

# SEAT BELT USE AND EFFECTIVENESS OF SEAT BELT REMINDERS AMONG CHILDREN AND YOUNG ADULTS IN REAL-WORLD CRASHES

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## ABSTRACT

The seat belt is one of the most effective ways to protect occupants in car crashes. Unfortunately, the average seat belt use in Europe (2018) was 83% for drivers and 81% for front seat passengers, where teenagers often have the lowest rate. The study aimed to use real-world car crashes to analyze the seat belt use among 0 to 18 year old children and teenagers as occupants and 18 to 20 year old drivers in Sweden 2011-2018. An additional aim was to analyze the effectiveness of seat belt reminders for both the front and the rear seats for the same age groups.

The Swedish Traffic Accident Data Acquisition was used, which is the Swedish national system for road traffic injury data collection. The data included 26 270 car crashes involving 30 447 car occupants in passenger cars. Regarding passengers, 5% were children aged 0 to 18 years and 12% of the drivers were aged 18 to 20 years.

Occupants aged 14 to 18 years had a lowest seat belt usage rate (89%), where the rate was even lower when these passengers had a young driver, 86% if the driver was aged 18 to 20 years and 93% if the driver was aged 30 years or above. And male passengers had a higher seat belt usage rate if they had a female driver, 94% if they had a female driver and 87% if they had a male driver. In the rear seat, children and teenagers aged 12 to 18 had a lowest seat belt usage rate and 18 year olds had the lowest (79%). The usage rate was lower when the passengers were sitting in the rear seat and when the driver was young.

For children above 8 years, seat belt use was higher in cars with an SBR. This was also the case for adults (over 30 years). There was a clear difference for the rear seat, especially for teenagers 14 to 18 years, among whom 100% used the seat belt in a seat with an SBR.

Young drivers had a higher risk to be involved in a road traffic accident compared to other age groups. Unfortunately, teenage passengers to these young drivers also have the lowest seat belt usage rate in the data. And there was indications that male teenage passengers have lower seat belt usage rate if their drivers also were male. One conclusion may be that the seat belt usage for a teenage passenger can depend on the driver. Therefore, it is important to put extra focus on this age group of drivers to increase seat belt use for their passengers

The present study clearly shows the need of actions aimed to increasing the seat belt use for rear seat passengers. The seat belt use in the rear seat is lower compared to the front seat, especially when the driver is young. The SBR has been shown to be effective in the front seat, and should therefore have the same specifications in the rear seat.

## BACKGROUND

It is well known that seat belt usage is one of the most effective ways to protect occupants in car crashes. A modern seat belt reduces the risk of death of approximately 50% [1]. Combined with airbag the protective effect is approximately 65% [2]. In 2018, average seat belt use in Europe was 83% for drivers and 81% for front seat passengers [1]. Unfortunately, seat belt use in the rear seat is still much lower, where the average usage rate is 60%. It is a global pattern that the seat belt usage rate in the rear seat is lower than in the front seat.

In Sweden, as in 104 other countries, there is a seat belt law. Furthermore, the driver has full responsibility for seat belt usage for all passengers of age 15 or younger [3].

Studies around the world have shown that teenagers have the lowest seat belt wearing rate [4-6]. A study from the U.S., based on self-reported seat belt use, showed that only 51% of high school students always wore a seat belt when riding as passengers [7]. In Britain, young drivers and passengers (aged 17-34) have the lowest seat belt usage rate, as compared to other age groups, combined with the highest accident rate [8]. Furthermore, drivers aged 16-19 years are three times more often involved in a crash than older drivers, and young males are more often involved in crashes than young females [9]. The seat belt use is lower in crashes, and in fatal accidents only 40% uses the seat belt [10].

Seat Belt Reminders (SBR) have been shown to be very effective in increasing seat belt wearing rates, where SBRs increase the seat belt use from 90% to 98% [11] for the driver. The same study also presented observational studies regarding seat belt use all over Europe. In Brussels, Belgium, for example, the seat belt use was 93% in cars with SBR systems compared to only 70% in cars without SBR.

The European New Car Assessment Program (Euro NCAP) gives points for an SBR since 2004 for both front and rear seats [12]. However, the requirements for front and rear seats differ. The requirements for front seats are considerably higher [13]. For example, there is a requirement for occupant detections for the front seats but not for the rear seats. There is also a difference regarding an audible signal between the front and the rear seats, and where the driver can choose to switch off the reminder for the rear seats but not for the front seats.

The study aimed at using real-world car crashes to analyze the seat belt use among 0 to 18 year old children and teenagers as occupants and 18 to 20 year old drivers in Sweden. An additional aim was to analyze the effectiveness of seat belt reminders for both the front and the rear seats for the same age groups.

## **MATERIAL AND METHOD**

The Swedish Traffic Accident Data Acquisition (STRADA) was used, which is the Swedish national system for road traffic injury data collection, containing police reported crashes and injury data from emergency care centers. The analyzed data included all car occupants who had been involved in a road traffic accident between 2011 and 2018, and who had received medical treatment at emergency departments of Swedish hospitals. In total, 26 270 car crashes with 30 447 car occupants were included. Occupants with unknown seat belt use were excluded (9%).

Three subgroups of passengers were defined: 0-8, 9-13 and 14-18 years of age, and three groups of drivers: 18-20, 21-30 and 30+ years of age. In 87% of the accidents, detailed information about the vehicle was known. This information was used to identify types of SBRs, and the Euro NCAP point scores.

**Table 1.**  
**Euro NCAPs point score for SBR**

SBR, only the driver's seat	1 point
SBR, only the front seats	2 points
SBR for all seats	3 points

To analyze the effectiveness of an SBR, only cars from 1999 or later were included (73%), because the number of cars with SBR started to increase at this time in Sweden. The points given by Euro NCAP were used together with information about seating position (driver seat, front passenger seat, rear passenger seat and unknown). When positions were unknown (3%), the accidents were excluded in the analyses comparing front and rear seat and analyses including the SBR. To analyze the effectiveness of the SBR a standard binomial hypothesis test was conducted.

The seat belt use for all 0 to 18 year old passengers was analyzed as well as comparisons between males and females. It was also analyzed if the age of the driver affects the seat belt use for the passengers of ages 0 to 18.

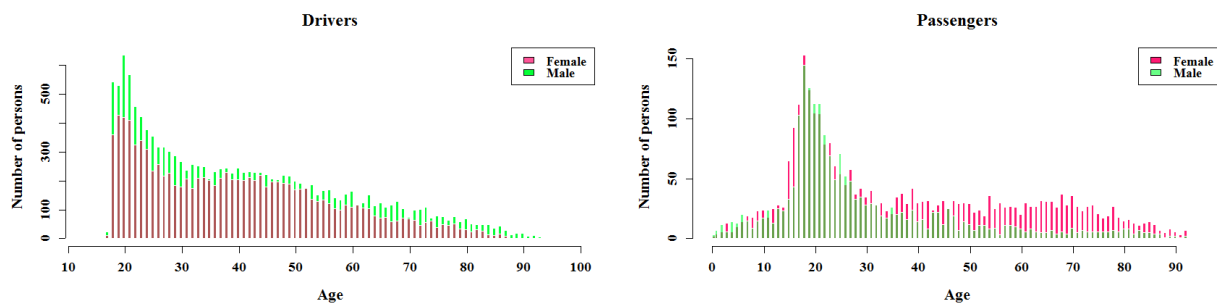
Comparisons were also made between young drivers in ages 18 to 20 and older drivers (> 20 years). The effectiveness of the SBR for these age groups was also analyzed.

## RESULTS

The data included 26 270 car crashes involving 30 447 car occupants in passenger cars. In total 81% were drivers, 12% were front seat passenger, 4% were rear seat passenger, and 3% were unknown. Of the passengers, 1 486 (5%) were children aged 0 to 18 years (15% below 8 years, 20% were 8 to 13 years, 65% were 14 to 18 years). In total, 2910 (12%) of the drivers were aged 18 to 20 years.

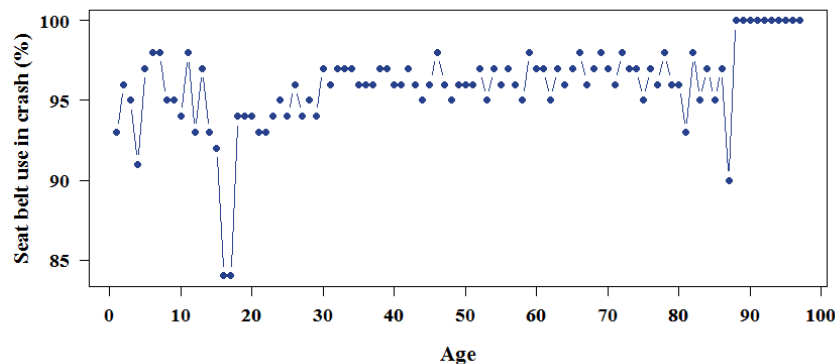
Including all data, males was more often involved in crashes (54% males and 46% females). Regarding drivers, males were more common for all age groups (See Figure 1). However, the greatest proportion (58%) was found for young males (aged 18 to 20 years).

Regarding passengers, females were more common as passengers aged 35 years and older, 72% of these passengers were females (See Figure 1). For passengers aged 0 to 18 years, the distribution between males and females was similar, except for passengers aged 15 to 16 years where females were more common (68% of these passengers were females).



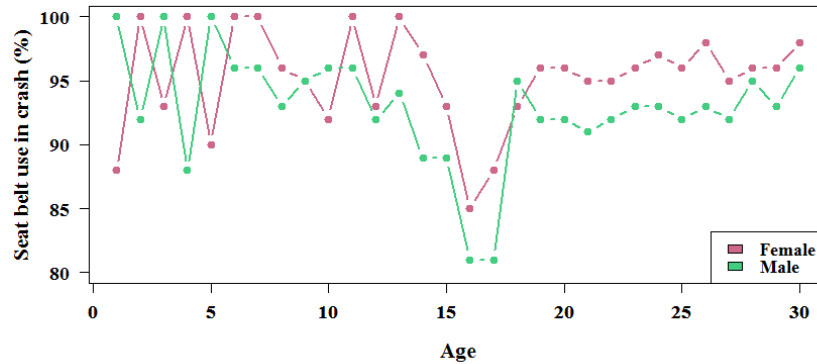
**Figure 1** Age distribution for women and men in car crashes related to drivers and passengers

The average seat belt usage rate for all ages was 96%, but for older children and teenagers the seat belt usage rate decreased, (See Figure 2). Occupants aged 14 to 18 years had a low seat belt usage rate (89%), and 16 year olds' showed the lowest rate (83%).



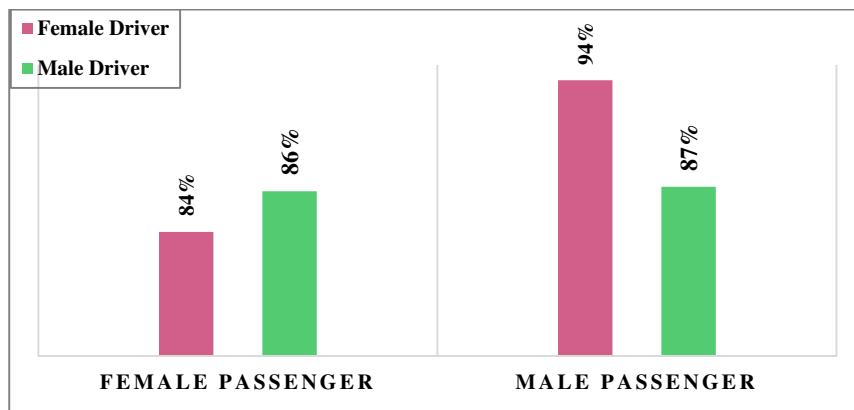
**Figure 2.** Seat belt usage rate in car crashes as related to age

There was a small difference in seat belt use between males and females, especially for 15-17 year old occupants, 84% usage rate for boys and 88% for girls (See Figure 3).



**Figure 3. Seat belt usage rate in car crashes as related to age (0 to 30 years) for females and males**

There was a notable difference in the seat belt usage rate for male passengers aged 14 to 18 years related to their driver’s gender (See Figure 4). If they had a female driver the seat belt usage rate was 94%, compared to 87% if they had a male driver. This was also seen for male passengers in all other ages. This large difference could not be found for females passengers in any age group.



**Figure 4. Seat belt usage rate for female and male passengers (aged 14 to 18 years) related to gender of the driver**

The seat belt usage rate was lower in the rear seat, as compared to the front seat for all ages (94% in the front seat and 86% in the rear seat). Children and teenagers aged 12 to 18 had a low usage rate (See Table 1), and 18 year old rear seat passengers had the lowest, only 79%.

**Table 1. Seat belt usage rate among passengers in the front and the rear seat**

Age group	Front seat	Rear seat
Under 8 years	100%	93%
9 to 13 years	96%	94%
14 to 18 years	92%	81%

### Teenagers traveling with young drivers

The seat belt usage rate was lower when the passengers had a young driver, especially for passengers in the age interval 12 to 18 years. If these passengers had a driver between 18 and 20 years age, the seat belt usage rate was 86%. This can be compared to a 93% seat belt usage rate when the drivers were 30 years and above.

For passengers aged 15 years or younger, the driver has the responsibility of their seat belt use. In cases where the driver was 18 to 20 years, seat belt usage among the passengers was 85%.

The seat belt usage rate was lower when the passengers were sitting in the rear seat and when the driver was young, especially for passengers aged 14 to 18 years (See Table 2). If the driver was aged 18 to 20 years, seat belt use in the rear seat was lower than if the driver was 30 and above (79% and 88%, respectively). Eighteen year old passengers had the lowest seat belt usage rate (76%).

**Table 2.**  
**Seat belt use for passengers aged 14 to 18 years, in the rear seat as related to the age of the driver**

Age (years)	With a driver 18 to 20 years		With a driver 30+ years	
	n	(%)	n	(%)
14	6	83%	22	91%
15	11	64%	13	92%
16	27	81%	23	91%
17	39	85%	23	87%
18	56	80%	21	76%

### Seat belt reminders

The model year of the car was 1998 or later in 19 287 of the evaluated crashes (73%). Of these, 45% were not fitted with an SBR, 4% had an SBR for the driver seat only, 19% for both front seats, 12% for all seats, and in 21% the information regarding SBR was unknown.

The seat belt usage rate for children under 8 years in the front passenger seat was 100% irrespective if the seat had an SBR or not, (see Table 3). For children above 8 years, seat belt use was higher in cars with an SBR. This was also the case for adults (over 30 years). There was a clear difference for the rear seat, especially for teenagers 14 to 18 years, among whom 100% used the seat belt in a seat with an SBR. For children under 8 years, 89% were using a seat belt if the car had an SBR for the front seat. Note, however that this subgroup only included 9 children.

**Table 3. Seat belt usage rate in cars with and without SBR related to age**

Age groups	Driver's seat		Passenger in front seat		Passenger in rear seat	
	With SBR	Without SBR	With SBR	Without SBR	With SBR	Without SBR
<b>Over 30 years</b> (n = 17 583)	98%	95%	98%	93%	93%	85%
<b>14 to 18 years</b> (n = 1 885)	98%	95%	99%	90%	100%	78%
<b>8 to 13 years</b> (n = 300)	n/a	n/a	100%	93%	100%	93%
<b>Under 8 years</b> (n = 220)	n/a	n/a	100%	100%	89%	97%

The estimated probability of seat belt use in the front seat was 92% if the car had an SBR for the front seat, based on cars involved in crashes. The null-hypothesis that the probability to use a seat belt in the rear seat if the car had an SBR was the same as the front seat could be rejected at the 99%-level. In other words, the likelihood is lower that a car occupant uses a seat belt in the rear seat than in the front seat.

## DISCUSSION

The present study showed that children under 8 years often used a seat belt (95%). Unfortunately, the seat belt usage decreases with age, and teenagers (aged 12 to 18 years) had the lowest seat belt usage rate in the data (89%). This is in line with other studies in Sweden, Europe and in the U.S. [4-7]. Despite the seat belt law in Sweden, occupants sometimes chose not use a seat belt. The legal consequences of not wearing the seat belt may be too low. Other countries in Europe are using tools such as safety cameras to detect seat belt usages in cars on certain high-risk sites [14].

There was an indication that the seat belt usage rate among teenagers aged 14 to 18 was affected by the age of their drivers. The seat belt use for these passengers was much lower when the driver was aged 18 to 20 years. And there was an indication that the seat belt usage rate among male passengers was affected by their driver's gender. Male passengers had a much higher seat belt usage rate if they had a female driver (94%). This is higher compared to the average seat belt usage rate for the same age group (89%). One conclusion is probably that female drivers have a larger impact on the passenger seat belt use compared to male drivers. One way to influence the low seat belt use among teenage passengers may be to make the law stricter so that the driver is responsible for seat belt use for passengers up to age 18 years, not only for children below 15.

Young drivers are more often involved in car crashes compared to older drivers. It is therefore important to put extra focus on this age group, also to increase seat belt use for their passengers. Above all, they need to understand the importance of seat belts, and the consequences for those choosing not wear them. One way to target this may be through road safety campaigns. The Campaigns and Awareness-Raising Strategies in Traffic Safety (CAST) project was aimed to improve road safety with more efficient campaigns, supported by the European Commission [15]. The CAST-project developed tools for design, implementation and evaluation of the campaigns. However, campaigns should primarily be based on knowledge from real-world accident findings. Knowledge about how to reach out to the right target groups, together with research from real-world crashes and observations can change underlying factors known to affect road user behavior among young car occupants and their attitude to seat belts. However, other studies showing the effect of similar campaigns are rare.

The present study showed that seat belt use is much lower in the rear seat for all ages in Sweden (94% in the front seat and 86% in the rear seat). This is in line with other studies all over Europe [1, 5] and U.S. [4, 7]. The present study clearly shows the need for actions to increase seat belt use for rear seated passengers. SBR was shown to be very effective. However, the results indicate that there are big differences between the SBR for the front seat compared to SBR for the rear seat. Therefore, Euro NCAP should have similar requirements for SBR also in the rear seat, as studies have shown a high effectiveness of SBR for the front seat [11]. As mentioned, rear seats currently do not need to have occupant detections [13]. This means that the system will not detect when a rear passenger are seated and therefore the SBR will not be able to warn in the same way. But it should be emphasized that Euro NCAP has upgraded their point scoring involving occupant detections from November 2015 [16]. Manufacturers may now have the possibility for 0.5 extra points per rear seat position with occupant detection [13].

Unfortunately, there is a safety risk when occupants choose to disconnect the SBR due to annoyance, for example when the SBR is warning for a seat that no one is using. Fortunately, there are car maker's that invest in cameras inside the car, today to identify the driver's status (such as fatigue). In the future, these cameras may identify which seats that are used by a passenger but also if this passenger is unbelted.

## CONCLUSIONS

Young drivers have a higher risk to be involved in a road traffic accident compared to other age groups. Unfortunately, teenage passengers to these young drivers also have the lowest seat belt usage rate in the data. Also, there was indications that male teenage passengers have a much lower seat belt usage rate if their driver was male, compared to if their driver was female. One conclusion may be that the seat belt usage for a teenage passenger can depend on the driver. Therefore, it is important to put extra focus on this age group of drivers to increase seat belt use for their passengers

The present study clearly shows the need of actions aimed to increasing the seat belt use for rear seat passengers. The seat belt use in the rear seat is lower compared to the front seat, especially when the driver is young. The SBR has been shown to be effective in the front seat, and should therefore have the same specifications in the rear seat.

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