

MORTALITY OF FRONT-SEAT OCCUPANTS ATTRIBUTABLE TO UNBELTED REAR-SEAT PASSENGERS IN CAR CRASHES

Ichikawa, Masao, Nakahara, Shinji, Wakai, Susumu. *The Lancet*, 00995355, 1/5/2002, Vol. 359, Issue 9300.

The risk of death of unbelted rear-seat occupants is obviously increased in car *crashes*. However, there is little epidemiological evidence that unbelted rear-seat occupants will also increase the risk of death of front-seat passengers. We compared risk of death and severe injury of front-seat occupants in car *crashes* with belted or unbelted rear-seat passengers. The risk of death of belted front-seat occupants with unbelted rear-seat passengers was raised nearly five-fold. If rear *seatbelts* had been used, almost 80% of deaths of belted front-seat occupants could have been avoided. Rear *seatbelt* use should be encouraged for the safety of all car occupants.

Correspondence to: Mr Masao Ichikawa (e-mail: masao@m.u-tokyo.ac.jp)

In many industrialised countries, *seatbelt* use is a legal requirement for front-seat occupants of motor vehicles, but it is not compulsory for rear-seat passengers. Some countries are imposing *seatbelt* use for rear-seat passengers, for personal safety. Rear *seatbelt* use will be further justified if it also protects front-seat occupants. Unbelted rear-seat occupants in car *crashes* are forced forward into the back of the front seat, and this impact is immense.[1,2] If front-seat occupants of cars wear *seatbelts*, they have a low risk of ejection from their seat during a crash. The force from unbelted rear-seat passengers on front-seat occupants can be a main determinant of injury. We have assessed how much the risk of death and severe injury for front-seat occupants was raised in car *crashes* involving unbelted rear-seat passengers.

Car crash data were derived from the Institute for Traffic Accident Research and Data Analysis of Japan, which links traffic accident statistics compiled by the National Police Agency to vehicle registration data from the Ministry of Transport, from which the type of vehicle involved in the accident can be identified.[3] We included car-to-car *crashes* that happened between 1995 and 1999. Since police records do not identify driver's side or passenger's side of rear-seat occupants, and *seatbelt* use is recorded only if occupants are injured, we included accidents with two or more rear-seat occupants, in which all occupants were injured.

Because we did not know the total number of passengers, we used odds ratios to estimate the risk of death of, or severe injury to, front-seat occupants, caused by unbelted rear-seat occupants. The odds ratio was calculated for all *crashes* and by mode of crash--frontal, lateral, and rear *crashes*. In accordance with the police records, death included all who died within 24 h of a car crash and severe injury, all who required treatment for more than 30 days.[4]

We had information on 103 590 front-seat occupants (73 893 drivers and 29 697 front-seat passengers) who were injured in car-to-car *crashes*. Of these 211 drivers (2 86

per 1000) and 173 front-seat passengers (5.83 per 1000), respectively, were killed and 1557 (21.07 per 1000) and 1185 (39.90 per 1000), respectively, were severely injured.

The risk of death of drivers and front-seat passengers who used *seatbelts* was increased about five-fold when rear-seat occupants were unrestrained (table 1). Risk of death alone was not significantly raised for unrestrained front-seat occupants. Combined risks of death and severe injury were raised two-fold for belted drivers and front-seat passengers and three-fold for unbelted front-seat passengers. A risk percentage based on odds ratio estimates suggested that 742 deaths and severe injuries of 1520 belted front-seat occupants might have been prevented by rear *seatbelt* use during the 5-year period. Deaths could have been reduced by 79.2% (141/178).

In frontal *crashes*, risk of death for restrained drivers was increased six-fold when the rear occupant was unbelted, and risk for front-seat passengers was raised over seven-fold, but was not significantly raised in side and back *crashes*. Risk of death and severe injury was increased about two-fold for both drivers and front-seat passengers in frontal and lateral *crashes*, but was not significantly raised in rear *crashes*. Overall, the risk of death and severe injury was higher for those involved in frontal *crashes* than for those in lateral or rear *crashes*.

Our findings show that *seatbelt* use by rear-seat occupants of cars is associated with less injury and death of front-seat occupants. In frontal *crashes*, unbelted rear-seat occupants can be thrown forward, increasing the forces on front-seat occupants. In other modes of crash, the rear-seat passengers can be thrown in different directions, and the impact from the steering wheel, dashboard, or other interior surfaces could have masked the forces from rear-seat occupants.

We excluded car *crashes* with uninjured rear-seat occupants. The car *crashes* we included in our study were probably more severe than those involving belted occupants because minor *crashes* that caused no injuries were not included. If minor *crashes* involving unbelted occupants were also excluded, our odds ratio estimates would have been raised.

There were no noticeable differences in proportions of children and adults with respect to seat-belt use. Child restraints were not in common use at the time of our study. Thus, these factors did not bias the odds ratio estimates by much.

Our findings provide a basis for making rear *seatbelt* use compulsory. Most deaths and severe injuries of front-seat occupants of cars would potentially be averted by rear *seatbelt* use. To reduce the burden of road traffic injuries, we recommend that all car occupants should wear *seatbelts* for protection of not only themselves but also the other passengers.

Contributors

M Ichiwaka designed the study and analysed the data with help from S Nakahara and S Wakai. All authors were involved in the interpretation of the results and preparation of the report.

Conflict of interest statement None declared.

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Table 1: Risk of death and severe injury for drivers and front-seat passengers by front and rear *seatbelt* use

Legend for Chart:

A - Location of front-seat occupant

B - **Seatbelt** use Front

C - **Seatbelt** use Rear

D - Number of front-seat occupants

E - Death n

F - Death Odds ratio (95% CI)

G - Death and severe injury n

H - Death and severe injury Odds ratio (95% CI)

A	B	C	D	E	F	G	H
Driver							
(+)	(+)		15158	6		141	
(+)	(-)		52768	102	4.93 (2.16-11.22)	938	1.93 (1.61-2.30)
(-)	(+)		178	2		8	
(-)	(-)		5789	101	1.61 (0.39-6.60)	470	1.88 (0.92-3.84)
Passenger							
(+)	(+)		6363	6		112	
(+)	(-)		16893	76	4.85 (2.11-11.15)	582	1.99 (1.62-2.44)
(-)	(+)		162	0		4	
(-)	(-)		6279	91	(..)	487	3.32 (1.23-9.00)

Table 2: Risk of death and severe injury for belted drivers and front-seat passengers by rear **seatbelt** use and by mode of car crash

Legend for Chart:

- A - Location of front-seat occupant
- B - Mode of car crash
- C - Rear **seatbelt** use
- D - Number of front- seat occupants
- E - Death n
- F - Death Odds ratio (95% CI)
- G - Death and severe injury n
- H - Death and severe injury Odds ratio (95% CI)

	A	B	C	D	E	F	G	H
Driver								
Front		(+)	4797	3			71	
		(-)	18610	69	6.02 (1.89-19.14)		562	2.07 (1.62-2.66)
Lateral		(+)	2138	2			25	
		(-)	8977	28	3.37 (0.80-14.17)		208	2.00 (1.32-3.04)
Rear		(+)	8223	1			45	
		(-)	25181	5	1.63 (0.19-14.00)		168	1.22 (0.88-1.70)
Passenger								
Front		(+)	1822	2			54	
		(-)	5166	42	7.70 (1.86-31.83)		343	2.33 (1.74-3.12)
Lateral		(+)	790	4			31	
		(-)	2320	32	2.82 (0.99-7.99)		164	1.86 (1.26-2.76)

Rear (+) 3751 0 27
(-) 9407 2 (...) 75 1.11 (0.71-
1.72)

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By Masao Ichikawa, MSc, Department of Community Health, School of International Health, Graduate School of Medicine, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan; Shinji Nakahara, MD, Department of Community Health, School of International Health, Graduate School of Medicine, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan and Susumu Wakai, MD, Department of Community Health, School of International Health, Graduate School of Medicine, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

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