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# Lives Saved FAQs

National Highway Traffic Safety Administration
National Center for Statistics and Analysis
Office of Traffic Records and Analysis

# Lives Saved FAQs

<u>Introduction</u>

1) Q: Why does NHTSA calculate estimates of lives saved in motor vehicle crashes?
   A: Lives saved estimates are one of the basic measurements used to quantify the benefits of certain traffic safety devices (i.e., seat belts) and laws (i.e., minimum legal drinking age) that are designed to reduce highway traffic fatalities and injuries. These estimates can help weigh the importance of the usage of a traffic safety device or passage of a traffic safety law.

   For example, NHTSA lives saved calculations estimate how many lives were saved by seat belt use in past years, and how many more lives could have been saved by an increase in seat belt use.

2) Q: For what categories does NHTSA currently produce annual lives saved estimates?
   A: NHTSA estimates lives saved annually by seat belts, frontal air bags, child restraints, motorcycle helmets, and minimum legal drinking age laws. Below is a table from a NHTSA CrashStat titled "Lives Saved in 2007 by Restraint Use and Minimum Drinking Age Laws" (DOT HS 811 049).

**Lives Saved by Restraint Use and 21-Year-Old Minimum Drinking Age Laws, And Additional Lives That Would Have Been Saved At 100-Percent Seat Belt and Motorcycle Helmet Use, 2003 - 2007**

| Year | Lives Saved, Age 4 and Younger | Lives Saved, Age 5 and Older | Lives Saved, Age 13 and Older | Lived Saved, All Ages | Lives Saved, Age 18 to 20 | Additional Lives That Would Have Been Saved At 100-Percent Use | |
|---|---|---|---|---|---|---|---|
| | Child Restraints | Seat Belts | Frontal Air Bags | Motorcycle Helmets | Minimum Drinking Age Law | Seat Belts | Motorcycle Helmets |
| 2003 | 447 | 15,095 | 2,519 | 1,173 | 918 | 6,151 | 651 |
| 2004 | 455 | 15,548 | 2,660 | 1,324 | 927 | 5,874 | 673 |
| 2005 | 424 | 15,688 | 2,752 | 1,554 | 882 | 5,667 | 731 |
| 2006 | 427 | 15,458 | 2,824 | 1,667 | 888 | 5,468 | 756 |
| 2007 | 382 | 15,147 | 2,788 | 1,784 | 826 | 5,024 | 800 |

*Source: FARS 2003-2006 Final File, 2007 Annual Report File*

3) Q: Why does NHTSA produce estimates of lives saved, instead of exact counts?
A: All national and State lives saved calculations are estimates, due to the practical limitation that it is impossible to know the exact crash scenario that occurred in every fatal and/or potentially fatal crash in the United States.

The various estimates of lives saved are made each year once the Fatality Analysis Reporting System (FARS) data is available. FARS data provides a wealth of information pertaining to many aspects of fatal crashes, such as vehicle type, restraint use, and seating position of the vehicle occupants. However, no database can provide the plethora of information that would be needed to produce exact lives saved counts. This limitation exists since a large number of potentially fatal crashes occur in which one or more lives was saved (i.e., due to seat belt use), and either no data or a limited amount of data was collected for that potentially fatal crash.

4) Q: What types of lives saved estimates are produced?
A: Three main types of lives saved estimates are produced: lives saved, potential lives saved, and additional lives saved. Potential lives saved represents the maximum number of lives that could have been saved if the restraint device was used by all vehicle occupants. Additional lives saved equals the difference between lives saved and potential lives saved.

An example of these estimates is seen under the category of motorcycle helmet use. NHTSA estimated that the use of motorcycle helmets saved 1,784 lives in 2007. If all motorcycle riders had worn their helmets, an estimate of 2,584 lives would have been saved. Therefore the estimate of potential lives saved for motorcycle helmets in 2007 is 2,584. Eight hundred is the difference between the estimates of potential lives saved (2,584) and lives saved (1,784). This estimate of 800 equals the number of additional lives that could have been saved by motorcycle helmets in 2007, if all motorcycle riders had worn their helmets.

5) Q: What does effectiveness mean, with regard to motor vehicle crashes?
A: Effectiveness is a quantitative estimate of how a safety device (e.g., seat belt, air bag, and motorcycle helmet) or passage of a law (minimum drinking law, speed limit) improves a person's chance of surviving a potentially fatal crash. Effectiveness is most often discussed when an attempt is made to quantify the "protection" provided by a seat belt, air bag, child safety seat, or motorcycle helmet. If a restraint device in a certain potentially fatal crash scenario has an estimated effectiveness of 45 percent, then a person in that crash scenario is 45 percent less likely to be fatally injured if the person used that restraint device.

For example, if a safety device is 50-percent effective, then someone in a potentially fatal crash is 50 percent less likely to be fatally injured if the person used that restraint device. If a restraint device is 70 percent effective, then someone in a potentially fatal crash is 70 percent less likely to be fatally injured if the person used that restraint device. The larger the estimated effectiveness of a restraint device is, the more "protection" that the restraint device provides.

Effectiveness can also apply to the passage of a law, such as a minimum legal drinking age law. See FAQ #19 for more details on the estimated effectiveness of the minimum legal drinking age law.

6) Q: What is an example of an effectiveness estimate?
A: Three-point seat belts for passenger car occupants in the front right seat, age 5 and older, are 37 percent effective (E=0.37). That statement means that *if the person uses a three-point seat belt*, a passenger car occupant 5 and older in the front right seat is 37 percent more likely to survive a potentially fatal crash, compared to an *unbelted* passenger car occupant 5 and older in the front right seat.

7) Q: How are effectiveness estimates used to estimate the number of lives that are saved by seat belts?
A: Lives saved calculations are made for each of the many different applicable effectiveness estimates. The basic formula for calculating lives saved includes the following variables: LS = number of lives saved, E = effectiveness, F = number of belted fatalities. The equation which relates these three variables is the following: $LS = E*F/(1-E)$. For each applicable crash scenario, the fatality counts (F), along with the corresponding type of effectiveness (E), are inserted into the equation to estimate the number of lives saved (LS).

To produce a national total for lives saved, the total number of fatalities is stratified into each of the many differing crash scenarios for which NHTSA has produced an effectiveness estimate, and individual estimates of lives saved are calculated for each of those specific crash scenarios, using the lives saved formula provided in this FAQ. The total number of lives saved in the Nation is equal to the sum of the lives saved estimates from every category of crash scenarios.

8) Q: Are lives saved and potential lives saved measured the same way?
A: No. The method for estimating lives saved for a certain type of safety devices or laws is done as shown in FAQ #7 using the fatality counts (F) and estimates of effectiveness (E) for that crash type. By comparison, the method for estimating potential lives saved uses statistical modeling.

Modeling is needed to estimate the relationship between overall daytime seat belt use, as estimated in seat belt surveys such as the National Occupant Protection Use Survey (NOPUS), and seat belt use in potentially fatal crashes. NHTSA calculates an estimate of the number of belted occupants who were involved in potentially fatal crashes and yet survived the crashes. This estimated number of restrained occupants is not included in the FARS database of fatal crashes, because the occupant's use of a restraint device saved the occupant's life and prevented the crash from being a fatal crash. The estimate must be calculated through statistical modeling, since the FARS database is made of only fatal crashes, and does not include potentially fatal crashes where no fatalities occurred.

The “(restraint) use in potentially fatal crashes” or UPFC, is modeled based on many years of seat belt use rates collected by NOPUS or collected by individual States. These seat belt uses rates are used to estimate the UPFC, which is then used to estimate how many lives could have been saved if more occupants were buckled up. Each year, NHTSA uses this model to estimate the total number of additional lives that could have been saved if everyone had used their seat belts, and also how many lives could have been saved for each 1-percent increase in belt use.

## Effectiveness

9) Q: How is effectiveness calculated for seat belts?
A: To estimate effectiveness, NHTSA researchers compared data on two groups of occupants in similar fatal crashes. One group of occupants, who are restrained, is compared to another similar group of occupants, who are not restrained. The other information (i.e., vehicle type, seat position, seat belt type) about the groups is made to be as similar as possible, with the exception of their restraint use. The amount that the restraint device was able to improve an occupant's chance of surviving the potentially fatal crash is measured by comparing the percent of occupants in each group who survived.

10) Q: Are seat belts equally effective for each seat position in the motor vehicle?
A: No. The effectiveness of a seat belt varies depending on where the occupant is seated. Separate effectiveness estimates are used for the driver seat, front right seat, front middle seat, rear outboard seat, rear middle seat, and other seats. A table of effectiveness estimates is listed below following FAQ #13.

11) Q: Are seat belts equally effective in all vehicles?
A: NHTSA effectiveness estimates are categorized into two different vehicle types: passenger cars (PC), and light trucks/vans (LTV). The vehicle type of light trucks and vans includes sport utility vehicles, pickups, and vans. Separate effectiveness estimates are made for each of these two vehicle type categories. Effectiveness estimates are not individually made for different vehicle makes and models (i.e., Honda Accord, or Ford Mustang) due to sample size limitations of the fatal crash data.

12) Q: Are some types of seat belts more effective than other types of seat belts?
A: Yes. The 3-point seat belt is the most effective seat belt. Less effective seat belts include lap belts or two-point belts. See the table of effectiveness estimates following FAQ #13 for a complete list of seat belt effectiveness estimates.

13) Q: What are the highest and lowest effective estimates for seat belts?
A: The effectiveness of seat belts varies according to many details of a crash, including seat belt type, vehicle type, and seat position. NHTSA estimates for seat belt effectiveness range from a lap belt's estimated effectiveness of 19 percent for an occupant in the front middle seat of a passenger car, to a lap/shoulder belt's effectiveness of 73 percent for an occupant in the rear outboard seat of a light truck or van. The seat belt effectiveness that is most frequently quoted is 48-percent effectiveness for a 3-point or lap/shoulder belt for an occupant in the driver's seat of a passenger car. Each of these effectiveness estimates apply only to occupants 5 or older. A table of effectiveness estimates for seat belts is listed below.

| Effectiveness Ratings for Seat belts for Occupants 5 and Older | | | | | | |
|---|---|---|---|---|---|---|
| **Seating Position** | **Front Left (Driver)** | **Front Right** | **Front Middle** | **Rear Outboard** | **Rear Middle** | **Other** |
| | | | ***Passenger Cars*** | | | |
| ***2-Point*** | 32% | 32% | NA | NA | NA | NA |
| ***3-Point*** | 48% | 37% | NA | NA | NA | NA |
| ***Lap/Shoulder*** | 48% | 37% | NA | 44% | NA | NA |
| ***Lapbelt*** | 32% | 32% | 19% | 32% | 32% | 32% |
| ***Unknown Type*** | 32% | 32% | 19% | 32% | 32% | 32% |
| | | | ***Light Trucks and Vans*** | | | |
| ***2-Point*** | NA | NA | NA | NA | NA | NA |
| ***3-Point*** | 61% | 58% | NA | NA | NA | NA |
| ***Lap/Shoulder*** | NA | NA | NA | 73% | NA | NA |
| ***Lap Belt*** | NA | NA | 32% | 63% | 63% | 63% |
| ***Unknown Type*** | 61% | 58% | 32% | 63 % | 63% | 63% |

There are no belts of the indicated type in cells labeled “NA.”

Sources: Kahane, 2000, and Morgan, 1999

14) Q: How effective are frontal air bags?
A: Frontal air bags are estimated to have an effectiveness of 11 percent if the occupants are wearing their seat belts. If the occupant is in the much less safe scenario of not wearing the seat belt, then a frontal air bag is estimated to have an effectiveness of 14 percent. These air bag effectiveness estimates only apply to frontal air bags, and not side air bags.

15) Q: Are frontal air bags equally effective for all vehicle occupants?
A: Frontal air bags are only effective for drivers and right-front passengers 13 and older. Frontal air bags are considered to be effectively neutral for occupants in the front center seat, as well as occupants in the second row or further back in the vehicle. Air bag effectiveness estimates apply only to occupants 13 and older, as air bags are considered to be effectively neutral for all occupants 12 and under.

16) Q: Can a joint effectiveness be calculated for a person who is both wearing a seat belt and sitting in front of a frontal air bag?
A: Yes. For example, consider the scenario where an occupant has a seat belt available to use that is 48 percent effective. As previously mentioned, the effectiveness of a frontal air bag is 14 percent for an unbelted occupant, and 11 percent for a belted occupant.

If the occupant is in front of an air bag and is not belted, then the joint effectiveness is 14 percent, since the seat belt effectiveness is clearly 0 percent when an occupant isn't belted. This calculation was done by adding 0.00 + 0.14*(1-0.00) = 0.14 or 14 percent.

If the occupant is in front of an air bag and also is belted, then the joint effectiveness is 54 percent. This calculation is done by adding 0.48 + 0.11*(1-0.48) = 0.5372, which is 0.54, or 54 percent, when rounded. The 11 percent air bag effectiveness was used in this calculation since the occupant was belted. The air bag effectiveness of 14 percent applies to unbelted occupants. It is important to note that the effectiveness of air bag only (14 percent) is much less than the effectiveness of seat belt only (48 percent).

See table below for effectiveness ratings for seat belts in conjunction with frontal air bags.

**Effectiveness Ratings for Seat belts in Conjunction With Frontal Air Bags, For Occupants Over 12 Years Old**

| Seating Position | Front Left (Driver) | Front Right | Front Middle | Rear Outboard | Rear Middle | Other |
|---|---|---|---|---|---|---|
| | | | ***Passenger Cars*** | | | |
| ***2-Point*** | 39% | 39% | NA | NA | NA | NA |
| ***3-Point*** | 54% | 44% | NA | NA | NA | NA |
| ***Lap/Shoulder*** | 54% | 44% | NA | 44 | NA | NA |
| ***Lap Belt*** | 39% | 39% | 19% | 32% | 32% | 32% |
| ***Unknown Type*** | 39% | 39% | 19% | 32% | 32% | 32% |
| | | | ***Light Trucks and Vans*** | | | |
| ***2-Point*** | NA | NA | NA | NA | NA | NA |
| ***3-Point*** | 65% | 63% | NA | NA | NA | NA |
| ***Lap/Shoulder*** | NA | NA | NA | 73 | NA | NA |
| ***Lap Belt*** | NA | NA | 32% | 63% | 63% | 63% |
| ***Unknown Type*** | 65% | 63% | 32% | 63% | 63% | 63% |

There are no belts of the indicated type in cells labeled "NA."

Sources: Kahane, 2000, and Morgan, 1999

17) Q: What is the estimated effectiveness for motorcycle helmets?
A: Motorcycle helmets have an estimated effectiveness of 37 percent for the motorcycle rider/operator, and 41 percent for the motorcycle passenger.

18) Q: What is the estimated effectiveness for child safety seats (CSS)?
A: Child safety seats have effectiveness estimates for two age categories: age <1, and age 1 to 4. Separate CSS effectiveness estimates exist for passenger cars and for LTVs. For passenger cars, CSS effectiveness is 71 percent for age <1 and 54

percent for age 1 to 4. By comparison, CSS effectiveness in LTVs is 58 percent for age <1 and 59 percent for age 1 to 4.

Seat belts have separate effectiveness estimates for occupants up to 4 years old, compared to occupants 5 and older. In both passenger cars and LTVs, for children 1 through 4, the effectiveness for seat belts is 36 percent. Seat belts have no effectiveness for children of age less than one. The higher effectiveness of child safety seats (compared to seat belts) for children less than 5 is why NHTSA advocates placing a child of this age in a CSS rather than a seat belt.

Booster seats do not currently have a NHTSA effectiveness estimate for preventing fatalities, due to lack of available data on booster seat use in fatal crashes. In 2009, the FARS variable for restraint use will modified to include a category for booster seat, and this will allow NCSA to estimate booster seat effectiveness in the future.

19) Q: Can a law have an effectiveness estimate?
A: Yes. NHTSA estimates the effectiveness of the minimum legal drinking age (MLDA) law to be 13 percent. NHTSA currently estimates the number of lives saved by the MLDA laws based on the reduction in target (18- to 20-year-old) driver involvements and the number of fatalities in crashes with those involvements. Thus “lives saved” in this context refers not to a reduction in young driver fatalities, but in all fatalities, driver or passenger, young or old, regardless of alcohol involvement, in crashes where at least one driver was in the targeted age group. NHTSA considers this method to be reasonable since it is not only 18- to 20-year-old drivers who can be killed in their crashes, but indeed any occupant in any involved vehicle, as well as nonmotorists.

Calculating Lives Saved

20) Q: What are a couple of examples of calculating lives saved by seat belts?
A: FARS 2007 data shows that 760 fatalities involved drivers in passenger cars, using 3-point seat belts, with no frontal air bag. In this first example, F = 760, E = 0.48, and the equation for lives saved calculates that LS = 0.48*760/(1-0.48) = 702 lives were saved. In this example, the seat belt was used, and there was no air bag.

FARS 2007 data also shows that 783 fatalities involved drivers in passenger cars with no frontal air bags, where the driver was NOT using a 3-point seat belt that was available for use in the vehicle. In this second example, the effectiveness of NOT using the seat belt is 0.00. Inserting these numbers into the lives saved equation shows that LS = 0.00*783/(1-0.00) = 0 lives saved. In this example, zero lives are saved by seat belts, since none of the 783 drivers wore their seat belts.

21) Q: What is an example of calculating lives saved by air bags?
A: FARS 2007 data shows that 4,305 fatalities involved drivers in passenger cars with a frontal air bags and NOT using 3-point seat belts. In this example, F = 4,305, E = 0.14, and the equation for lives saved calculates that LS = 0.14*4305/(1-0.14) = 701 lives were saved. Note that the air bag was the only restraint device used for this lives saved calculation, since these 4,305 drivers were not using seat belts.

22) Q: What is an example of lives saved by seat belts and air bags working together?
A: FARS 2007 data shows that 2,518 fatalities involved drivers in LTVs using 3-point seat belts and with frontal air bags. In this example, a joint effectiveness (see FAQ #16 for details on joint effectiveness) is calculated by combining the effectiveness of a 3-point belt for a driver in an LTV (0.61) with the effectiveness of an air bag. An air bag has an effectiveness of 0.11 when is it used by a belted occupant. The joint effectiveness is 0.61 + 0.11*(1-0.61) = 0.6529, which is 0.65, or 65 percent, when rounded. In this example, F = 2,518, E = 0.6529, and the equation for lives saved calculates that LS = 0.6529*2518/(1-0.6529) = 4,736 lives were saved. In this example, the seat belt was used in combination with an air bag.

23) Q: What is an example of calculating lives saved by the MLDA law?
A: As stated in FAQ #19, the effectiveness of a MLDA law is 0.13, or 13 percent. NHTSA currently estimates the number of lives saved by the MLDA laws based on the reduction in target (18- to 20-year-old) driver involvements and the number of fatalities in crashes with those involvements. In 2007, 5,530 fatalities occurred in crashes where at least one driver in the crash was 18, 19, or 20. Therefore the number of lives saved by the MLDA is LS = 0.13*5530/(1-0.13) = 826. This calculation shows that in 2007, an estimated 826 lives were saved by the MLDA being shifted from 18 to 21 years old.

24) Q: If everyone properly wore seat belts, can it be estimated how many more lives would be saved?

A: Yes. The effectiveness of a seat belt only applies to occupants who were belted at the time of the crash. The number of lives saved by belts if all unbelted occupants were to hypothetically have worn their seat belts at the time of the crashes is referred to as "potential lives saved." By subtracting the lives saved count from the "potential lives saved" count, then the difference is referred to as an "additional lives (that could be) saved" count. In 2007, 15,147 lives were saved by seat belts, among ages 5 and older. The number of potential lives saved was calculated to be 20,171, and therefore the number of additional lives that could be saved was 20,171 – 15,147 = 5,024 additional lives that could be saved.

In summary, this number was produced by applying the appropriate effectiveness of a seat belt, according to the seat position of the occupant, to all unbelted occupants who were fatally injured. This seat belt effectiveness is applied to these unbelted occupants in order to calculate the hypothetical number of additional lives that would be saved had those unbelted occupants been wearing their seat belts.

25) Q: What steps are involved in making estimates for the number of potential lives saved?

A: Several calculations must be made to estimate the potential increase in the number of lives saved if additional vehicle occupants were to hypothetically wear their seat belts.

NOPUS and individual States produce estimates for the seat belt use of occupants in the front seat of a passenger vehicle during the daytime. It is important to remember that the high majority of these vehicle occupants in the United States are not in potentially fatal crashes. Therefore, the seat belt use in potentially fatal crashes (UPFC) is modeled, based on the front seat daytime belt use (X). The equation for this model is UPFC = 0.47249*X^2+0.43751*X (Wang & Blincoe, 2003).

This model is based on many years of data for State seat belt use estimates and belt use in FARS fatal crashes. The equation can be used to estimate the increased seat belt use among occupants in potentially fatal crashes, based on an increase in overall front seat daytime seat belt use.

NHTSA publishes annual estimates for the number of potential lives saved if seat belt use were to increase by one percent (i.e., from 82 percent to 83 percent), or if seat belt use were to increase to 100 percent (i.e., from 82 percent to 100 percent).

If State belt use increases by a hypothetical amount, then the UPFC increases, according to the equation. Under the scenario of more unbelted occupants in fatal crashes hypothetically having been wearing their seat belts, then the number of potential lives saved increases.

As in lives saved calculations, potential lives saved calculations are stratified according to the specific effectiveness estimate for the vehicle occupant. These effectiveness estimates are based on vehicle type, seat position, seat belt type, air bag presence, occupant age, and more.

26) Q: Do seat belts and air bags work together to save lives?
A: Yes. A front seat occupant is safest when the occupant is both using a seat belt and sitting in front of an air bag. The effectiveness of an air bag is 14 percent for unbelted occupants, and 11 percent for belted occupants. Thus a driver in a passenger car with a 3-point belt has four different hypothetical effectiveness estimates that could exist, given that the seat belt effectiveness for this driver is 0.48, or 48 percent.

Using no seat belt and having no air bag creates zero percent effectiveness (E=0.00). Using no seat belt and having an air bag creates an effectiveness of 14 percent. Using a seat belt and having no air bag creates an effectiveness of 48 percent. Using a seat belt and having an air bag creates an effectiveness of 54 percent (see FAQ #16 for details). Therefore, it is always best for the occupant to use both a seat belt and air bag, if it is available. Note: NHTSA recommends that occupants 12 or younger should not sit in front of a frontal air bag.

27) Q: Are lives saved by occupants moving from the front seat to a rear seat?
A: Yes. However, NHTSA does not currently produce lives saved estimates of the number of occupants who chose to move from the front seat to the rear seat, where the rear seat is defined as the $2^{nd}$, $3^{rd}$, or $4^{th}$ row of seats. NHTSA published an estimate of seat position effectiveness to be 26 percent (Evans 1988). Therefore, a passenger in a potentially fatal crash is 26 percent less likely to be killed when seated in a rear seat, compared to when the passenger is in the front passenger seat.

28) Q: Could lives saved be estimated for other devices?
A: Yes. Two other examples of devices for which lives saved can be estimated are electronic stability control, or ESC, and side air bags. Both ESC and side air bags have expanded significantly throughout the vehicle fleet in recent years. As more crash data is collected on vehicles with ESC, or vehicles with side air bags, eventually estimates of lives saved from these vehicle improvements will be made.

29) Q: Are lives saved estimated for each State?
A: Yes. State estimates are based on the methodology discussed in these FAQs, yet they also use the individual State belt use rates, measured annually, in the calculations. The individual State belt use rate is also used when estimating potential lives saved for each State. States with lower belt use rates will have

higher counts of "additional lives (that could be) saved." As the belt use rate for a State approaches 100 percent, then the number of "additional lives (that could be) saved" is reduced.

30) Q: Can lives saved be estimated in different ways?
A: Yes. As with all statistical modeling, different models can be created, and no model is perfect. The lives saved estimates made by NHTSA are based on more than 30 years of modeling and analysis of traffic data, and have been updated as more information is obtained. These estimating methods will continue to be revised as occupant behavior, vehicle mechanics, and driving environments continue to evolve.

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