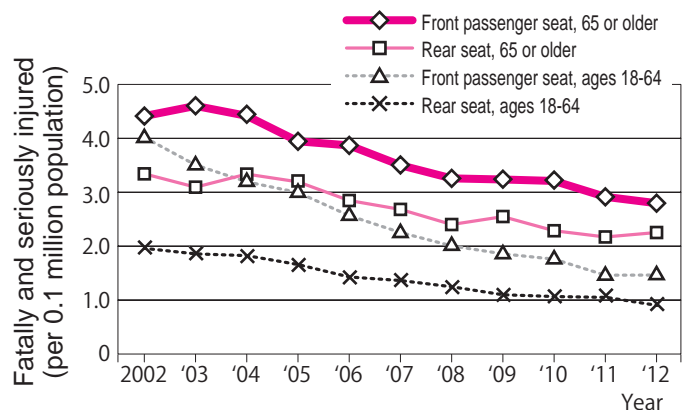


Fig.2 Trend in fatally and seriously injured passengers of 4-wheeled vehicles (per 0.1 million population)

(Population is based on the 'Population Estimates' taken by the Statistics Bureau of Ministry of External Affairs and Communications as of October 1 each year)

<The figures used hereafter are cumulative figures based on our Traffic Accident Research Database from 2008 through 2012. >

The composition ratio of injured occupants of driver seat, front passenger seat and rear seat reveals that older passengers (approx. 35%) account for more casualties (Fig.3) as well as fatal and serious injuries (Fig.4) as compared to the younger passengers (approx. 20%). While older driving license-holders are on the rise by the year, however when seen by the license ownership ratio in 2012 it was lower (46%) as compared to younger passengers (88%) which may be the reason for higher rate of older passenger casualties.

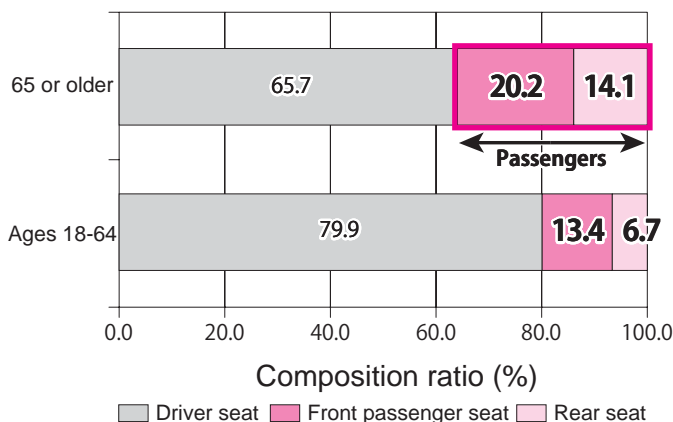


Fig.3 Composition ratio of casualties by seat position

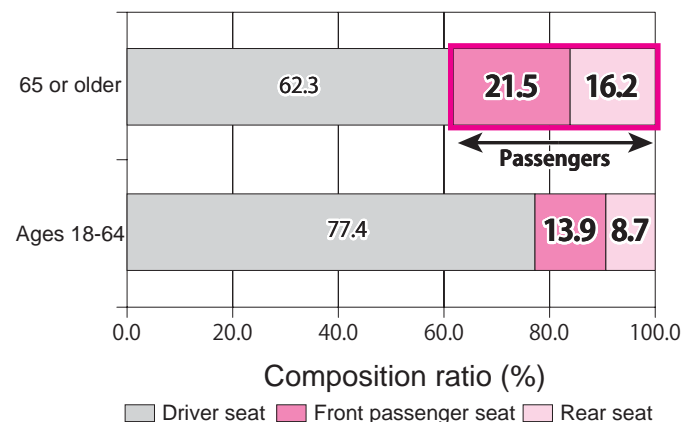


Fig.4 Composition ratio of fatally and seriously injured occupants by seat position

3 Effect of seat belt use on older passengers

How effective are seat belts in the event of an accident? Fig. 5 indicates that irrespective of age or seat position, there is a significant reduction in the rate of fatal and serious injuries with the use of seat belts. However, it is also evident that the rate is 3.5 to 4 times higher in older passengers than the younger passengers even though they were wearing seat belts. Therefore, in the following pages we have analyzed the situations that led to fatal and serious injuries in older passengers in spite of them wearing seat belts as well as the reason for higher rate of fatal and serious injuries as compared to younger passengers.

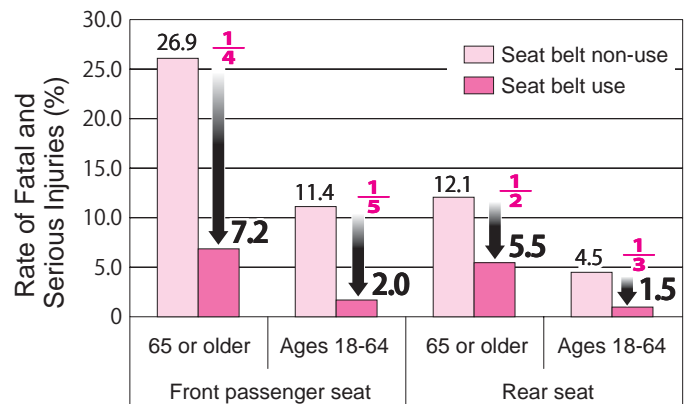


Fig.5 Rate of fatal and serious injuries by age, seat position and use/non-use of seat belts

(Rate of fatal and serious injuries = No. of fatal and serious injuries/ No. of casualties x 100)

4 In which situations older passengers sustain fatal and serious injuries?

(Limited to seat belt use)

Collision of which part of vehicle leads to more fatal and serious injuries?

Frontal collision of vehicles (total of head-on, front right and front left collisions) resulted in higher fatal and serious injuries of older passengers with front passenger seat and rear seat accounting for 76% and 68% of total collisions respectively (Table 1). Fig.6 and Fig.7 supplement that the rate of older passengers sustaining fatal and serious injuries regardless of whether occupying front passenger seat or rear seat is 3-4 times more than that of younger passengers in the event of frontal collision.

Table 1. No. of fatally and seriously injured older passengers by vehicle part collided (Total of 2008-2012)

	Head on	Front right	Front left	Right lateral	Left lateral	Rear total	Others	Total
Front passenger seat	1787	587	665	211	425	305	21	4001
Rear seat	490	201	164	99	133	121	46	1254

Accidents with frontal collision of vehicle (Front seat: 76% of total, Rear seat; 68% of total)

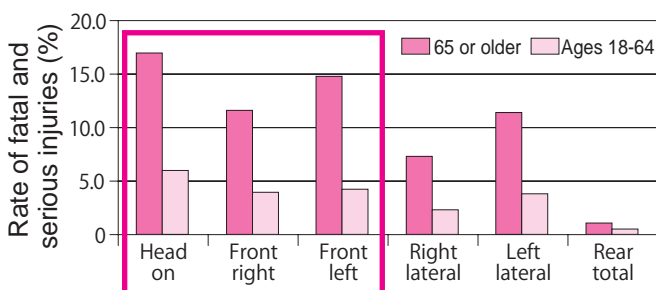


Fig.6 Rate of fatal and serious injuries to front seat passengers by vehicle part collided

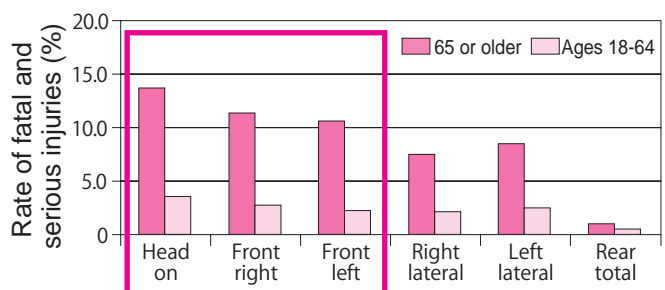


Fig.7 Rate of fatal and serious injuries to rear seat passengers by vehicle part collided

Further, frontal vehicle collisions caused chest injuries in many cases (graph not attached) at the rate of 44% and 34% respectively in front and rear seat older passengers. However the rates were lesser in the case of younger passengers at 29% and 21% respectively. Similarly, in the case of abdomen injuries resulting from frontal collisions, older passengers recorded higher rate at 11% as compared to 7% in younger passengers when rear seats were occupied. On the other hand, when the passengers were occupying the front seat the rate was around 7% regardless of their age.

Fig.8 and Fig.9 indicate that the rate of fatal and serious injuries of older passengers is higher for abdomen injuries for both front passenger seat and rear seat, and so is the gap with younger passengers. Besides, older passengers are more likely to sustain fatal and serious injuries to their arms and legs.

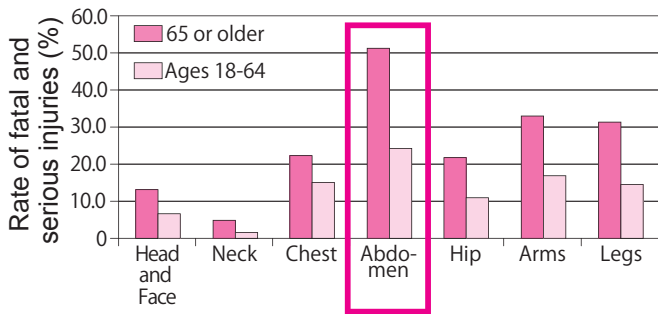


Fig.8 Rate of fatal and serious injuries to front seat passengers by body part mainly injured

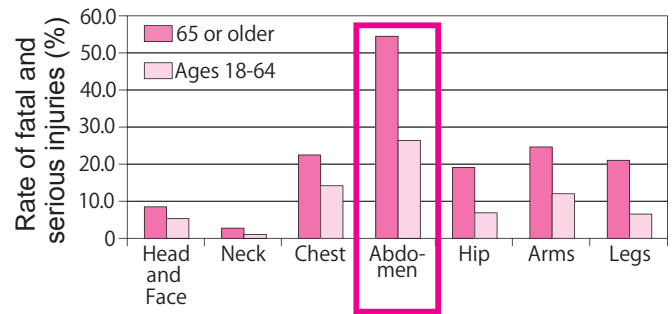


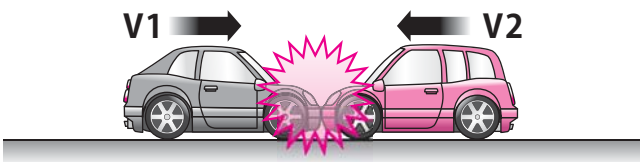
Fig.9 Rate of fatal and serious injuries to rear seat passengers by body part mainly injured

At what collision speed are fatal and serious injuries caused more frequently?

We analyzed the degree of impact of the vehicle using Quasi-ΔV*1 (Estimated variance in vehicle speed before and after collision; hereafter “collision speed.” The degree of impact is directly proportional to the collision speed). Highlighted columns of Table 2 indicate that frontal vehicle collisions causing fatal and serious injuries to 80% of older passengers occurred at collision speeds ranging from 11km/h to 50km/h or less.

Relatively speaking based on the composition ratio of the body part of older passengers mainly injured (graph not attached,) chest injuries dominated at all collision speeds with 40-50% for front passenger seat and 30-38% for rear seat. Whereas abdomen injuries to rear seat passengers increased greatly with increase in collision speed; at the rate of 2% for 20km/h or less, then rising to 8%, 11% with the rise in speeds and to 21% for 50km/h or less. Injuries to arms at collision speed 20km/h or less accounted for 19% and 23% in case of front and rear seat passengers respectively.

*1 Quasi-ΔV refers to the estimated variance in vehicle speed before and after collision and is calculated based on danger perception speed and complete vehicle curb mass. Here it is shown as “collision speed.”



For reference: Consider that your vehicle (1) and other party's vehicle (2) collide, then the estimated equation for “Collision speed” (Quasi-ΔV) of your vehicle is as follows:

$$\Delta V1 = M2 / (M1 + M2) \times (V1 + V2)$$

where **M** = complete vehicle curb mass,
V = danger perception speed

Supposing **M1** is 1000kg and **M2** is 1500kg while the danger perception speed for both vehicles is 50 km/h, then **ΔV1 = 60 km/h.**

Table 2. No. of fatally and seriously injured older passengers by collision speed (Quasi-ΔV) (total of 2008 to 2012; unknown cases excluded)

	10 km/h or less	20km/h or less	30km/h or less	40km/h or less	50km/h or less	60 km/h or less	Over 60km/h
Front passenger seat	71	237	361	497	455	210	194
Rear seat	9	64	99	147	144	54	65

Fig. 10 through Fig.13 show the relation between “collision speed” and rate of fatal and serious injuries by body parts mainly injured. In case of older passengers chest injury grows in proportion to the collision speed. Further, abdomen injury grows sharply beyond 21km/h especially for rear seat passengers, while arm injury shows a characteristic high even at low speed. Also, as compared with younger passengers, older passengers demonstrate increase in the rate of fatal and serious injuries from low speed itself for all body parts.

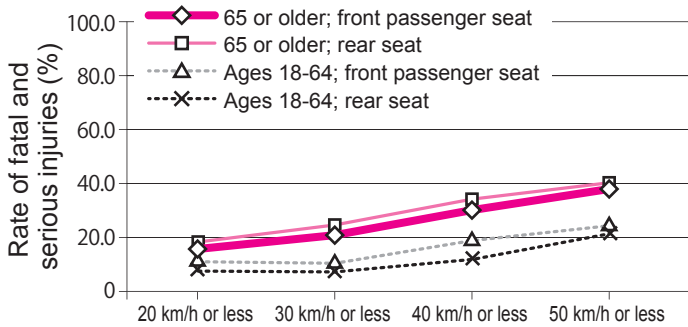


Fig.10 Rate of fatal and serious injuries to chest by collision speed (Quasi-ΔV)

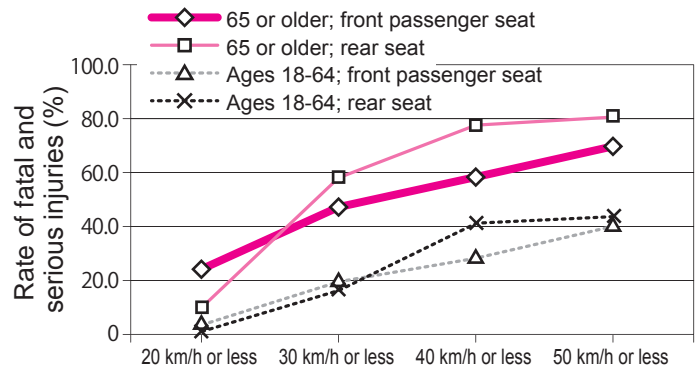


Fig.11 Rate of fatal and serious injuries to abdomen by collision speed (Quasi-ΔV)

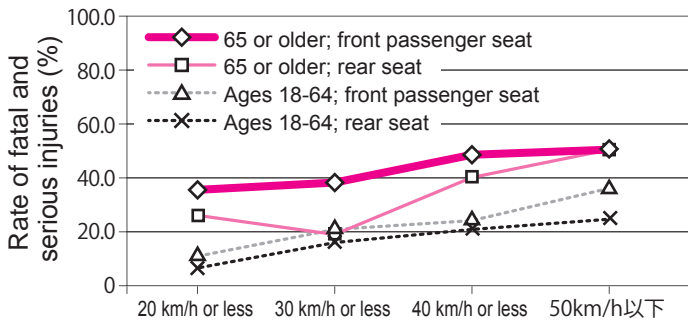


Fig.12 Rate of fatal and serious injuries to arms by collision speed (Quasi-ΔV)

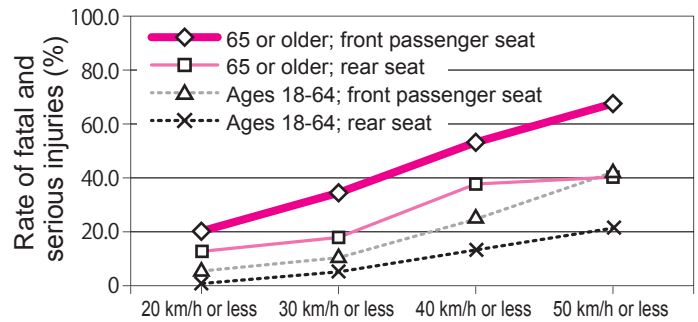


Fig.13 Rate of fatal and serious injuries to legs by collision speed (Quasi-ΔV)

Collision with which parts of the vehicle interior cause injuries? (Injuring vehicle parts)

In frontal vehicle collisions where older passengers sustained fatal and serious injuries, 70-90% was due to vehicle parts such as “seat” and “other vehicle interiors”^{※2}. From the following section of case example of accidents it is conceivable that seat belts account for majority of such injuries. Further, in case of front passenger seat, “door and window glass” and “dashboard vicinity” caused injuries in 10% each (see highlighted area of Table 3).

Ratio of injured body parts by seat position and injuring vehicle parts (graph not attached) shows that chest injuries are predominant in all the cases regardless of which vehicle part is inflicting injuries (31-50% for front passenger seat and 20-40% for rear seats). However, “other vehicle interiors” has been the cause of abdomen injuries in 13% of rear seats and is higher than that of front passenger seats which is at 8%. Further, “door and window glass” inflicted arm injuries at the rate of 36% in rear seats and 34% in front passenger seats whereas “dashboard vicinity” was the cause in 22% of the leg injury cases.

※2 ‘Other vehicle interiors’ as described in the Traffic Accident Statistics Handbook issued by National Police Agency, refers to such vehicle interior parts and loaded baggage that inflict injuries to human body other than the steering wheel, front glass, dashboard vicinity, door and window glass, column, roof and seat.

Table 3 No. of fatally and seriously injured older passengers by injuring vehicle parts (total of 2008-2012)

Older passengers	Seat	Other vehicle interiors	Door and window glass	Dashboard vicinity	Others	Total
Front passenger seat	989	1181	314	304	251	3039
Rear seat	462	305	45	8	35	855

Fig.14 through Fig.17 show the relation of the injuring vehicle parts and the rate of fatal and serious injuries by body parts of older passengers mainly injured. Whereas the rate is low for chest injuries irrespective of the injuring vehicle part, it is high in case of abdomen injuries. As compared to younger passengers, seats have caused higher rate of abdomen injuries to older passengers. Further, contact with dashboard vicinity is the reason for high rate of arm and leg injuries in front seat passengers.

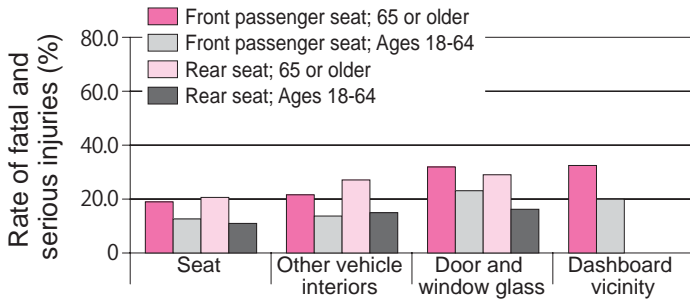


Fig.14 Rate of Fatal and Serious Injuries to Chest by Injuring Vehicle Parts

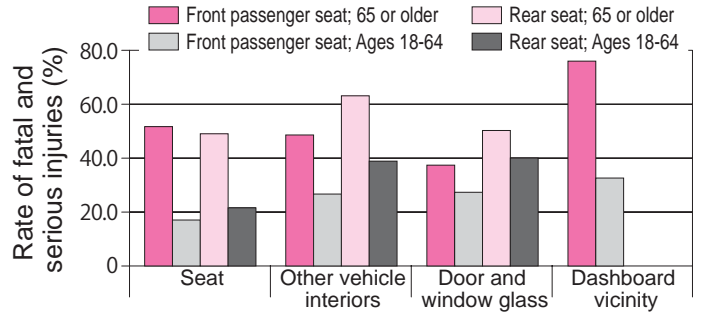


Fig.15 Rate of fatal and serious injuries to abdomen by injuring vehicle parts

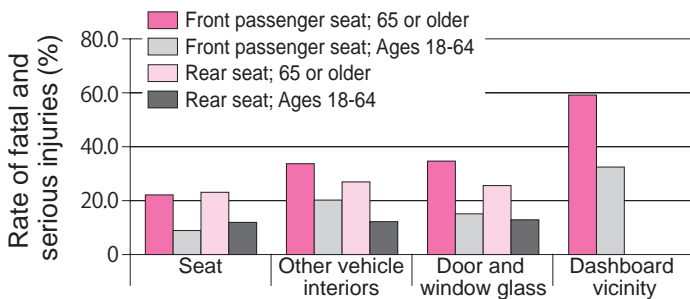


Fig.16 Rate of fatal and serious injuries to arms by injuring vehicle parts

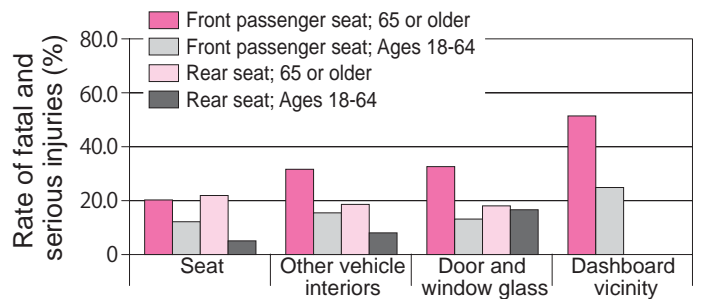


Fig.17 Rate of fatal and serious injuries to legs by injuring vehicle parts

What type of injury condition is caused most frequently that is applicable to all the above-mentioned situations?

Fig.18 and Fig.19 show the composition ratio of injury condition for front passenger seat and rear seat respectively by the body parts mainly injured. Apparently, fracture ratio is high in both front and rear seats in case of chest injury while rupture of internal organs is high in rear seats as well. In case of abdomen injury, rupture of internal organs occurred more often in both front and rear seats with the ratio exceeding 60% in rear seats whereas over 90% of the arm and leg injuries were fractures.

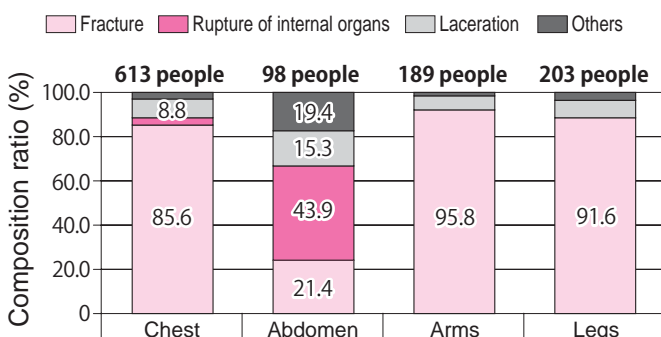


Fig. 18 Injury condition of older front seat passengers by body parts mainly injured

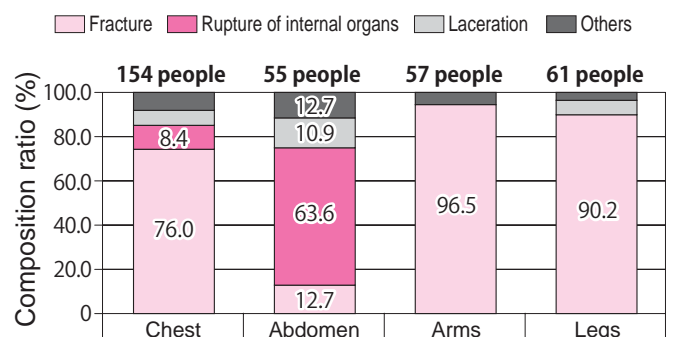


Fig. 19 Injury condition of older rear seat passengers by body parts mainly injured

5 Characteristics deduced from Case Examples

Based on the analysis so far it can be said about the fatal and serious injuries in older passengers who wore seat belts that, chest injuries were higher in terms of absolute number whereas abdomen injuries were higher in terms of the rate. Nevertheless, in order to find out other injury factors that were not covered in our Traffic Accident Research Database, we investigated our In-depth Case Studies (hereafter 'microdata'). The effects of 1) difference in physiques of older passengers and 2) unusual factors^{※5} were studied.

Microdata for a period of 10 years from 2003 through 2012 on frontal vehicle collisions that resulted in fatal and serious injuries in older passengers wearing seat belts were examined. Though little in number, 17 relevant cases were analyzed and the following characteristics were deduced (this includes hip injuries).

■ Difference in physiques of older passengers

Case examples of older passengers with a small frame less than 155 cm derived from the average height of older men and women^{※3} were studied. Table 4 and Fig. 20 indicate that out of twelve older passengers with fatal and serious injuries in chest, abdomen or hip, eight were small framed and their injury conditions varied. However, difference in physiques had little effect on the fatality rates or serious injury rates due to injuries to these body parts. These results suggest that older passengers with small frames are more likely to get injured in chest, abdomen or hip due to seat belts.

※3 Average height of older population aged 65-79 based on the Health and Nutrition Survey conducted by the Ministry of Health, Labor and Welfare in 2010 and 2011: Men: 163 cm Women: 150 cm

Table 4 Injury condition^{※4} based on difference in physiques

		Height	
		Less than 155 cm	155 cm or more
No. of fatal and serious injuries		10 people	5 people
Injuries to chest, abdomen, hip		8 people	4 people
Injury condition (injured due to seat belt)	Chest	Sternal fracture	Rib fracture
		Rib fracture	Heart injury
		Lung injury	Abrasion
		Vascular injury	Bruise
		Intrathoracic injury	
		Bruise	
	Abdomen	Injury to Pancreas	Liver injury
		Retroperitoneal injury	Lacerated wound
		Lacerated wound	
	Hip	Intrapelvic injury	Pelvic fracture
		Lumbar spine fracture	

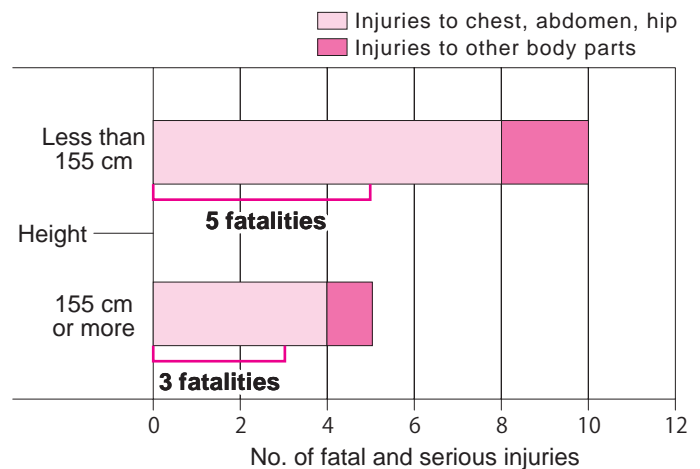


Fig. 20 Injury condition by difference in physique and fatalities

■ Unusual factors^{※5}

Table 5 and Fig. 21 show that the rate of injuries to chest, abdomen and hip is more than 80% in the presence of unusual factors^{※5}, whereas the rate is 60% in their absence and that many such injuries proved fatal.

Table 5 Injury condition etc.^{※4} in Presence of Unusual Factors^{※5}

		Unusual factors	
		Present	Absent
No. of fatal and serious injuries		7 people	10 people
Injuries to chest, abdomen, hip		6 people	6 people
Injury condition (injured due to seat belt)	Chest	Rib fracture	Rib fracture
		Sternal fracture	Bruise
		Lung injury	Abrasion
		Heart injury	Lacerated wound
		Vascular injury	
		Intrathoracic injury	
	Abdomen	Liver injury	Retroperitoneal injury
		Pancreatic injury	Pancreatic injury
		Lacerated wound	
	Hip	Intrapelvic injury	Pelvic fracture
		Lumbar spine fracture	

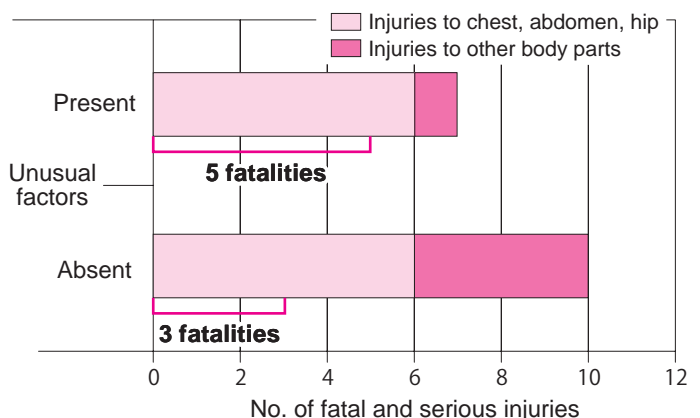


Fig. 21 Injury condition in presence of unusual factors and fatalities

※4 Injury condition also includes other injuries which did not result in fatal or serious injuries.

※5 Unusual factors include cases like cushion was placed on the seat, seat was reclined, seat slider was dislocated etc.

6 Conclusion

■ Characteristics of Injuries to Older Passengers in Accidents

- Seat belts prove effective for older passengers regardless of their seat positions, but are less effective as compared to that of younger passengers.
- Despite wearing seat belts, older passengers are more likely to sustain fatal or serious injuries as follows and the injury condition in such cases are mostly fractures for the chest, arms and legs whereas rupture of internal organs for abdomen.
 - 1) Fatal and serious injuries in frontal vehicle collisions: By absolute number chest injuries are high whereas by rate abdomen injuries are high.
 - 2) Accidents with “collision speed” (variance in speed before and after collision) ranging from 11km/h to 50km/h or less: Rate of fatal and serious injuries begin to show an increase from a lower collision speed as compared to that of younger passengers.
 - 3) In accidents where “seats” and “other vehicle interiors” inflict injuries, seat belts are the causes in most cases.
- Microdata indicate that
 - 1) Rate of older passengers with small frame sustaining injuries in chest, abdomen and hip due to seat belt is high.
 - 2) Rate of sustaining fatal injuries to chest, abdomen and hip owing to the placement of cushions on the seats etc., is high.

■ How to reduce the risk of fatal and serious injuries in older passengers

Starting with the obvious, always encourage them to wear seat belts correctly regardless of their seat positions. However, there are can be various reasons as to why they are not seated properly or not wearing their seat belts properly. Therefore, we urge drivers and other co-passengers to pay attention to the following points.

◇ Are they seated properly?

It is possible that gap has developed between the hip and the seat back causing backward tilting of the pelvis due to factors such as back of the knee hitting the front edge of the seat preventing passengers with small frame to sit deep, slumped posture due to old age etc. (See fig.22).

Also reclining the seat too much will lead to similar condition. In such cases, the seat belt in the hip region tends to ride up increasing the risk of hip injury. In order to avoid the dislocation of seat belt in the hip region, ensure correct sitting posture by erecting the seat back as much as possible, providing cushion for back and hip support and the like. (Do not overdo as the situation may differ from person to person.)

◇ Check for any unfastened or slippery cushion placed on the seat.

Case examples of accidents reveal that cushion may slide the hip forward causing the seat belt to ride up which may result in serious injuries to abdomen and chest. If the cushion is unavoidable ensure that it is fastened properly and is not slippery.

◇ Is the seat position drawn too forward?

Contact with dashboard vicinity has caused many arm and leg injuries to older passengers on the front seat. Also, drawing the seat too forward may retard the view of the driver by creating a dead angle. So ensure that the seat is adjusted slightly backward than the driver seat.

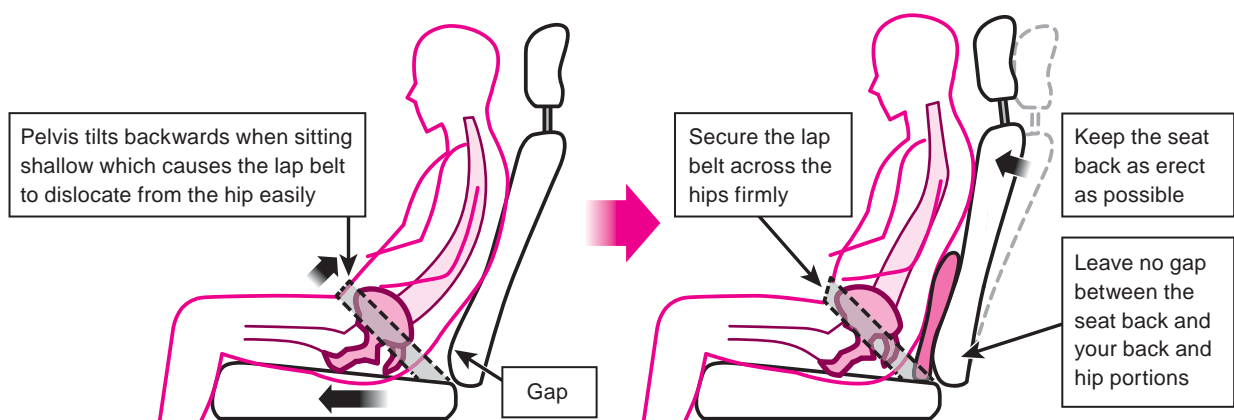


Fig.22 Better sitting posture

In the above section, actions that need to be undertaken with immediate effect were mentioned. Nevertheless, since the older population would continue to grow, vehicle accessory manufacturers are expected to further develop user-friendly seat-belts and new restraint and vehicle systems going forward.

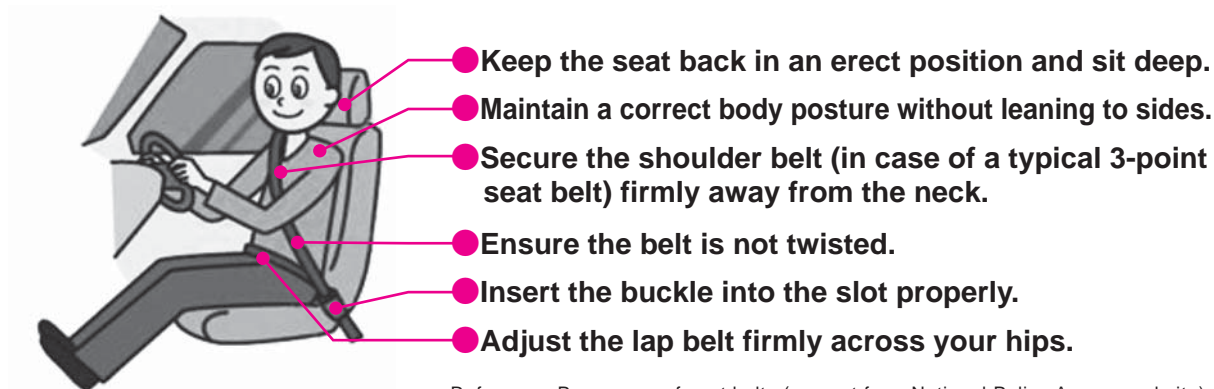
However, purchasing a new vehicle would be a personal decision and is something that cannot be done right away; as such we recommend the use of seat belt cushions or chest protectors that can be easily worn by the passengers! We explored the availability of shock-absorbing protectors for adult passengers but were unable to find any. Nevertheless, we did come across shock-absorbing pads in Europe that is meant for child seats to protect the neck from impacts which is used by sliding it through the seat belt.

In Japan, many chest protectors for motorcycle riders and chest pads for baseball players are commercially available. Taking reference from such products going forward, we may expect the development and dissemination of products that can help reduce injuries to older passengers of 4-wheeled vehicles.

(Motoki Tanaka)

Proper use of Seat belts

Securing the seat belts properly will significantly reduce the damages of a traffic accident.



Reference: Proper use of seat belts (excerpt from National Police Agency website)

当センターは、平成4年(1992年)に国家公安委員会、運輸省(当時)、建設省(当時)から設立許可を受けて、公益法人として設立されました。その後平成24年(2012年)4月に公益財団法人に移行しました。我が国で唯一道路交通法の定める「交通事故調査分析センター」の指定を国家公安委員会から受けた調査研究機関であり、交通事故の防止と被害の軽減のための交通事故の調査分析を行っています。

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