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Analysis of Unreported Right Front Seat Occupants in FARS and Their Influence on Air Bag Effectiveness Estimates

Final Report

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NOTICE

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16. Abstract

The objective of this study was to determine which states did not have information on uninjured right-front-seat occupants of cars in the Fatality Analysis Reporting System (FARS), and how this would affect estimates of air bag effectiveness based on comparison of drivers and right-front-seat occupants. For the period 1991 to 1996, eight states did not seem to completely report uninjured right-front-seat occupants. One state reported uninjured right-front-seat occupants for only part of that period. Including these states in the analyses of air bag effectiveness had a negligible effect compared with the current statistical precision of such estimates.

It was found that air bag effectiveness was higher for adult right-front-seat occupants than it was for drivers (27 versus 14% in frontal impacts). For children under 5 years old, no effect was apparent. For children of 5-12 years old, an uncertain negative effect was apparent. Air bag effectiveness was higher for women than for men, ranging from a small, uncertain difference to a difference of about 35 percent when two women were in the front seats compared with two men.

17. Key FARS, crash reporting, right-front-seat occupants, air bag effectiveness, children, sex, gender

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

(Revised September 1993)

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Technical Summary

Some estimates of air bag effectiveness rely on comparing injuries and deaths of both drivers and right-front-seat vehicle occupants. Of special importance are estimates of the reduction of fatality risks that are based on fatal crashes from the Fatility Analysis Reporting System (FARS) data files. If uninjured right-front-seat occupants are not completely reported in the FARS files, then estimates of air bag effectiveness are distorted, to an unknown degree. In this study, there were strong indications that some states did not completely report uninjured right-front-seat occupants. The primary objective of this study was to determine which states did not report or did not completely report uninjured right-front-seat occupants. Secondary objectives were to estimate air bag effectiveness based only on the data of the states that seemed to report completely and to compare with estimates based on all states.

It was found that during the years 1991 to 1996, Indiana, Iowa, Maryland, Virginia, and Wyoming consistently reported very low percentages of uninjured right-front-seat occupants. Whether this was genuine underreporting or just misclassification could not be determined. In Georgia percentages of uninjured right-front-seat occupants changed in 1993 from extremely low to what appears to be normal. Other states with suspiciously but not extremely low percentages of uninjured right-front-seat occupants were Alaska, Idaho, and North Dakota. It was found that the inclusion of the states with very low and suspiciously low reporting in the data base of air bag effectiveness estimates had only a minimal effect, negligible compared with the precision of current estimates. Reported seat belt use which is considered unreliable, was not used in the analyses; therefore, estimates of air bag effects reflect whatever effects air bags had above and beyond those of belts as used ("as used" combines the effect for seat belt users with the lack of effect for non-users).

For adult drivers, air bag effectiveness in all crashes was a reduction of the fatality risk by 6 (± 4)[1] percent and, in frontal impacts, by 14 (± 4) percent. For adult right-front-seat occupants, the corresponding figures were higher, 16 (± 4), and 17 (± 5) percent. Because of the different configurations of driver and of right-front air bags, differences are not surprising. There was also a consistent pattern suggesting that air bags might have a negative effect for the driver in left-side impacts.

For children under 5 years of age no effect was apparent and for children 5 to 12 years old, an uncertain negative effect was apparent.

For the right-front-seat occupant, but not for the driver, air bag effectiveness seems to increase with age, from between 10 to 13 % for young drivers to between 29 to 33 % for old drivers.

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[1]Numbers in parentheses are estimated standard errors

With regard to differences between men and women, the following complex patterns in air bag effectiveness appear: For two men in the front seats, there was practically no reduction of the fatality risks. For two women, the effects were greater: There was a 36 percent reduction in fatality risk for the driver, 45 percent for the passenger. For a man and a woman in the front seats, the effects were in between these extremes. Somewhat simplified: the presence of a women, whether as a driver or a passenger, increases air bag effectiveness for the other person. Some of these differences might be due to height or other physical factors; other differences are more likely consequences of different driving and crash conditions.

In addition to these effects, there are weak indications that other factors also influence the effectiveness of air bags. Identifying such factors might help to develop better specifications for air bags and to increase their overall effects.

1. Introduction

One method of estimating air bag effectiveness is to compare deaths of drivers and of right-front-seat occupants in cars with only a driver-side air bag with those in cars without air bags. Similarly, one can estimate the effects of passenger-side air bags by comparing deaths of drivers and right-front-seat occupants in cars with only a driver-side air bag with those in cars with dual air bags. These methods require information on death as well as survival for both driver and right-front-seat occupant. Information on drivers and their injury status is always available in crash data files (except in cases of a hit-and-run vehicle or in rare cases when the identity of the driver is not certain). Many states require that in fatal crashes information on all occupants is provided, including their injury status. However, it is not clear to what extent this is required, and if it is required, it is not known to what extent it is actually done. If the presence of an uninjured right-front-seat occupant is not known, analyses comparing drivers and right-front-seat occupants will be biased, possibly seriously.

Working with 1994 and 1995 FARS data files, it was noticed that Indiana, Iowa, Maryland, and Virginia had extremely low numbers of uninjured right-front-seat occupants. Minnesota and Wyoming also had low absolute numbers and percentages, but not extremely low.

The objective of this study was to determine patterns of apparent nonreporting or incomplete reporting of uninjured right-front-seat occupants and to compare air bag effectiveness estimates for states where reporting appears to be normal (there can be no assurance that reporting is complete) with those for states where incomplete reporting is suspected. Once such states were identified, estimates of air bag effectiveness for drivers and for right-front-seat occupants in all crashes were calculated. Air bag effectiveness estimates were also calculated for certain classes of crashes, cars, and persons, including children in the right-front-seat.

2. Data

Data from the 1991 to 1996 FARS files were used. Earlier years contain relatively few cars equipped with air bags, and changes in the data format would have complicated processing somewhat.

Air bag availability in cars was determined by a computer program that NHTSA provided as a file called AOPVIN.SAS. This program decodes the Vehicle Identification Number (VIN) of cars and light trucks of model years 1987 and later. Thus, the analysis was restricted to cars of these model years.

Selected were cars for which AOPVIN could identify the presence or absence of an air bag and for which records of an occupant in the left-front and right-front-seating position were present. For the analyses of air bag effectiveness, only cases where at least one of the two persons was killed were used. This selection resulted in a file of nearly

16,000 vehicles. The numbers of cases used in the various analyses were slightly smaller, because necessary information was missing. In some analyses, only "matched" drivers and right-front-seat occupants were studied. Then the number of cases used would be substantially smaller. For those analyses, the actual numbers are shown.

3. Uninjured occupant reporting

Table 3-1 shows by state and by calendar year the percentages of uninjured right-front-seat occupants. Table 3-2 shows the same data, for each calendar year sorted by the percentage of uninjured right-front-seat occupants. Figures 3-1 to 6 show the same information as table 3-2 in the form of cumulative probability distributions with a normal probability scale for each year.

These graphs show, for each percentage of uninjured right-front-seat occupants, the percentage of the 51 states (including the District of Columbia) having this or a lower percentage of uninjured right-front-seat occupants. The normal probability scale was used because it is readily available, and because many empirical distributions can be approximated by a normal distribution. It is used simply as a heuristic device without any expectation that the values should follow it.

Figure 3-1 shows that most values for 1991 fall nearly perfectly on a straight line and that six states with low percentages deviate clearly from this pattern. The pattern for 1992 (Figure 3-2) is much less clear: one may see three sets of points lying on three lines, and perhaps only one point deviating from this pattern. None of the other graphs show a pattern as simple as the one for 1991, but most showed a few points with low percentages which clearly differ from the overall pattern.

Comparing the columns of Table 3-1 and Figures 3-1 to 3-6 showed that it is not always the same states that had very low percentages of uninjured right-front-seat occupants; only Virginia and Maryland always had very low values. Therefore, clustering techniques were tried to "objectively" identify clusters of states similar in terms of uninjured right-front-seat occupants. First, the six annual percentages were used as variables characterizing each state. No nontrivial clusters were found, and different criteria resulted in different sequences of aggregating clusters. Then, various ad hoc techniques were tried. None gave clusters that reasonably could be called objective. Therefore, the final choice of clusters was made by subjective judgement. The results of the various attempts to formally cluster states were used, together with a closer inspection of the graphs which suggested that 4% uninjured right-front-seat-occupants might be a breakpoint. Also considered were the numbers of right-front-seat occupants. If this number was small, and the state had a very low percentage of uninjured right-front-seat occupants only once or twice, this was considered a random variation. The result of this partially subjective process was that Indiana, Iowa, Maryland, Virginia, and Wyoming were identified as states where reporting of uninjured right-front-seat occupants was likely to be incomplete. It is also possible that right-front-seat occupants which are coded uninjured in most other states were coded as C-injured in some of these states. Such a miscoding would have no effect on air bag effectiveness estimates.

Table 3.1 Percentage of uninjured right-front-seat passengers by state and calendar year.

State	1991	1992	1993	1994	1995	1996
AL	9.7	11.0	9.4	11.2	9.4	12.0
AK	4.3	0.0	0.0	5.0	5.9	6.3
AZ	9.2	11.4	9.1	6.1	10.0	13.4
AR	3.9	8.0	5.4	9.5	3.9	4.1
CA	13.6	11.7	10.4	11.9	12.2	14.2
CO	8.3	9.0	7.5	11.8	6.8	8.2
CT	11.2	12.1	15.7	11.6	12.5	8.0
DE	5.7	3.1	13.5	7.7	0.0	9.4
DC	33.3	6.3	12.5	4.5	11.8	15.0
FL	12.4	11.1	11.1	9.2	11.9	12.7
GA	1.0	0.3	0.2	9.0	9.1	7.1
HI	14.3	14.6	11.8	13.8	15.4	10.5
ID	6.7	2.5	6.3	0.0	8.6	4.3
IL	5.8	8.3	10.3	10.7	10.0	8.4
IN	0.4	1.8	0.9	0.4	1.9	1.1
IA	1.3	4.9	2.2	0.7	0.0	0.0
KS	7.1	7.0	5.9	5.9	5.8	5.6
KY	6.4	7.2	7.5	9.4	8.4	6.6
LA	7.8	9.1	5.3	8.2	5.2	6.0
ME	1.6	7.9	16.7	7.5	5.7	5.0
MD	0.0	1.4	0.0	0.0	1.0	0.5
MA	6.5	0.9	5.4	5.1	7.4	6.7
MI	8.5	11.1	9.9	9.1	8.5	8.5
MN	3.8	4.4	5.2	3.8	3.8	9.0
MS	5.5	3.7	8.7	7.2	10.3	4.1
MO	5.0	3.6	6.3	8.5	6.7	9.5
MT	8.9	2.4	4.2	7.4	6.8	5.6
NE	5.8	7.6	3.3	8.6	10.3	2.9
NV	12.3	7.6	9.9	10.9	13.7	5.9
NH	14.3	2.7	10.3	10.3	7.9	9.4
NJ	8.9	11.0	6.8	10.6	4.1	11.7
NM	11.5	6.0	13.7	13.3	15.3	8.5
NY	9.9	9.3	9.8	9.5	11.5	8.3
NC	5.9	5.8	8.7	6.7	7.3	9.1
ND	12.0	8.0	11.5	20.0	0.0	0.0
OH	6.4	5.8	5.1	5.5	6.5	8.2
OK	7.1	7.7	7.6	9.3	8.2	8.2
OR	7.8	10.2	9.0	7.2	3.4	2.0
PA	9.0	10.2	10.0	7.0	8.4	13.0
RI	13.6	9.5	5.0	30.0	4.8	5.0
SC	10.5	10.4	15.0	12.8	8.2	7.8
SD	5.0	2.0	9.1	0.0	2.6	2.3
TN	8.0	11.3	9.3	8.7	7.3	9.7
TX	7.2	8.7	9.2	8.0	10.0	9.6
UT	11.5	8.7	7.0	9.3	3.8	4.1
VT	9.4	14.3	17.1	10.7	6.7	11.8
VA	0.0	0.0	0.0	0.8	0.0	0.0
WA	10.0	6.6	11.3	6.7	9.6	8.9
WV	7.9	5.2	3.9	8.6	3.9	6.7
WI	10.4	5.6	5.3	6.6	9.0	9.3
WY	0.0	3.3	2.7	3.7	2.5	3.4

Table 3.2 Percentage of uninjured right-front-seat passengers, by state and calendar year. States are ordered by the percentage of uninjured passengers. States with consistently low percentages are marked with an asterisk, states with a frequently low percentage with a question mark. Georgia has low percentages only for the years 1991-1993.

1991		1992		1993		1994		1995		1996	
VA*	0.0	AK?	0.0	MD*	0.0	ID?	0.0	VA*	0.0	ND	0.0
WY*	0.0	VA*	0.0	VA*	0.0	SD?	0.0	IA*	0.0	VA*	0.0
MD*	0.0	GA*	0.3	AK?	0.0	MD*	0.0	ND	0.0	IA*	0.0
IN*	0.4	MA	0.9	GA*	0.2	IN*	0.4	DE	0.0	MD*	0.5
GA*	1.0	MD*	1.4	IN	0.9	IA*	0.7	MD*	1.0	IN*	1.1
IA*	1.3	IN*	1.8	IA*	2.2	VA*	0.8	IN*	1.9	OR	2.0
ME	1.6	SD?	2.0	WY*	2.7	WY*	3.7	WY*	2.5	SD?	2.3
MN	3.8	MT	2.4	NE	3.3	MN	3.8	SD?	2.6	NE	2.9
AR	3.9	ID?	2.5	WV	3.9	DC	4.5	OR	3.4	WY*	3.4
AK?	4.3	NH	2.7	MT	4.2	AK?	5.0	UT	3.8	AR	4.1
SD?	5.0	DE	3.1	RI	5.0	MA	5.1	MN	3.8	MS	4.1
MO	5.0	WY*	3.3	OH	5.1	OH	5.5	AR	3.9	UT	4.1
MS	5.5	MO	3.6	MN	5.2	KS	5.9	WV	3.9	ID?	4.3
DE	5.7	MS	3.7	LA	5.3	AZ	6.1	NJ	4.1	RI	5.0
NE	5.8	MN	4.4	WI	5.3	WI	6.6	RI	4.8	ME	5.0
IL	5.8	IA*	4.9	MA	5.4	WA	6.7	LA	5.2	KS	5.6
NC	5.9	WV	5.2	AR	5.4	NC	6.7	ME	5.7	MT	5.6
OH	6.4	WI	5.6	KS	5.9	PA	7.0	KS	5.8	NV	5.9
KY	6.4	NC	5.8	MO	6.3	OR	7.2	AK?	5.9	LA	6.0
MA	6.5	OH	5.8	ID?	6.3	MS	7.2	OH	6.5	AK?	6.3
ID?	6.7	NM	6.0	NJ	6.8	MT	7.4	VT	6.7	KY	6.6
KS	7.1	DC	6.3	UT	7.0	ME	7.5	MO	6.7	MA	6.7
OK	7.1	WA	6.6	CO	7.5	DE	7.7	MT	6.8	WV	6.7
TX	7.2	KS	7.0	KY	7.5	TX	8.0	CO	6.8	GA	7.1
OR	7.8	KY	7.2	OK	7.6	LA	8.2	TN	7.3	SC	7.8
LA	7.8	NE	7.6	MS	8.7	MO	8.5	NC	7.3	CT	8.0
WV	7.9	NV	7.6	NC	8.7	WV	8.6	MA	7.4	OH	8.2
TN	8.0	OK	7.7	OR	9.0	NE	8.6	NH	7.9	OK	8.2
CO	8.3	ME	7.9	SD?	9.1	TN	8.7	OK	8.2	CO	8.2
MI	8.5	ND	8.0	AZ	9.1	GA	9.0	SC	8.2	NY	8.3
MT	8.9	AR	8.0	TX	9.2	MI	9.1	KY	8.4	IL	8.4
NJ	8.9	IL	8.3	TN	9.3	FL	9.2	PA	8.4	NM	8.5
PA	9.0	UT	8.7	AL	9.4	UT	9.3	MI	8.5	MI	8.5
AZ	9.2	TX	8.7	NY	9.8	OK	9.3	ID?	8.6	WA	8.9
VT	9.4	CO	9.0	MI	9.9	KY	9.4	WI	9.0	MN	9.0
AL	9.7	LA	9.1	NV	9.9	AR	9.5	GA	9.1	NC	9.1
NY	9.9	NY	9.3	PA	10.0	NY	9.5	AL	9.4	WI	9.3
WA	10.0	RI	9.5	IL	10.3	NH	10.3	WA	9.6	NH	9.4
WI	10.4	PA	10.2	NH	10.3	NJ	10.6	AZ	10.0	DE	9.4
SC	10.5	OR	10.2	CA	10.4	VT	10.7	TX	10.0	MO	9.5
CT	11.2	SC	10.4	FL	11.1	IL	10.7	IL	10.0	TX	9.6
NM	11.5	NJ	11.0	WA	11.3	NV	10.9	NE	10.3	TN	9.7
UT	11.5	AL	11.0	ND	11.5	AL	11.2	MS	10.3	HI	10.5
ND	12.0	FL	11.1	HI	11.8	CT	11.6	NY	11.5	NJ	11.7
NV	12.3	MI	11.1	DC	12.5	CO	11.8	DC	11.8	VT	11.8
FL	12.4	TN	11.3	DE	13.5	CA	11.9	FL	11.9	AL	12.0
CA	13.6	AZ	11.4	NM	13.7	SC	12.8	CA	12.2	FL	12.7
RI	13.6	CA	11.7	SC	15.0	NM	13.3	CT	12.5	PA	13.0
HI	14.3	CT	12.1	CT	15.7	HI	13.8	NV	13.7	AZ	13.4
NH	14.3	VT	14.3	ME	16.7	ND	20.0	NM	15.3	CA	14.2
DC	33.3	HI	14.6	VT	17.1	RI	30.0	HI	15.4	DC	15.0

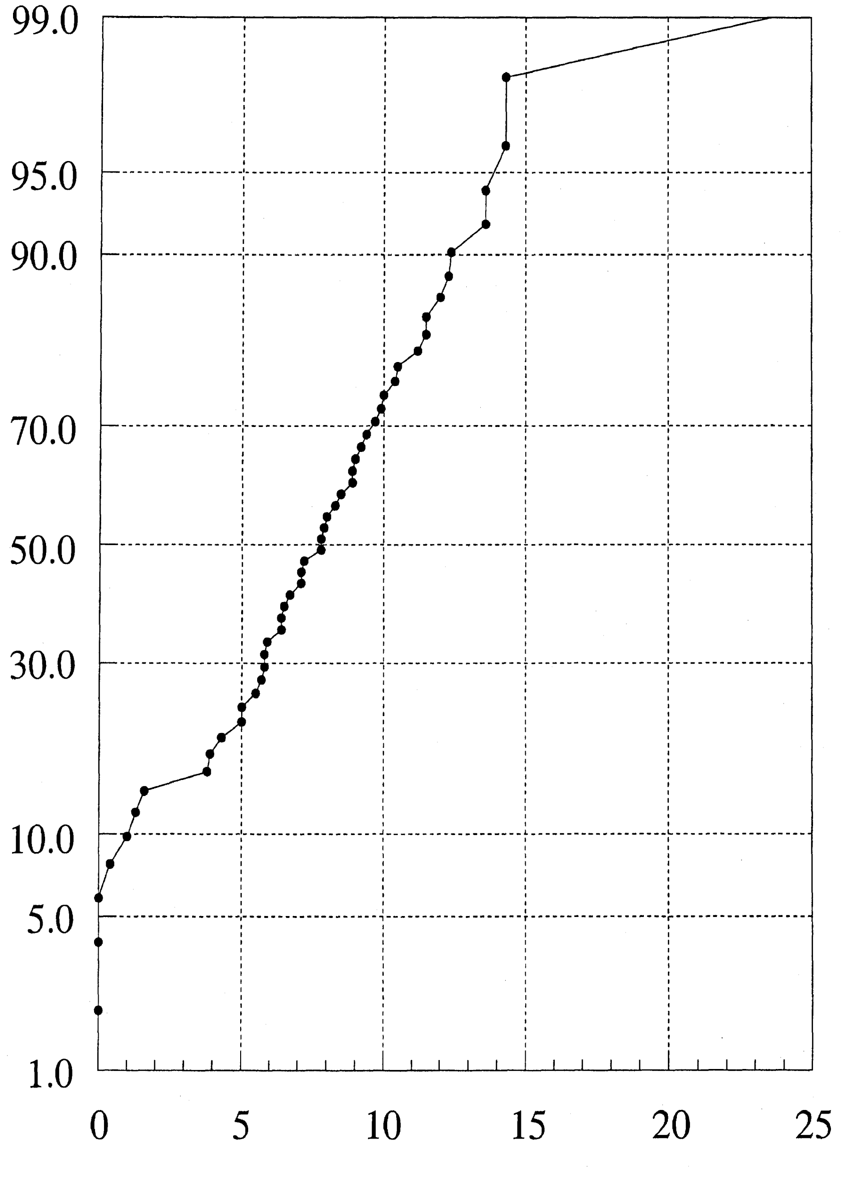

Figure 3-1. Cumulative distribution of states by percentage of uninjured right-front-seat occupants, 1991. The vertical scale is a normal probability scale.

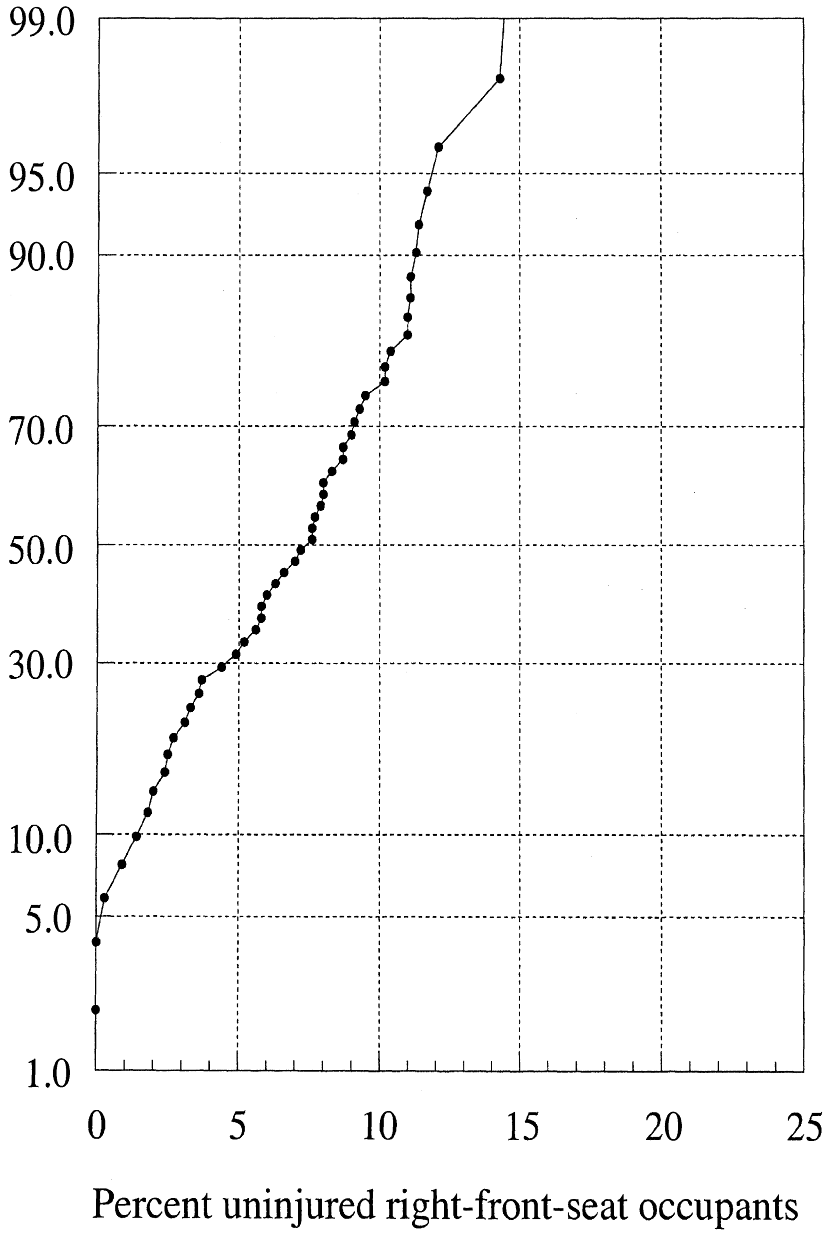

Figure 3-2. Cumulative distribution of states by percentage of uninjured right-front-seat occupants, 1992. The vertical scale is a normal probability scale.

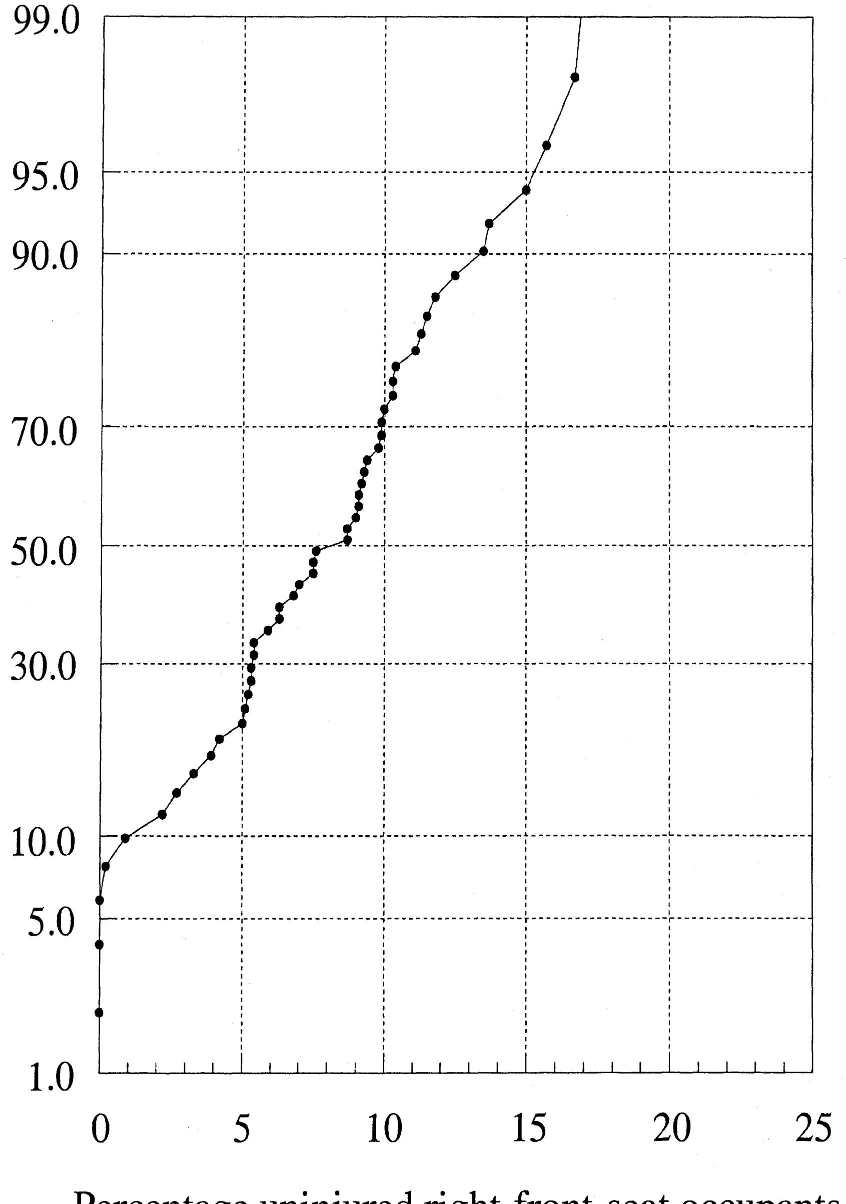

Figure 3-3. Cumulative distribution of states by percentage of uninjured right-front-seat occupants, 1993. The vertical scale is a normal probability scale.

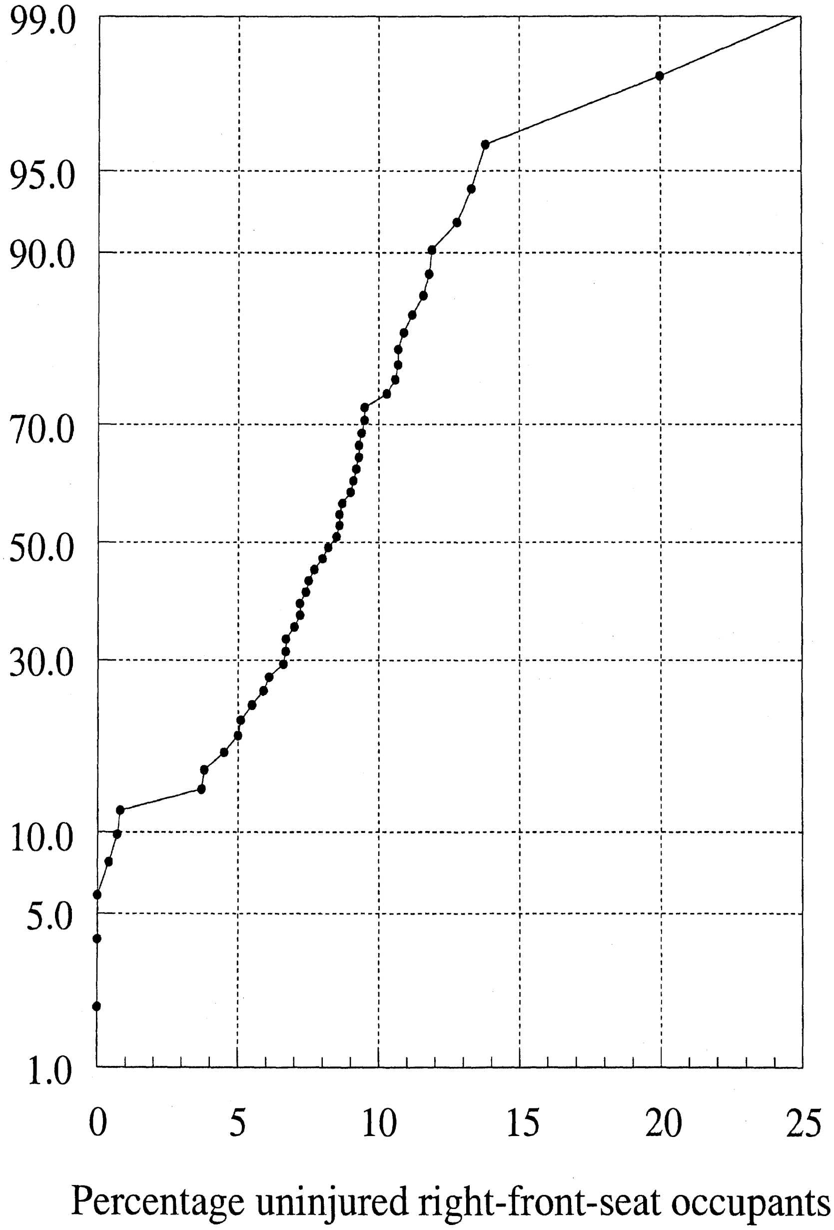

Figure 3-4. Cumulative distribution of states by percentage of uninjured right-front-seat occupants, 1994. The vertical scale is a normal probability scale.

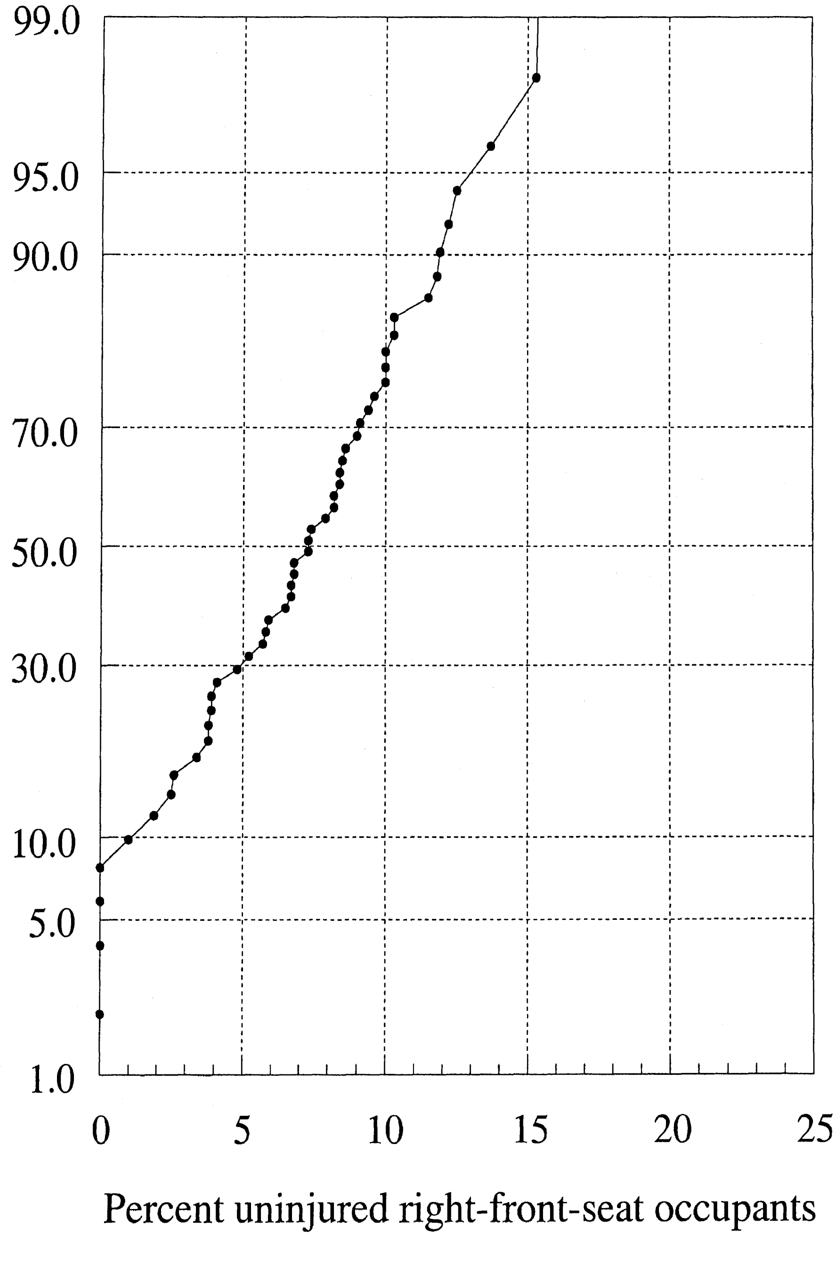

Figure 3-5. Cumulative distribution of states by percentage of uninjured right-front-seat occupants, 1995. The vertical scale is a normal probability scale.

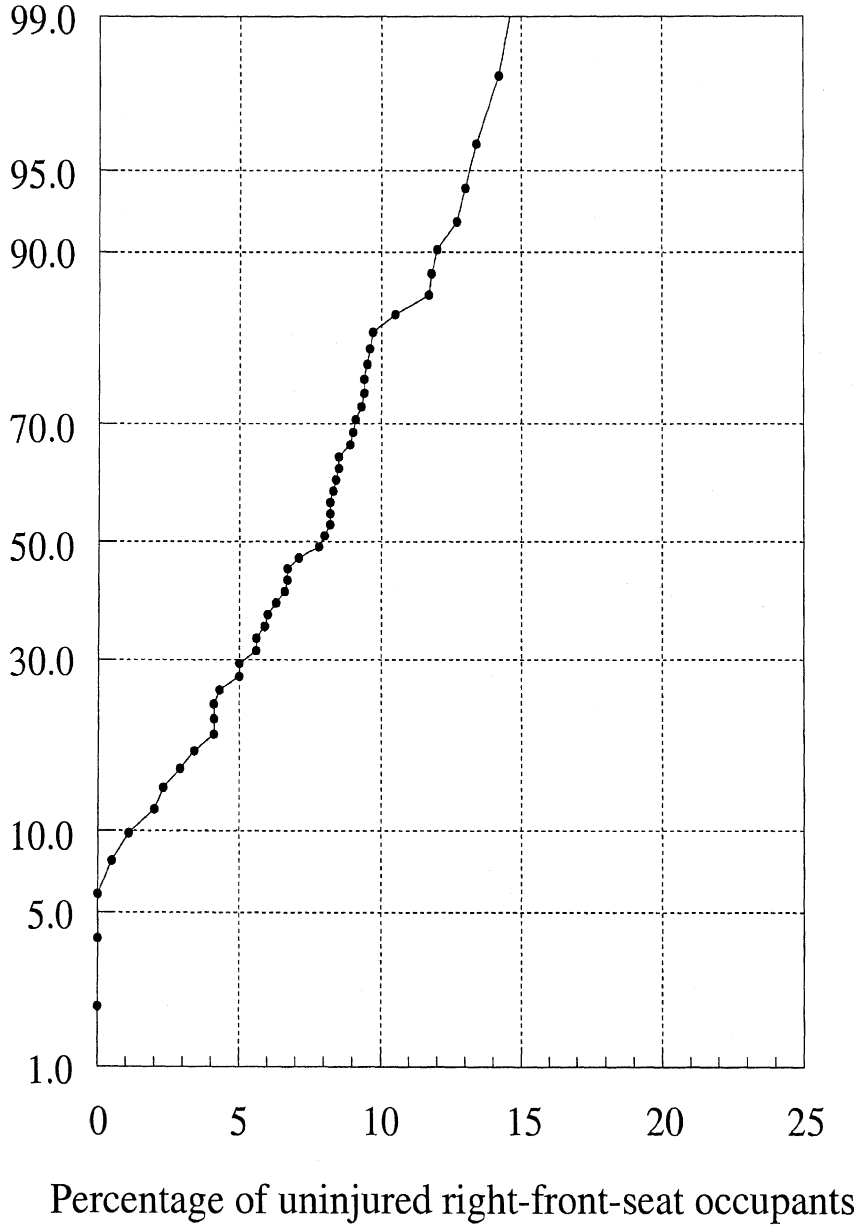

Figure 3-6. Cumulative distribution of states by percentage of uninjured right-front-seat occupants, 1996. The vertical scale is a normal probability scale.

Georgia is a special case. The percentages of uninjured right-front-seat occupants are 1.0, 0.3, and 0.2 during the first three years and 9.0, 9.1, and 7.1 during the last three years. Given the large case numbers in Georgia, this difference is too great to be explained by random variability. Clearly, there must have been a change in reporting.

Three other states were found that often had low percentages of uninjured right-front-seat occupants, but not so low as to be suspicious. These states were Arkansas, Idaho, and North Dakota. It is suspected that these states, or certain police agencies in them, might have special reporting requirements or practices in terms of the presence of a killed occupant (some states required reporting of uninjured vehicle occupants only if a vehicle occupant was killed). Tabulations by driver injury, by interstate highways (that are often served by state police agencies) versus other highways, and by urban versus rural highways (because urban and rural police departments often differ in the availability of special accident investigation units, and other characteristics) were made and examined. No patterns were apparent. However, the disaggregated numbers were so small that differences would have had to be very large to be recognizable.

While performing this work, it was noticed that very few, close to zero, uninjured drivers were reported in Maryland. All other states reported appreciable percentages of uninjured drivers. This was checked with NHTSA staff, but no explanation was found.

4. Air bag effectiveness estimates

4.0 The statistical approach

Only cars with a driver and right-front-seat passenger were considered. It is critical that not only killed, but also surviving drivers and right-front-seat occupants have been completely reported. Three separate data sets were formed: one consisting of cars with no air bags, the second of cars with only a driver side air bag, and the third of cars with dual air bags. Under plausible assumptions, the ratio of drivers killed and right-front-set passengers killed in each seat is an estimate of the ratio of the probabilities of death in a crash. Air bags change these probabilities. The ratios of these two ratios provide estimates of factors by which these probabilities are changed. These factors are shown. For instance, a factor of 1 means that there is no effect, a factor of 0.87 indicates that a probability of death is reduced by 13 percent, and a factor of 1.07 indicates an increase of the probability by 7%. Details of the mathematics are shown in Appendix 1.

Probabilities of death are influenced by many factors. To reduce the confounding effects of such factors, one makes comparisons among similar crashes. Because case numbers are limited, using strict standards for similarity results in low statistical precision of the estimates, so that they may even become useless.

Statistics enters when estimating errors of the estimates. The technique used was bootstrapping, described in Appendix 2. While it has several advantages over certain frequently used approximations, straightforward implementations can fail if case numbers are small.

All estimates are shown with standard errors. Significance levels are not shown. The reason is that standard errors provide direct information on the precision of the estimates. Also, one may question whether significance levels are really meaningful in the given context. There is no longer a question *of whether* air bags have an effect, but rather *how much* of an effect they have.

4.1 Comparing states

For the initial analysis, only impact sides on the car were distinguished. FARS codes impacts by 12 clock positions. In this study, 11,12 and 1 were interpreted as frontal impacts, 2,3,4 as right-side impacts, etc. However, one should be aware that the original state accident reports, on which FARS is based, use several different coding schemes. It is not always possible to unambiguously translate them into clock positions, especially in corner impacts. This adds "noise" to the data, and possibly also biases. No other person, vehicle or crash characteristics were considered. Table 4.1-1 shows the resulting air bag factors for drivers and for right-front-seat occupants over 15-years old by impact side. Estimates obtained from all states are shown as well as estimates obtained from those states that appear to be reporting completely (referred to as "good" states), and the difference between the two estimates is shown. Because these estimates are not independent, the standard errors of the differences are much smaller than one would expect on the basis of the standard errors of the factors themselves. The differences are not larger than their standard errors in all but one case. In that single case, right-front-seat passengers in rear impacts, the difference is 1.7 times its standard error. With 3 negative and 2 positive signs for the five impact types, the difference for right-front-seat occupants are as balanced as possible. For drivers, there are 4 negative and 1 positive difference. One might wonder whether this suggests a systematic difference. If positive and negative differences were equally likely, the probability for 4 or more negative differences would be 16%. However, one would ask a similar question if one had observed 4 positive and one negative difference. Therefore, the probability for such a pattern possibly suggesting a difference is 32%. Clearly, such patterns can very likely be the result of random variations.

Table 4.1-1. Air Bag Factors for all States and for 'Good' States. By impact side, and for drivers and right-front-seat passengers both over 15 years old. Standard errors are in parentheses.

States	Impact Side: Front	Right	Rear	Left	Other	All
	Drivers					
Good	0.86 (.04)	0.96 (.09)	1.04 (.16)	1.10 (.11)	1.05 (.13)	0.94 (.04)
All	0.85 (.04)	0.95 (.08)	0.98 (.14)	1.11 (.10)	1.04 (.13)	0.93 (.03)
Difference	-.01 (.01)	-.01 (.03)	-.05 (.05)	0.01 (.03)	-.01 (.04)	-.00 (.01)
	Right-Front-Seat Occupants					
Good	0.73 (.05)	0.95 (.11)	0.99 (.22)	1.07 (.12)	0.94 (.14)	0.84 (.04)
All	0.73 (.05)	0.97 (.11)	0.86 (.19)	1.08 (.12)	0.93 (.12)	0.84 (.04)
Difference	-.00 (.02)	0.02 (.03)	-.12 (.07)	0.01 (.04)	-.00 (.04)	-.00 (.01)

In no case are the standard errors of the estimates for all states greater than those of the estimates based only on the good states; in 5 of the 10 cases, they are even slightly lower.

In conclusion, it makes no practically relevant difference for estimating overall air bag effectiveness to include or exclude the states that report few or no uninjured right-front-seat occupants. Therefore, in the body of the report only results from the good states will be shown. However, there is still the possibility that incomplete reporting affects estimates of air bag effectiveness under special conditions. Therefore, results from all states and the differences are shown in Appendix 3.

4.2 Overall effectiveness

Table 4.2-1 repeats some of the information shown in Table 4.1-1 to make comparisons simpler. For drivers, the factors differed only in frontal impacts by more than one standard error from 1; indeed, they differed by 3.5 standard errors. Expressed as a percentage, the air bag reduces the driver fatality risk by 14%; a rough estimate of the $\pm 2\sigma$ confidence range is from 6% to 22%. Combining all impacts, the fatality risk reduction is still 6% with a rough $\pm 2\sigma$ confidence range from -2% to 14%.

Table 4.2-1. Air bag Factor. All drivers and right-front-seat occupants over 15 years. States with good information. Standard errors are in parentheses.

	Impact Side					
	Front	Right	Rear	Left	Other	All
Driver	0.86 (.04)	0.96 (.09)	1.04 (.16)	1.10 (.11)	1.05 (.13)	0.94 (.04)
Right-front-seat occupant	0.73 (.05)	0.95 (.11)	0.99 (.22)	1.07 (.12)	0.94 (.14)	0.84 (.04)

For the right-front-seat occupant, again only in frontal impacts do the factors differ by more than 1 standard error from 1. The reduction in frontal impacts is 27% with a rough confidence range from 17% to 37%. It is about twice as much as for the driver, but the rough confidence intervals overlap widely.

Because of the geometric symmetry, one might expect that left side impacts affect the driver in a similar way as right side impacts the right-front-seat occupant, and vice versa (aside from effects of the steering column). On the other hand, driver and passenger air bags differ in their relative positions to the person, and in size.

The data in Table 4.2.1 refutes this expectation. The estimated effects in same-side-impacts differ widely between driver and right-front-seat occupants, as do the estimated effects for other-side occupants. Contrasting with this, the effects in left-side-impacts are practically the same for driver and right-front-seat occupants, as are the effects in right-side- impacts.

This suggests that there might be differences in the severity of left side and right side impacts which result in differences in air bag effectiveness.

4.3 Effectiveness by occupant age

Air bag effectiveness by occupant age is of interest for two reasons. First: It is of interest in itself to know whether air bag effectiveness depends on the occupant's age. The second reason is more subtle. The fatality risk in a crash increases with the occupant's age, especially at higher ages. This can confound the comparisons between drivers and passengers used in this study.

Several approaches were tried to deal with driver age. I finally decided on the following approach: Only cases where the occupants' ages were "matched" were used, and the average of both ages was used as an age variable. Matching was done at three alternative levels. The closest match used cases with ages differing by no more than 5 years. This reduced the number of cases to 10,000. The next level used ages differing by no more than 10 years, which resulted in 12,400 cases. The last level used cases with ages within 15 years, resulting in 13,400 cases. The results for the three data sets differed surprisingly little. Therefore, only those for the 5 and 15 year match are shown here. Complete tables are in Appendix 3.

TABLE 4.3-1. Air Bag Factors by Person Age. Drivers and right-front-seat occupants. Ages differ by no more than shown as "age match." Frontal impacts. States with good information. Standard errors are in parentheses.

Age Match	Average Age		
	16-25	26-65	over 65
	Drivers		
5 years	0.86 (.08)	0.87 (.09)	0.88 (.10)
15 years	0.85 (.08)	0.85 (.06)	0.90 (.09)
	Right-front-seat passenger		
5 years	0.90 (.11)	0.76 (.12)	0.67 (.11)
15 years	0.87 (.10)	0.75 (.09)	0.61 (.11)

Table 4.3-1 shows the air bag factors for drivers and right-front-seat passengers by their average age. The three age groups were formed to contain approximately the same number of cases.

The standard errors for the 15-year age match are not much smaller, if at all, than those for the 5-year age match. This is not surprising: under plausible assumptions increasing the number of cases by one-third decreases standard errors by roughly one-sixth, everything else being equal. The greater variability within the broader age range, however, will counteract this.

Overall, the air bag factors for the 15-year match seem to be slightly smaller (indicating a slightly greater air bag effect), than those for the 5-year match. However, the differences are only a fraction of a standard error.

For drivers, the air bag factor seems to be constant. For right-front-seat passengers, however, a clear trend appears: air bag effectiveness seems to increase from about one tenth for the youngest group, to over one quarter for the middle age group to one third for the oldest group. The group-to-group differences never exceed one standard error, but the uniform increase of air bag effectiveness with age strongly suggests further exploration of this question. One possible confounding factor is belt use, which varies with age.

4.4 Effectiveness for Children

I treat the analysis of children as right-front-seat passengers as a special case of age analysis, though the actual distinguishing factor should not be age. Children weighing under 40 lbs. should be and are usually in special child seats. The weight is not available in the FARS file, but typically, children up to 40 lbs. are under 5 years old.

For older children, height would be a factor influencing air bag effectiveness. Again, it is not given in the FARS file. Height varies greatly among children of the same age. Since many children of 12 years of age have the height of some adult women, we use 12 as the cutoff age for children.

Table 4.4-1 shows the air bag factors for children under 5 years (Factors for drivers are also shown. They were automatically generated by the computer program, and will be discussed below). The number of cases was small: 468, in which 289 children under 5 years were killed. Therefore, a standard error could be calculated only for frontal impacts. The standard error is so large, and the factor is practically equal to 1 that there is not even a suggestion of an effect for small children. This is not unexpected.

TABLE 4.4-1. Air bag factors by impact side for right-front - seat occupants under 5 years of age. Only states with good information included. Standard errors are in parentheses. A dash (-) in parentheses is explained in Appendix 2.

	Impact Side					
	Front	Right	Rear	Left	Other	All
Driver	0.78 (.23)	0.39 (.29)	0 (-)	2.14 (-)	0.67 (-)	0.72 (.19)
Child	0.98 (.47)	0.38 (--)	- (-)	2.50 (-)	- (-)	0.86 (.32)

Table 4.4-2 shows the results for children 5-12 years old. Again, it is based on a small number of cases: 725, in which 353 children were killed. Only one standard error could be calculated-for frontal impacts, and it is large. Nevertheless, it is noteworthy that no air bag factor is less than 1. This suggests no beneficial effect for children in this age group and possibly even a detrimental effect.

Table 4.4-2. Air bag factors by impact side for right-front-seat occupants from 5-12 years old. Only states with good information. Standard errors are in parentheses. A dash (-) in parentheses is explained in Appendix 2.

	Impact Side					
	Front	Right	Rear	Left	Other	All
Driver	0.97 (.23)	0.86 (.25)	0.70 (-)	2.06 (-)	1.60 (-)	1.16 (.17)
Child	1.96 (.80)	1.59 (-)	1.00 (-)	1.88 (-)	2.00 (-)	1.56 (.38)

As a byproduct of the estimates for children, I also obtained the air bag factors for their drivers. Their values from tables 4.4-1 and 4.4-2 are shown, together with the values for drivers with right-front-seat occupants over 15 years old (from Table 4.2-1) in Table 4.4-3.

TABLE 4.4-3. Air bag factors by impact side for drivers with right-front-seat occupants over 15, between 5-12 years old and under 5 years old. Only states with good information have been included. Standard errors are in parentheses. A dash (-) in parentheses is explained in Appendix 2.

	Impact Side					
	Front	Right	Rear	Left	Other	All
Drivers with right-front-seat passenger over 15	0.86 (.04)	0.96 (.09)	1.04 (.16)	1.10 (.11)	1.05 (.13)	0.94 (.04)
Drivers with children 5-12	0.97 (.23)	0.86 (.25)	0.70 (-)	2.06 (-)	1.60 (-)	1.16 (.17)
Drivers with children <5	0.78 (.23)	0.39 (.29)	0 (-)	2.14 (-)	0.67 (-)	0.72 (.19)

Considering the large standard errors for drivers with children, no difference is apparent between drivers with right-front-seat passengers over 15 years old and drivers with right-front-seat passengers 5-12 years old. To the contrary, one commonality appears: the factors for left-side impacts are in both cases large, suggesting a detrimental effect of the air bag. However, for drivers with children, no standard errors could be calculated, and for drivers with adult passengers, the estimate differed by less than one standard error.

The standard errors for drivers with children under 5 years are very similar to those with children 5-12 years old, the air bag factors are smaller except in left-side impacts, sometimes much smaller than those for the other two driver groups, though the differences are only for right-side impacts greater than 1.2 standard error.

The fact that the air bag factor in all three distinct driver populations for left-side impacts is greater than 1 deserves closer examination, though standard errors could not be calculated. It might not necessarily be an actually detrimental physical effect of the air bag, but an indirect effect of crash patterns that result in differences in certain factors between left-side impact and other impacts.

4.5 Effectiveness for men and women

I separated crashes into four groups, according to the possible combinations of men and women as drivers and right-front-seat occupants.

Table 4.5-1 shows the effectiveness factors for these combinations. Some very clear patterns appear. First, air bag effectiveness always appears greater for the right-front-seat passenger, even after controlling for sex. However, the differences would be considered marginally "significant" in only one case: a male driver and a female passenger. Second, air bag effectiveness appears greater for drivers as well as right-front-seat passengers, if the driver is female; again, the difference would be considered "significant" in only one case, where the right-front-seat passenger is female. Third, air bag effectiveness for drivers as well as right-front-seat occupants appears greater if the right-front-seat occupant is female. In this situation, three comparisons are "significant" or marginally "significant." The term "significant" is used in an illustrative sense only. It does not imply any rigorous test.

TABLE 4.5-1. Air bag factors by seating position and sex for occupants over 15 years old in frontal impacts. Only states with good information have been included. Standard errors are in parentheses.

Driver	Right-front-seat passenger			
	Male		Female	
	Driver	Passenger	Driver	Passenger
Male	1.00 (.09)	0.89 (.10)	0.84 (.07)	0.66 (.07)
	Driver	Passenger	Driver	Passenger
Female	0.91 (.10)	0.86 (.15)	0.64 (.09)	0.55 (.10)

I do not attempt to speculate how to explain this complicated pattern. However, the apparent influence of the right-front passenger suggests that not only physical, but also social factors related to trip purpose might have an indirect effect on air bag effectiveness. Another possible confounding factor is that belt use differ between men and women.

4.6 Effectiveness by age and sex

The analyses by age (Section 4.3) and by sex (Section 4.5) shows complex patterns that have no obvious explanation. Therefore, the data were also disaggregated by age and sex together to recognize any potential confounding of the two factors. Tables 4.6-1 and 4.6-2 show the resulting air bag factors, for drivers and right-front-seat passengers "matched" by age within 5 years, and within 15 years.

Table 4.6-1. Air bag factors by seating position, age and sex. Occupants over 15 years old in frontal impacts. Only states with good information have been included. Age is the average of the two ages, only cases with age differences up to 5 years. Standard errors are in parentheses. A dash (-) in parentheses is explained in Appendix 2.

Driver	Right-front-seat passenger				
	Male			Female	
Male	Age	Driver	Passenger	Driver	Passenger
	16-25	1.03 (.14)	1.09 (.20)	0.80 (.14)	0.66 (.16)
	26-65	0.93 (.18)	0.77 (.22)	0.82 (.13)	0.72 (.18)
	>65	0.59 (.50)	- (-)	0.92 (.14)	0.69 (.14)
Female	Age	Driver	Passenger	Driver	Passenger
	16-25	0.81 (.24)	1.70 (.68)	0.55 (.08)	0.42 (.24)
	26-65	0.95 (.31)	0.77 (.31)	0.95 (.42)	1.10 (1.20)
	>65	1.14 (.42)	1.00 (.60)	0.51 (.28)	0.47 (.34)

Because of the much finer disaggregation, the standard errors are much greater than in the separate analyses by age and by sex. Also, the factors show greater variability, and no clear and consistent patterns are apparent.

What these tables suggest is that a fine disaggregation of a data set may hide the pattern one is looking for in the increased "noise." One way to escape this might be to use such finely categorized tables only in intermediate steps, as a basis for developing standardized tables. In this case, for instance, one would compare seating positions, standardizing by age and sex; compare age classes, standardizing for seating positions and sex; and compare sexes by standardizing for seating positions and ages. Standardization by itself is not difficult. However, problems can arise if the disaggregation has resulted in empty cells. In such situations, special methods have to be applied, for instance pseudo-Bayesian estimates for the empty cells. Even in the simple situations without empty cells, the estimation of standard errors becomes much more complicated.

Another approach would be to try expressing the values in a detailed table such as 4.6-1 as a function of the various factors of age, sex, seating position, and perhaps interactions. That can be done in a much more "mechanical" way than standardization, because empty cells can be simply ignored. However, there is a danger that a model will be so specified that it leads to spurious effects. I did experiment with this approach, using a fine disaggregation of age. However, no usable results were obtained.

Table 4.6-2. Air bag factors by seating position, age and sex or occupants over 15 years in frontal impacts. Only states with good information have been included. Age is the average of the two ages, only cases with age differences up to 15 years. Standard errors are in parentheses. A dash (-) in parentheses is explained in Appendix 2.

Driver	Right-front-seat passenger				
	Male			Female	
Male	Age	Driver	Passenger	Driver	Passenger
	16-25	1.03	1.00	0.71	0.67
		(.13)	(.18)	(.14)	(.18)
	26-65	0.96	0.81	0.76	0.74
		(.16)	(.17)	(.08)	(.13)
	>65	0.91	0.35	0.95	0.64
		(.52)	(-)	(.14)	(.13)
Female	Age	Driver	Passenger	Driver	Passenger
	16-25	0.81	1.52	0.60	0.49
		(.24)	(.84)	(.15)	(.17)
	26-65	1.00	0.68	0.71	0.75
		(.16)	(.20)	(.20)	(.35)
	>65	1.04	0.79	0.54	0.34
		(.24)	(.34)	(.18)	(.21)

4.7 Effectiveness by car weight

Vehicle weight has a direct effect on fatality risk in collisions between vehicles and can have an indirect effect in single-vehicle crashes if heavier cars provide more occupant space, better protection against compartment intrusion, and energy management. I disaggregated cars into three classes so that roughly one- third fell into each class: under 2,500 lbs., 2,500 to less than 3,100 lbs., and heavier.

Table 4.7-1 shows the air bag factors by car weight. For right-front passengers, there is no difference in relation to weight. For drivers, there appears to be a difference between cars under 2,500 lbs. and the other two weight classes.

Table 4.7-1. Air bag factor by car weight for occupants over 15 years old in frontal impacts. Only states with good information have been included.

	Car Weight (lbs.)		
	<2,500	2,500-3,099	>3,099
Driver	0.71 (.08)	0.88 (.06)	0.88 (.08)
Right Front Passenger	0.72 (.12)	0.73 (.10)	0.73 (.07)

The apparently greater effectiveness of air bags for right-front-seat passengers, which appears, e.g. in Table 4.2-1, seems to be limited to heavier cars. There is no obvious reason for this, and it raises the suspicion that driver and use factors may play a role.

To assess whether there might be a strongly nonlinear relation between car weight and air bag effectiveness, I disaggregated the lowest weight class further. No pattern was apparent, and the standard errors became so large that any apparent pattern would have been suspected to be only a random variation.

4.8 Effectiveness by speed environment

Crash severity in terms of delta v, impact speed, or similar measure may influence air bag effectiveness. Such information, however, is not available in FARS. The closest proxy is the speed limit, which is often set to reflect the 85th percentile of travel speed. Of course, individual travel speeds can deviate greatly from the speed limit. Therefore, one should not expect too much from comparing air bag factors in relation to the speed limit.

To group crashes by speed limit so that approximately one-third were in each group, and so that no group covered too wide a range of speeds proved impossible. I had to settle for the following groups: speed limits up to 40 mph, 25% of the cases; speed limits of 41 - 55 mph with 65% of the cases; and over 55 mph with 10% of the cases.

Table 4.8-1 shows the corresponding air bag factors. The familiar pattern that effectiveness is higher for right-front-seat occupants appears again. Another pattern is that effectiveness seems to be lower for the highest speed limits.

TABLE 4.8-1. Air bag factor by speed limit for occupants over 15 years old in frontal impacts. Only states with good information have been included. Standard errors are in parentheses.

	Speed Limit (mph)		
	<41	41-55	>55
Driver	0.88 (.12)	0.80 (.04)	1.08 (.12)
Right Front Passenger	0.65 (.12)	0.71 (.06)	0.84 (.13)

4.9 Effectiveness by crash type

Table 4.9-1 shows separate estimates of air bag effectiveness in single-vehicle and in multivehicle crashes. For the driver, the effect appears to be about three times as large in multivehicle crashes, for the right-front-seat occupant it is not greater than one standard error.

Table 4.9-1. Air bag effectiveness for single-vehicle and for multivehicle crashes for occupants over 5 years old. Only states with good information have been included.

	Crash Type	
	Single Vehicle	Multi-vehicle
Driver	0.94 (.07)	0.81 (.05)
Right-front-seat occupant	0.77 (.08)	0.71 (.06)

5. Comparing the findings with Kahane's findings

C.J. Kahane has performed a very extensive and thorough evaluation of air bag effectiveness.[2] This present study had a different emphasis, therefore it differs in several respects. There are some differences in the data base, in some of the levels of detail, and in the approaches. Therefore, no exact one-to-one comparison is possible. However, I will compare the major findings, and highlight similarities and differences. Differences reflect the effect of data selection and model assumptions upon effectiveness estimates. Comparing such differences with the standard error gives one an idea how cautious one must be when using standard error as indicators of the accuracy of the estimates.

The overall estimate of effectiveness for the driver air bag is 6% (± 4) in this study; Kahane's estimate is 10%, if based on a comparison of the driver with the right-front-seat occupant, 12% if he uses non-frontal impacts as basis for comparison. The differences are not much more than one standard error and thus not unexpected.

For passenger-side air bags, the estimate in this study is 16% (± 4); Kahane's estimate is 17% if using drivers as the comparison group. If using nonfrontal impacts as the comparison group, Kahane's estimate is only 10%. Again, the estimates are comparable.

Most of the air bag effects occur in frontal impacts. This study uses the 11, 12, and 1 o'clock positions to define frontal impacts; this might include some corner impacts with little frontal component of force. Kahane defines purely frontal impacts as 12 o'clock only, which reduces the case numbers, and defines partial frontal impacts as including the 10, 11, 1, and 2 o'clock positions. This is likely to include some corner and even side impacts with little or no frontal component.

The estimate for frontal impacts from this study is a 14% (± 4) fatality risk reduction for the driver and 27% (± 5) for the right-front-seat passenger. Kahane's combination of purely and partially frontal crashes shows a reduction of 18% for the driver, if using the right-front passenger for comparison. If he uses non-frontal impacts the reduction is 19%. Both estimates are larger than in this study, but still comparable when considering the estimated error.

For the right-front-seat passenger, Kahane finds an 18% fatality risk reduction if comparing with the driver, and an 18% reduction if comparing with nonfrontal impacts. This might still be within the error limits, but it is noteworthy that Kahane does not find the greater effectiveness for right-front-seat occupants which is pervasive in the findings of this present study.

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[2] C.J. Kahane, Fatality Reduction by Air Bags. Analysis of Accident Data Through Early 1996. Report NHTSA Washington, D.C., DOT HS 808 470, August 1996.

With regard to vehicle weight, Kahane finds no trend in driver air bag effectiveness. This study shows, at best, a small trend. However, Kahane uses a limit of 2,778 lbs. for his lightest class, whereas my limit is 2,500 lbs. This difference may appear small, but in my data base, 25% of all cases fall into this narrow range and adding them to my lowest class increases its size by nearly 80%. Thus, if air bags did indeed have a greater effect in lighter cars, this could be hidden by Kahane's classification.

6. Findings

6.1 Reporting uninjured occupants

During the years 1991-1996, the following states consistently reported extremely low percentages of uninjured right-front-seat occupants: Indiana, Iowa, Maryland, Virginia, and Wyoming. It appears nearly certain that uninjured occupants are either not reported or reported as C-injured. This conclusion is supported by the case of Georgia. During the years 1991-93, 1% or less of the right-front-seat occupants were reported as injured. During the later years, between 7 and 9% of the right-front-seat occupants were reported as injured. With the substantial case numbers in Georgia, this clearly indicates a change in reporting practices.

States with sometimes, but not consistently, very low percentages of uninjured right-front-seat occupants were Alaska, Idaho, and North Dakota. No indication was found that this might be due to reporting of uninjured right-front-seat occupants by only certain police agencies or for certain types of crashes. It was also noticed that Maryland reported no or only very few uninjured drivers. The only plausible explanation is that drivers who would be reported as uninjured in other states were coded as C-injured in Maryland.

6.2 Effects of incomplete reporting

Estimates of overall air bag effectiveness based on data from all states, and those based on data excluding the named eight states and Georgia for the years 1991-1993, differed only very little, usually less than 1 standard error. It seems that studies similar to this one can ignore the differences in reporting. However, this might not hold if the data are more finely disaggregated.

6.3 Estimates of air bag effectiveness

When estimating air bag effectiveness, reported seat belt use was ignored. Thus, the estimates show additional effects of air bags, beyond that of belts as used. For drivers over 15 years old, a 6 (± 4) % reduction of the fatality risk was found for all crashes combined. In crashes with frontal impacts, a 14 (± 4) % reduction of fatality risk was found for all crashes. For right-front-seat occupants over 15 years old, the corresponding estimates were 16 (± 4) and 27 (± 5) %.

Estimates for children under 5 years of age in the right-front seat, ignoring whether they were in a child seat or not, had very large standard errors and did not suggest any effect. Estimates for children 5-12 years old suggested a negative, but uncertain effect of the passenger-side air bag, but also had large standard errors.

These three data sets, adult right-front-seat occupants, children under 5 in the right-front seat, and children 5-12 years old in the right-front seat, are disjoint. Therefore, they provide three independent estimates of air bag effectiveness for drivers. They showed consistent adverse, though uncertain, effects of air bags for the driver in left-side impacts. This should be of concern. If the effect were real, some change in the driver-side air bag is needed. If the effect is an artifact, one needs to know whether it similarly affects another approach to evaluating the effectiveness of air bags in which fatality risk in frontal and in side impact are compared. If the effect inflated the apparent risk in left-side impacts, the estimates of air bag effects would be exaggerated.

For the driver, air bag effectiveness did not change with the person's age. For right-front-seat occupants, however, effectiveness appeared to increase uniformly, from 10-13% for the youngest age group to 29-33% for the oldest age group. Though small, these differences should not be ignored, because it is not implausible that the larger passenger-side air bag offers better protection to older people.

A very puzzling pattern appeared when the effects for men and women were estimated. The combinations of the two sexes and the two seating positions were examined separately. When two men were driving together, the air bag had no effect for the driver, and, only a small effect for the passenger. With a female passenger, the effect for the male driver increased to 16%, and, for the female passenger, to 34%. If a female driver had a male passenger, both got some benefits from the air bag. If a women drove with another women, both got very large benefits from the air bag: 36%, and 45% respectively.

While some differences in air bag effectiveness between men and women might be due to differences in height, and others to more subtle physiological differences, it is more difficult to explain how the effectiveness for the driver should depend on the sex of the passenger, and how the effectiveness for the passenger should depend on the sex of the driver. One might suspect effects of social factors which influence driving environment, driving style, and crash severity. Also, differences in seat belt use could affect the estimates.

For the right-front-seat passenger, air bag effect did not vary with vehicle weight. Only for the driver, it appeared greatest in the lightest car group.

Delta v, impact speed, or similar crash severity measures were not available. As a gross indicator of the speed environment, the speed limit was used. There was a weak, suggestion that air bags have no effect or only minimal effect where the speed limit is over 55 mph.

There was no difference in air bag effectiveness for right-front-seat passengers in single-vehicle and multivehicle crashes. For drivers, it appeared 3 times higher in multivehicle collisions.

Overall, there are clear beneficial effects of air bags. However, the effects differ systematically between drivers and right-front-seat occupants, and in a complex manner between men and women. There appear to be more differences, but they are small. It is likely that some of the apparent differences are due to a few factors which are correlated with others and, thus, appear as effects of these factors.

7. Recommendations

7.1 Examining the homogeneity of FARS data

It was found that the FARS files are not homogeneous with respect to two variables: injury severity of right-front-seat occupants (and, to a very small extent, of drivers), and impact point. The first variable had only a negligible effect in this study, but could have a greater effect in other studies. The second variable could have a major effect in some studies.

The fact that there are two variables with regard to which FARS data are not homogeneous raises the likelihood that there are others. Analyses of FARS data might be affected to unknown degrees. Therefore, it is recommended that NHTSA require that any study based on FARS data should examine the relevant variables to determine whether reporting is homogeneous. If reporting is not homogeneous, attempts to account for inhomogeneities should be required.

7.2 Air bag effectiveness for special crash types

Several unexpected patterns were noted in the air bag effectiveness estimates. One was a suggestion that a driver-side air bag increased the driver's fatality risk in left-side impacts. If this is a real effect, it would be of serious concern. If it is an artifact, it should be determined if it also affects estimating air bag effectiveness by comparing frontal impacts with side impacts. Another unexpected finding was that air bag effectiveness is not only greater for women than for men, but that it also seems to be greater, for the other person, if the driver is a women, and for the driver, if the other person is a women. There were also patterns with regard to occupant age and speed limit.

It seems likely that these complex patterns result from a combination of simpler effects, direct physical effects related to age and sex of the victims, and indirect effects of age and sex on crash type and crash severity. The interactions of such effects should be studied, because the results could show where air bags are most effective, and where they are less effective, leading to improved specifications for air bags. Considering the limited number of cases which are currently available, and which will be available in the near future, more sophisticated statistical techniques have to be used to separate such effects.

7.3 Improved statistical techniques

It was found that air bag effectiveness varies in a complex way with several factors. Some of this complexity is probably the result of interactions and correlations between these factors, and not necessarily of the underlying physical effects.

The standard approaches to understand such interactions are either to develop a complete multivariate model or to look at one factor at a time, standardizing for differences in the other factors. The first approach requires at least an approximately correct model, otherwise the results can be grossly erroneous. The second approach requires fewer assumptions and is therefore more likely to give realistic results, but runs into difficulties when a fine classification of cases results in empty cells. One way to overcome this is by using empirical Bayesian techniques. Their use should be explored, and they possibly could be modified for the special problem of estimating air bag effectiveness, which relies directly or indirectly on double ratios.

Error estimates for double ratios require approximations which can be rough if the numbers involved are small. Bootstrapping is a promising alternative, which was used in the present study. However, it is not obvious how to apply it together with standardization. Also, it encounters problems if, in the course of resampling, empty cells appear. This can be addressed by using empirical Bayesian techniques. However, applications in this context are not routine and have to be developed.

Appendices

Appendix 1. Calculation of fatality risk reduction

The FARS data allow only the calculation of relative fatality risks, not of absolute risks. Calculated were fatality risks for drivers relative to right-front-seat occupants (or vice versa) in vehicles in which at least one of them was killed. To estimate the effects of air bags, these relative fatality risks were compared among cars without air bags, cars with driver-side-only air bags, and cars with air bags for the driver and the right-front-seat passenger.

Table A-1 shows how the basic formulas are derived. If one has crashes of a certain physical severity, where if both occupants are present, the simplest and most plausible assumption is that death of the driver (probability p_1) and death of the right front seat occupant (probability p_2) are independent.[3] Thus, the probability that only the driver is killed is $p_1(1-p_2)$, that only the right-front-seat occupant is killed is $p_2(1-p_1)$, and that both are killed is p_1p_2.

The Table shows the expected counts of cases where only the driver is killed (u_1, v_1, w_1), where only the passenger is killed (u_2, v_2, w_2), and where both are killed (u_3, v_3, w_3). Cases where neither the driver nor the passenger is killed are not used because only some of them are contained in FARS. These counts are shown as functions of the counts of total cases n', n'', n''', (which include cases not reported in FARS), of the probabilities that a driver is killed in a crash (p_1, fp_1, fp_1) and that a right-front passenger is killed in a crash (p_2, p_2, gp_2). The factors f and g describe how the fatality risk for a driver, and for a right-front-seat occupant, respectively, is reduced by an air bag.

From the formulas in Table A-1, one can deviate the following formulas:

$$r' = \frac{u_1 + u_3}{u_2 + u_3} = \frac{p_1}{p_2} \quad \text{(A-1)}$$

$$r'' = \frac{v_1 + v_3}{v_2 + v_3} = \frac{p_1}{p_2} f \quad \text{(A-2)}$$

$$r''' = \frac{w_1 + w_3}{w_2 + w_3} = \frac{p_1}{p_2} \frac{f}{g} \quad \text{(A-3)}$$

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[3]Even if one doubts the assumption of independence, there is no way to check this without information on all crashes in which neither driver or right front seat occupants were killed. If the crashes studied are of varying severity and therefore varying p_1 and p_2, then the occurrences of death for driver and right front seat occupant are indeed not independent, but the dependence can not be estimated without data on crashes in which neither driver nor right front seat occupant were killed. To avoid problems due to possible dependence, one needs to stratify crashes as finely as practicable.

Table A-1. Formulas for numbers of drivers and right-front-seat occupants killed.

1. Cars without air bags. Total, unknown, number of cases n'.

Passenger	Driver: Survived	Driver: Killed
Survived		$u_1=n'p_1(1-p_2)$
Killed	$u_2=n'p_2(1-p_1)$	$u_3=n'p_1p_2$

2. Cars with driver side only air bag. Total, unknown number of cases, n".

Passenger	Driver: Survived	Driver: Killed
Survived		$v_1=n''p_1f(1-p_2)$
Killed	$v_2=n''p_2(1-p_1f)$	$v_3=n''p_1fp_2$

3. Cars with driver and right-front-seat air bags. Total, unkown number of cases n'".

Passenger	Driver: Survived	Driver: Killed
Survived		$w_1=n'''p_1f(1-p_2g)$
Killed	$w_2=n'''p_2g(1-p_1f)$	$w_3=n'''p_1fp_2g$

from which one obtains

(A-5) $$f = \frac{r''}{r'},$$

and

(A-6) $$g = \frac{r''}{r'''}.$$

The formulas in Table A-1 hold if the probabilities p_1 and p_2 have the same values in all crashes. Actually, they also hold if the probabilities vary among crashes, as long as certain conditions are satisfied. Thus, the estimates derived from A-5 and A-6 may still hold if crashes of different severity are aggregated, as long as the factors f and g do not vary with crash severity. However, if air bag effectiveness varies with crash severity (or other factors, such as crash configuration), then the equations in Table A-1 and those derived from them no longer hold. Developing this in greater detail shows that factors f and g derived from formulas A-5 and A-6 are weighted averages of the varying f and g. However, the weights are not transparent and the averages may not be correctly interpreted. Therefore, it is preferable to calculate the f and g for classes of crashes with fairly similar conditions.

Appendix 2. Bootstrapping to estimate standard errors of air bag effectiveness factors.

The factors f and g which quantify air bag effects (Appendix 1) are double ratios of counts. Approximate standard errors can be obtained by assuming that the counts are random variables following a Poisson-distribution, and linear expansion of the double ratio in terms of the random variations of the counts. For large counts, this gives a good approximation. For small counts, however, the approximation can be very poor.

A simple method for estimating standard errors for complex expressions, such as double ratios, is bootstrapping.[4] The basic idea is that a set of n observations is given, one selects repeatedly random samples from these observations and calculates the variables of interest, in our case f and g, for each sample. From the obtained values of the f and g, one can then calculate their standard errors. The key point which makes this process meaningful is that the samples are taken with replacement. That means that nearly always some observations are not in the sample, others are included several times.

To obtain error estimates which are reasonably close to the real values (which one can test in simple cases), one needs a sufficient number of samples: 20 are rarely enough, 50 are usually enough, and to go beyond 1,000 is rarely worthwhile. After some experiments, I decided to use 100 in this study. Using the straightforward approach, it would have taken considerable time on a personal computer to select a sample from 15,000 observations and to process it. I used a modification - which I believe to be novel - which dramatically reduced computer time. I made use of the fact that with only categorical variables in the analysis, all cases fell into relatively few classes within which cases were indistinguishable. For the estimation of overall effectiveness, only the nine classes shown in Table A-2 needed to be distinguished. That means that only the number of cases in each cell needs to be known. Instead of randomly selecting individual cases form the data file, assigning them to the cells and finally counting them, one can proceed as follows.

One defines 9 random variables which follow a multinomial distribution with probabilities proportional to the actual cell counts. Creating one such set of random variables is exactly equivalent to selecting cases individually from the complete file.

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[4]The literature on bootstrapping is growing. A simple introduction is B. Efron, *The Jackknife, the Bootstrap, and Other Resampling Plans.* Society for Industrial and Applied Mathematics, Philadelphia, PA, 1982. A more comprehensive work is B. Efron, R.J. Tibshirani, *An Introduction to the Bootstrap.* Chapman & Hall, New York, 1993.

TABLE A-2. Crash classes to be distinguished in the analysis of overall air bag effectiveness.

	No Air bag	Driver-Only Air Bag	Dual Air Bag
Driver killed			
Right-front-seat passenger killed			
Both killed			

Creating multinomial variables is somewhat, though not prohibitively, complicated. A much simpler approach which gives nearly the same result is to treat each cell individually: assign to it a Poisson variable as sample count with the actual cell count as mean. The difference of this approach against using the multinomial variables is that the resulting total count of all cells usually differs somewhat from the actual total case number. While this may appear as a disadvantage at first glance, it can be considered an advantage, because the actual number of cases itself is a random variable, and in many analyses, they are treated as such. Thus, the error estimates based on Poisson variables are more realistic than those based on the multinomial distribution.

Using this approach accelerated the bootstrapping analyses considerably. One-hundred replications of the overall analysis based on 9 cells took only 5 seconds on a personal computer with a Pentium 100; the more detailed analyses took only a little longer.

To generate Poisson distributed random numbers, a special program was written. For means up to 100, a simple exact routine was written which was slightly faster than those available in the literature. For higher means, a normal approximation was used, for which a modification of the function GASDEV from the basic version of *Numerical Recipes*[5] was written.

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[5]W.H. Press, B.P. Flannery, S.A. Teukolsky, W.T. Vetterling, *Numerical Recipes*, Cambridge University Press, London, England, 1986.

In some analyses, some cell counts were low, and some bootstrap samples contained cells with counts of 0. If they occur in certain cells, no air bag factors can be calculated. In such cases, no standard error could be calculated. This was indicated by "(-)" in the tables. This is an unsatisfactory situation. An obvious way to avoid it is to repeat sampling until a sample is obtained with no zeros in critical cells. This approach is not acceptable because it seems to result in error estimates that are too low. Work is needed to find a solution for this problem.

Appendix 3. Detailed tables.

Table A.3-1. Air bag factors for drivers and right-front-seat occupants, over 15 years old.

impact	good states		all states		difference	
	factor	error	factor	error	factor	error
			drivers			
other	1.049	0.131	1.042	0.134	-0.006	0.038
front	0.858	0.043	0.851	0.044	-0.007	0.012
right	0.959	0.104	0.948	0.097	-0.012	0.033
rear	1.038	0.132	0.986	0.119	-0.052	0.045
left	1.103	0.091	1.110	0.092	0.007	0.027
all	0.935	0.037	0.932	0.036	-0.004	0.010
			right-front-seat occupants			
other	0.936	0.109	0.935	0.101	-0.001	0.001
front	0.726	0.052	0.725	0.052	-0.001	0.001
right	0.951	0.109	0.967	0.102	0.016	0.017
rear	0.986	0.222	0.865	0.198	-0.121	0.124
left	1.072	0.136	1.083	0.136	0.012	0.012
all	0.835	0.049	0.835	0.045	-0.000	0.000

Table A.3-2. Air bag factors by average age of occupants, differing by no more than 5 years in age.

age	impact	good states factor	good states error	all states factor	all states error	difference factor	difference error
				driver			
16-25	other	1.096	0.216	1.115	0.220	0.019	0.064
	front	0.865	0.077	0.836	0.068	-0.029	0.029
	right	0.900	0.158	0.840	0.147	-0.060	0.035
	rear	1.378	0.602	1.250	0.484	-0.128	0.180
	left	1.016	0.217	1.000	0.197	-0.016	0.060
	all	0.909	0.058	0.890	0.054	-0.019	0.018
26-65	other	1.048	0.314	0.988	0.271	-0.060	0.122
	front	0.872	0.092	0.886	0.088	0.014	0.034
	right	0.976	0.179	0.986	0.171	0.010	0.057
	rear	0.720	0.206	0.807	0.219	0.087	0.073
	left	1.690	0.546	1.475	0.450	-0.215	0.197
	all	0.945	0.066	0.946	0.061	0.002	0.023
>65	other	0.556	0.628	0.549	0.394	-0.007	0.408
	front	0.880	0.098	0.883	0.096	0.003	0.039
	right	0.966	0.245	1.015	0.241	0.049	0.074
	rear	0.984	0.378	0.831	0.343	-0.153	0.115
	left	0.967	0.171	0.984	0.168	0.017	0.047
	all	0.940	0.072	0.941	0.070	0.001	0.025
				right-front-seat occupant			
16-25	other	1.086	0.295	1.087	0.283	0.000	0.065
	front	0.905	0.114	0.869	0.103	-0.036	0.038
	right	0.780	0.158	0.788	0.162	0.008	0.033
	rear	1.508	0.782	1.193	0.597	-0.315	0.295
	left	1.238	0.307	1.185	0.287	-0.053	0.092
	all	0.934	0.076	0.902	0.069	-0.032	0.024
26-65	other	0.799	0.271	0.857	0.283	0.058	0.091
	front	0.763	0.115	0.752	0.110	-0.011	0.044
	right	0.876	0.192	0.922	0.201	0.046	0.056
	rear	1.178	0.581	1.262	0.587	0.084	0.115
	left	1.514	0.579	1.341	0.470	-0.173	0.199
	all	0.827	0.078	0.834	0.076	0.007	0.027
>65	other	0.667	-	0.857	-	0.190	-
	front	0.669	0.114	0.713	0.111	0.044	0.046
	right	0.868	0.312	0.973	0.325	0.105	0.123
	rear	0.542	-	0.451	-	-0.090	-
	left	0.938	0.305	1.005	0.300	0.067	0.069
	all	0.755	0.100	0.811	0.104	0.056	0.036

Table A.3-3. Air bag factors by average age of occupants, differing by no more than 10 years in age.

age	impact	good states factor	good states error	all states factor	all states error	difference factor	difference error
				driver			
16-25	other	1.030	0.200	1.081	0.197	0.051	0.048
	front	0.850	0.078	0.826	0.067	-0.024	0.023
	right	0.859	0.126	0.797	0.120	-0.061	0.032
	rear	1.385	0.488	1.274	0.449	-0.110	0.134
	left	0.996	0.207	0.976	0.186	-0.020	0.052
	all	0.886	0.055	0.871	0.051	-0.014	0.015
26-65	other	0.971	0.226	0.917	0.194	-0.054	0.080
	front	0.848	0.059	0.855	0.057	0.007	0.024
	right	1.012	0.133	1.038	0.125	0.026	0.041
	rear	0.794	0.198	0.821	0.203	0.027	0.063
	left	1.388	0.311	1.323	0.252	-0.065	0.108
	all	0.927	0.049	0.931	0.046	0.004	0.016
>65	other	0.730	0.342	0.642	0.254	-0.088	0.136
	front	0.895	0.093	0.889	0.084	-0.006	0.029
	right	1.001	0.172	1.031	0.157	0.030	0.060
	rear	1.035	0.354	0.927	0.311	-0.108	0.116
	left	0.930	0.137	0.957	0.138	0.028	0.044
	all	0.952	0.057	0.958	0.053	0.005	0.020
				right-front-seat occupant			
16-25	other	1.092	0.261	1.092	0.254	0.001	0.073
	front	0.869	0.103	0.847	0.099	-0.021	0.029
	right	0.765	0.172	0.767	0.175	0.002	0.028
	rear	1.575	0.574	1.318	0.501	-0.257	0.227
	left	1.175	0.292	1.121	0.276	-0.054	0.078
	all	0.909	0.070	0.883	0.068	-0.026	0.020
26-65	other	0.774	0.213	0.778	0.203	0.005	0.056
	front	0.752	0.088	0.756	0.085	0.005	0.035
	right	1.008	0.205	1.013	0.198	0.005	0.049
	rear	1.037	0.372	1.068	0.385	0.031	0.091
	left	1.217	0.335	1.193	0.285	-0.023	0.108
	all	0.834	0.071	0.845	0.067	0.011	0.022
>65	other	1.300	-	1.412	-	0.112	-
	front	0.606	0.114	0.639	0.105	0.033	0.035
	right	1.110	0.326	1.171	0.289	0.061	0.119
	rear	0.462	0.234	0.408	0.191	-0.054	0.130
	left	0.831	0.204	0.890	0.210	0.060	0.054
	all	0.725	0.080	0.773	0.078	0.048	0.023

Table A.3-4. Air bag factors by average age of occupants, differing by no more than 15 years in age.

age	impact	good states factor	good states error	all states factor	all states error	difference factor	difference error
				driver			
16-25	other	1.030	0.200	1.081	0.197	0.051	0.048
	front	0.850	0.078	0.826	0.067	-0.024	0.023
	right	0.859	0.126	0.797	0.120	-0.061	0.032
	rear	1.385	0.488	1.274	0.449	-0.110	0.134
	left	0.996	0.207	0.976	0.186	-0.020	0.052
	all	0.886	0.055	0.871	0.051	-0.014	0.015
26-65	other	0.971	0.226	0.917	0.194	-0.054	0.080
	front	0.848	0.059	0.855	0.057	0.007	0.024
	right	1.012	0.133	1.038	0.125	0.026	0.041
	rear	0.794	0.198	0.821	0.203	0.027	0.063
	left	1.388	0.311	1.323	0.252	-0.065	0.108
	all	0.927	0.049	0.931	0.046	0.004	0.016
>65	other	0.730	0.342	0.642	0.254	-0.088	0.136
	front	0.895	0.093	0.889	0.084	-0.006	0.029
	right	1.001	0.172	1.031	0.157	0.030	0.060
	rear	1.035	0.354	0.927	0.311	-0.108	0.116
	left	0.930	0.137	0.957	0.138	0.028	0.044
	all	0.952	0.057	0.958	0.053	0.005	0.020
				right-front-seat occupant			
16-25	other	1.092	0.261	1.092	0.254	0.001	0.073
	front	0.869	0.103	0.847	0.099	-0.021	0.029
	right	0.765	0.172	0.767	0.175	0.002	0.028
	rear	1.575	0.574	1.318	0.501	-0.257	0.227
	left	1.175	0.292	1.121	0.276	-0.054	0.078
	all	0.909	0.070	0.883	0.068	-0.026	0.020
26-65	other	0.774	0.213	0.778	0.203	0.005	0.056
	front	0.752	0.088	0.756	0.085	0.005	0.035
	right	1.008	0.205	1.013	0.198	0.005	0.049
	rear	1.037	0.372	1.068	0.385	0.031	0.091
	left	1.217	0.335	1.193	0.285	-0.023	0.108
	all	0.834	0.071	0.845	0.067	0.011	0.022
>65	other	1.300	-	1.412	-	0.112	-
	front	0.606	0.114	0.639	0.105	0.033	0.035
	right	1.110	0.326	1.171	0.289	0.061	0.119
	rear	0.462	0.234	0.408	0.191	-0.054	0.130
	left	0.831	0.204	0.890	0.210	0.060	0.054
	all	0.725	0.080	0.773	0.078	0.048	0.023

Table A.3-5. Air bag factors for children under 5 years old in the right-front-seat and drivers over 15 years old.

impact	good states factor	good states error	all states factor	all states error	difference factor	difference error
			drivers			
other	0.667	-	0.692	-	0.026	-
front	0.780	0.233	0.939	0.236	0.159	0.090
right	0.388	0.291	0.385	0.292	-0.003	0.022
rear	0.000	-	0.000	-	0.000	-
left	2.143	-	2.250	-	0.107	-
all	0.718	0.193	0.844	0.205	0.127	0.067
			children in right-front-seat			
other	-	-	-	-	-	-
front	0.982	0.466	1.344	0.597	0.363	0.229
right	0.381	-	0.381	-	0.000	-
rear	-	-	-	-	-	-
left	2.500	-	3.000	-	0.500	-
all	0.859	0.317	1.108	0.388	0.249	0.137

Table A.3-6. Air bag factors for children 5-12 years old in the right-front-seat and for drivers over 15 years old.

impact	good states factor	good states error	all states factor	all states error	difference factor	difference error
drivers						
other	1.600	-	1.545	-	-0.055	-
front	0.967	0.226	0.991	0.228	0.024	0.042
right	0.859	0.251	0.910	0.284	0.051	0.070
rear	0.700	-	0.857	-	0.157	-
left	2.055	-	1.658	1.666	-0.397	-
all	1.158	0.172	1.181	0.175	0.023	0.043
children in right-front-seat						
other	2.000	-	2.000	-	0.000	-
front	1.965	0.799	1.921	0.779	-0.045	0.158
right	1.588	-	1.500	-	-0.088	-
rear	1.000	-	1.333	-	0.333	-
left	1.875	-	1.409	-	-0.466	-
all	1.565	0.384	1.464	0.345	-0.101	0.083

Table A.3-7. Air bag factors by sex of occupants and seating position. Ages of occupants are over 15 years old and differ by no more than 5 years.

driver passenger	impact	good states factor	good states error	all states factor	all states error	difference factor	difference error
				driver			
male male	other	0.848	0.188	0.826	0.177	-0.022	0.044
	front	0.998	0.086	0.949	0.079	-0.050	0.028
	right	1.191	0.182	1.168	0.172	-0.023	0.061
	rear	1.215	0.343	0.998	0.280	-0.217	0.140
	left	0.872	0.129	0.891	0.128	0.019	0.034
	all	1.003	0.063	0.973	0.059	-0.030	0.019
male female	other	0.985	0.251	0.953	0.214	-0.033	0.084
	front	0.837	0.072	0.835	0.070	-0.002	0.017
	right	0.810	0.102	0.840	0.099	0.030	0.035
	rear	0.845	0.212	0.861	0.200	0.017	0.066
	left	1.262	0.181	1.249	0.159	-0.013	0.062
	all	0.896	0.050	0.896	0.048	0.000	0.013
female male	other	0.997	0.318	1.168	0.344	0.172	0.151
	front	0.911	0.096	0.916	0.093	0.005	0.033
	right	0.805	0.162	0.804	0.152	-0.001	0.050
	rear	0.705	0.316	0.690	0.290	-0.015	0.089
	left	1.015	0.239	1.055	0.244	0.040	0.068
	all	0.875	0.070	0.909	0.071	0.034	0.021
female female	other	2.540	1.378	2.303	1.326	-0.238	0.440
	front	0.643	0.088	0.671	0.080	0.028	0.029
	right	1.111	0.212	1.011	0.178	-0.099	0.066
	rear	1.624	0.930	1.500	0.766	-0.124	0.308
	left	1.253	0.305	1.232	0.290	-0.021	0.095
	all	0.982	0.088	0.972	0.081	-0.010	0.024

Continuation of A.3-7

right-front-seat occupant

male	other	0.841	0.212	0.816	0.199	-0.025	0.047
male	front	0.886	0.102	0.878	0.099	-0.008	0.032
	right	1.155	0.228	1.141	0.218	-0.014	0.058
	rear	1.316	0.490	1.013	0.355	-0.303	0.199
	left	1.088	0.237	1.083	0.239	-0.005	0.069
	all	0.960	0.079	0.926	0.075	-0.034	0.022
male	other	1.028	0.269	1.002	0.244	-0.027	0.088
female	front	0.663	0.070	0.663	0.067	0.000	0.022
	right	0.863	0.163	0.928	0.171	0.065	0.052
	rear	0.821	0.294	0.816	0.250	-0.006	0.102
	left	0.978	0.186	1.003	0.179	0.025	0.057
	all	0.785	0.063	0.802	0.060	0.017	0.018
female	other	1.229	0.527	1.500	0.622	0.271	0.211
male	front	0.863	0.150	0.841	0.148	-0.022	0.041
	right	0.824	0.201	0.779	0.198	-0.044	0.075
	rear	0.381	0.219	0.375	0.214	-0.006	0.101
	left	1.294	0.413	1.247	0.414	-0.047	0.113
	all	0.899	0.103	0.917	0.098	0.017	0.027
female	other	0.853	0.502	0.707	0.434	-0.146	0.170
female	front	0.548	0.102	0.564	0.098	0.016	0.030
	right	0.988	0.361	0.992	0.342	0.004	0.046
	rear	2.727	-	2.308	-	-0.420	-
	left	1.054	0.341	1.103	0.323	0.049	0.099
	all	0.748	0.080	0.739	0.072	-0.009	0.023

Table A.3-9. Air bag factors by sex and age of occupants and seating position. Ages of occupants are over 15 years old and differ by no more than 5 years. Age is the average of the two occupant's ages.

age	driver/ passenger	side	good states factor	good states error	all states factor	all states error	difference factor	difference error
				driver				
16-25	m/m	other	0.847	0.251	0.834	0.245	-0.013	0.044
		front	1.031	0.144	0.952	0.124	-0.079	0.054
		right	0.772	0.205	0.729	0.180	-0.043	0.056
		rear	0.986	0.662	0.867	0.611	-0.120	0.166
		left	0.864	0.228	0.863	0.213	-0.001	0.074
		all	0.933	0.084	0.897	0.078	-0.037	0.027
	m/f	other	0.962	0.633	1.004	0.498	0.042	0.307
		front	0.802	0.135	0.764	0.125	-0.038	0.033
		right	1.081	0.364	1.033	0.357	-0.048	0.066
		rear	1.538	-	1.400	-	-0.138	-
		left	1.002	0.352	0.947	0.333	-0.055	0.040
		all	0.892	0.118	0.856	0.113	-0.036	0.029
	f/m	other	0.831	0.653	1.151	0.730	0.320	0.265
		front	0.812	0.235	0.748	0.190	-0.064	0.081
		right	0.763	0.308	0.766	0.306	0.003	0.074
		rear	0.818	-	0.818	-	0.000	-
		left	2.059	-	1.263	-	-0.796	-
		all	0.680	0.148	0.708	0.134	0.027	0.043
	f/f	other	3.503	-	3.319	-	-0.184	-
		front	0.552	0.147	0.627	0.168	0.075	0.069
		right	1.154	0.410	0.990	0.340	-0.163	0.139
		rear	-	-	-	-	-	-
		left	1.645	-	1.788	-	0.143	-
		all	1.050	0.173	1.057	0.171	0.007	0.060
25-65	m/m	other	1.516	0.967	1.272	0.688	-0.244	0.449
		front	0.933	0.181	0.964	0.179	0.032	0.055
		right	1.520	0.535	1.591	0.524	0.071	0.161
		rear	1.143	-	0.750	-	-0.393	-
		left	1.362	-	1.421	2.048	0.059	-
		all	1.086	0.150	1.099	0.147	0.013	0.040
	m/f	other	1.091	0.616	0.964	0.537	-0.127	0.183
		front	0.816	0.127	0.853	0.121	0.037	0.044
		right	0.549	0.198	0.595	0.192	0.047	0.064
		rear	0.713	0.353	0.881	0.431	0.168	0.131
		left	1.850	0.926	1.582	0.583	-0.268	0.481
		all	0.872	0.107	0.876	0.096	0.004	0.031
	f/m	other	0.736	0.829	1.008	1.007	0.272	0.456
		front	0.946	0.307	0.937	0.274	-0.009	0.097
		right	0.995	0.596	0.982	0.526	-0.013	0.179
		rear	0.500	-	0.550	-	0.050	-
		left	1.257	-	1.026	-	-0.231	-
		all	0.946	0.197	0.974	0.184	0.028	0.055

Continuation of Table A.3-9

	f/f	other	0.600	-	0.545	-	-0.055	-
		front	0.947	0.415	0.814	0.343	-0.132	0.146
		right	1.762	0.989	1.458	0.796	-0.304	0.324
		rear	0.625	-	0.875	-	0.250	-
		left	2.970	-	1.946	-	-1.024	-
		all	1.033	0.240	0.955	0.212	-0.078	0.095
>65	m/m	other	-	-	-	-	-	-
		front	0.593	0.495	0.394	0.280	-0.199	0.264
		right	1.500	-	1.083	-	-0.417	-
		rear	-	-	-	-	-	-
		left	1.185	-	1.212	-	0.027	-
		all	0.729	0.260	0.589	0.198	-0.139	0.100
	m/f	other	0.718	-	0.667	-	-0.051	-
		front	0.919	0.137	0.904	0.129	-0.014	0.042
		right	1.025	0.255	1.111	0.275	0.086	0.114
		rear	1.012	0.645	0.817	0.538	-0.195	0.265
		left	1.035	0.244	0.992	0.217	-0.043	0.069
		all	0.995	0.100	0.981	0.094	-0.013	0.030
	f/m	other	0.417	-	0.500	-	0.083	-
		front	1.144	0.416	1.257	0.373	0.113	0.158
		right	0.542	0.290	0.641	0.315	0.099	0.126
		rear	-	-	-	-	-	-
		left	0.885	0.467	1.034	0.502	0.148	0.115
		all	0.942	0.184	1.019	0.178	0.076	0.053
	f/f	other	-	-	-	-	-	-
		front	0.508	0.281	0.594	0.324	0.086	0.090
		right	1.401	0.712	1.222	0.546	-0.179	0.261
		rear	0.800	-	0.800	-	0.000	-
		left	0.686	0.508	0.738	0.538	0.053	0.139
		all	0.799	0.214	0.845	0.217	0.045	0.065
				right-front-seat occupant				
16-25	m/m	other	0.898	0.320	0.875	0.297	-0.022	0.046
		front	1.094	0.197	1.008	0.181	-0.087	0.080
		right	0.687	0.322	0.697	0.329	0.010	0.051
		rear	1.100	0.753	0.765	0.530	-0.335	0.303
		left	1.436	0.438	1.281	0.389	-0.155	0.130
		all	0.996	0.119	0.915	0.106	-0.081	0.038
	m/f	other	1.455	1.140	1.484	0.880	0.030	0.730
		front	0.658	0.163	0.656	0.159	-0.002	0.031
		right	1.200	0.972	1.235	1.049	0.035	0.151
		rear	2.000	-	3.000	-	1.000	-
		left	0.356	9.938	0.485	0.242	0.129	9.920
		all	0.805	0.140	0.829	0.147	0.024	0.042
	f/m	other	0.980	1.280	1.429	1.788	0.449	0.672
		front	1.699	0.683	1.458	0.555	-0.242	0.247
		right	0.685	-	0.750	-	0.065	-
		rear	1.000	-	1.000	-	0.000	-

Continuation of Table A.3-9

		left	5.600	-	3.000	-	-2.600	-
		all	1.144	0.303	1.147	0.283	0.003	0.085
	f/f	other	1.360	-	1.133	-	-0.227	-
		front	0.423	0.241	0.457	0.270	0.034	0.057
		right	0.646	0.336	0.593	0.295	-0.054	0.065
		rear	-	-	-	-	-	-
		left	2.125	-	2.250	-	0.125	-
		all	0.815	0.205	0.800	0.200	-0.015	0.045
25-65	m/m	other	0.800	0.549	0.750	0.435	-0.050	0.267
		front	0.774	0.217	0.842	0.232	0.068	0.070
		right	0.960	0.493	0.970	0.479	0.010	0.077
		rear	0.857	-	0.750	-	-0.107	-
		left	0.892	-	1.076	1.284	0.183	-
		all	0.762	0.127	0.802	0.133	0.040	0.037
	m/f	other	0.750	0.463	0.786	0.461	0.036	0.111
		front	0.718	0.176	0.677	0.157	-0.041	0.067
		right	0.682	0.341	0.782	0.385	0.100	0.108
		rear	1.800	-		-	0.382	-
		left	1.956	0.970	1.580	0.705	-0.375	0.457
		all	0.890	0.143	0.866	0.130	-0.023	0.048
	f/m	other	1.400	1.406	1.800	1.782	0.400	0.560
		front	0.769	0.308	0.724	0.256	-0.045	0.128
		right	0.643	0.374	0.643	0.374	0.000	0.000
		rear	-	-	-	-	-	-
		left	1.222	-	0.929	-	-0.294	-
		all	0.836	0.210	0.852	0.203	0.016	0.071
	f/f	other	0.200	-	0.200	-	0.000	-
		front	1.100	1.196	1.059	0.980	-0.041	0.291
		right	1.273	-	1.167	-	-0.106	-
		rear	-	-	-	-	-	-
		left	2.100	-	1.350	-	-0.750	-
		all	0.796	0.295	0.781	0.296	-0.016	0.065
>65	m/m	other	-	-	-	-	-	-
		front	-	-	-	-	-	-
		right	0.500	-	0.500	-	0.000	-
		rear	-	-	-	-	-	-
		left	-	-	-	-	-	-
		all	0.175	-	0.172	-	-0.003	-
	m/f	other	1.333	-	2.000	-	0.667	-
		front	0.688	0.136	0.743	0.138	0.055	0.049
		right	0.787	0.316	0.988	0.406	0.201	0.167
		rear	0.714	1.281	0.521	0.752	-0.193	0.857
		left	1.162	0.388	1.203	0.376	0.041	0.127
		all	0.794	0.107	0.865	0.109	0.071	0.043

Continuation of Table A.3-9

f/m	other	0.500	-	0.667	-	0.167	-
	front	1.005	0.605	1.220	0.703	0.215	0.192
	right	0.533	-	0.529	0.415	-0.004	-
	rear	-	-	-	-	-	-
	left	1.063	-	1.125	-	0.063	-
	all	0.881	0.290	0.961	0.282	0.080	0.095
f/f	other	-	-	-	-	-	-
	front	0.471	0.343	0.529	0.355	0.059	0.181
	right	-	-	-	-	-	-
	rear	-	-	-	-	-	-
	left	0.400	-	0.480	-	0.080	-
	all	0.676	0.264	0.718	0.276	0.042	0.093

Table A.3-10. Air bag factors by sex and age of occupants and seating position. Ages of occupants are over 15 years old and differ by no more than 10 years. Age is the average of the two occupants ages.

age	driver/ passenger	impact	good states factor	good states error	all states factor	all states error	difference factor	difference error
					driver			
16-25	m/m	other	0.806	0.202	0.821	0.192	0.015	0.045
		front	1.032	0.127	0.949	0.111	-0.083	0.045
		right	0.755	0.182	0.707	0.161	-0.048	0.051
		rear	0.933	0.671	0.826	0.602	-0.108	0.158
		left	0.925	0.225	0.909	0.211	-0.015	0.067
		all	0.936	0.092	0.896	0.079	-0.041	0.029
	m/f	other	0.965	0.420	1.008	0.435	0.043	0.210
		front	0.713	0.154	0.678	0.141	-0.035	0.035
		right	1.007	0.388	0.957	0.358	-0.050	0.079
		rear	1.905	-	1.719	-	-0.186	-
		left	0.911	0.400	0.868	0.380	-0.043	0.039
		all	0.801	0.113	0.774	0.100	-0.027	0.029
	f/m	other	0.868	0.386	1.263	0.619	0.395	0.318
		front	0.815	0.190	0.785	0.172	-0.030	0.064
		right	0.720	0.374	0.692	0.324	-0.028	0.103
		rear	0.818	-	0.818	-	0.000	-
		left	2.143	-	1.270	-	-0.873	-
		all	0.690	0.123	0.733	0.118	0.043	0.036
	f/f	other	2.833	2.733	2.766	1.822	-0.067	1.294
		front	0.596	0.155	0.694	0.181	0.099	0.073
		right	1.136	0.516	0.978	0.426	-0.158	0.144
		rear	-	-	-	-	-	-
		left	1.247	-	1.342	-	0.095	-
		all	1.038	0.172	1.062	0.173	0.023	0.059
25-65	m/m	other	1.266	0.539	1.054	0.408	-0.211	0.270
		front	1.024	0.180	0.998	0.160	-0.027	0.048
		right	1.884	0.499	1.988	0.488	0.104	0.180
		rear	1.400	-	0.984	0.641	-0.416	-
		left	1.119	0.557	1.180	0.463	0.062	0.233
		all	1.172	0.128	1.141	0.119	-0.031	0.041
	m/f	other	1.140	0.636	1.015	0.487	-0.126	0.242
		front	0.750	0.086	0.789	0.088	0.039	0.034
		right	0.573	0.168	0.632	0.171	0.059	0.058
		rear	0.752	0.245	0.896	0.293	0.144	0.084
		left	2.139	0.882	1.811	0.611	-0.328	0.370
		all	0.847	0.073	0.863	0.071	0.017	0.025
	f/m	other	0.851	-	1.065	-	0.213	-
		front	1.100	0.242	1.092	0.218	-0.009	0.071
		right	0.978	0.483	1.029	0.486	0.051	0.073
		rear	0.533	-	0.567	-	0.033	-
		left	0.819	0.455	0.808	0.329	-0.011	0.196
		all	1.059	0.162	1.097	0.162	0.038	0.040

Continuation of Table A.3-10

	f/f	other	0.952	-	0.917	-	-0.036	-
		front	0.754	0.300	0.713	0.264	-0.041	0.105
		right	1.650	0.718	1.350	0.558	-0.300	0.228
		rear	0.259	0.313	0.286	0.392	0.026	0.146
		left	2.694	-	2.074	2.244	-0.620	-
		all	0.921	0.210	0.859	0.184	-0.061	0.067
>65	m/m	other	-	-	-	-	-	-
		front	0.714	0.477	0.481	0.328	-0.234	0.233
		right	2.833	-	2.222	-	-0.611	-
		rear	1.000	-	0.750	-	-0.250	-
		left	1.125	-	1.547	-	0.422	-
		all	0.922	0.293	0.868	0.291	-0.054	0.119
	m/f	other	0.492	0.319	0.438	0.297	-0.055	0.060
		front	0.931	0.110	0.893	0.101	-0.038	0.037
		right	1.028	0.227	1.126	0.213	0.098	0.084
		rear	0.839	0.511	0.750	0.445	-0.089	0.139
		left	0.994	0.252	1.021	0.251	0.027	0.070
		all	0.967	0.084	0.965	0.077	-0.002	0.025
	f/m	other	1.000	-	0.889	-	-0.111	-
		front	1.061	0.260	1.170	0.277	0.108	0.103
		right	0.760	0.442	0.776	0.455	0.015	0.130
		rear	3.125	-	2.778	-	-0.347	-
		left	1.085	0.388	1.182	0.413	0.097	0.092
		all	1.013	0.165	1.059	0.168	0.046	0.050
	f/f	other	-	-	-	-	-	-
		front	0.565	0.202	0.664	0.243	0.099	0.086
		right	1.308	0.633	1.167	0.572	-0.141	0.168
		rear	3.667	-	3.143	-	-0.524	-
		left	0.851	0.425	0.727	0.421	-0.124	0.202
		all	0.914	0.171	0.915	0.170	0.001	0.062
					right-front-seat occupant			
16-25	m/m	other	0.873	0.251	0.878	0.244	0.005	0.045
		front	1.024	0.166	0.960	0.140	-0.065	0.064
		right	0.726	0.220	0.724	0.216	-0.002	0.045
		rear	1.120	0.748	0.804	0.534	-0.316	0.302
		left	1.403	0.450	1.256	0.395	-0.146	0.124
		all	0.979	0.115	0.908	0.093	-0.071	0.039
	m/f	other	1.771	1.442	1.733	1.081	-0.038	0.742
		front	0.668	0.170	0.654	0.156	-0.015	0.037
		right	1.029	0.459	1.067	0.464	0.038	0.088
		rear	2.667	-	3.750	-	1.083	-
		left	0.309	-	0.427	0.237	0.117	-
		all	0.774	0.130	0.790	0.130	0.016	0.031

Continuation of Table A.3-10

	f/m	other	0.844	0.986	1.313	1.632	0.469	0.724
		front	1.440	0.551	1.306	0.505	-0.134	0.167
		right	0.720	-	0.779	-	0.059	-
		rear	1.000	-	1.000	-	0.000	-
		left	4.571	-	2.500	-	-2.071	-
		all	1.001	0.246	1.045	0.257	0.043	0.070
	f/f	other	1.322	1.753	1.063	1.122	-0.260	0.746
		front	0.487	0.190	0.541	0.216	0.054	0.074
		right	0.591	0.334	0.544	0.305	-0.047	0.045
		rear	-	-	-	-	-	-
		left	1.583	-	1.667	-	0.083	-
		all	0.835	0.214	0.820	0.210	-0.016	0.043
25-65	m/m	other	0.976	0.587	0.857	0.481	-0.119	0.229
		front	0.848	0.218	0.845	0.210	-0.003	0.060
		right	1.800	0.755	1.800	0.751	0.000	0.181
		rear	1.143	0.988	1.000	0.840	-0.143	0.238
		left	0.870	0.596	1.091	0.581	0.221	0.275
		all	0.952	0.156	0.954	0.152	0.001	0.041
	m/f	other	0.821	0.498	0.800	0.434	-0.021	0.153
		front	0.711	0.132	0.708	0.119	-0.002	0.047
		right	0.596	0.190	0.671	0.197	0.074	0.070
		rear	0.886	0.447	1.034	0.501	0.148	0.111
		left	1.714	0.789	1.383	0.537	-0.331	0.339
		all	0.812	0.092	0.815	0.086	0.003	0.030
	f/m	other	1.269	-	1.571	-	0.302	-
		front	0.892	0.316	0.808	0.251	-0.084	0.123
		right	0.669	0.493	0.641	0.421	-0.029	0.126
		rear	0.400	-	0.800	-	0.400	-
		left	1.056	0.881	0.933	0.706	-0.122	0.371
		all	0.915	0.198	0.924	0.182	0.009	0.061
	f/f	other	0.333	-	0.333	-	0.000	-
		front	0.944	0.636	0.923	0.578	-0.021	0.187
		right	1.125	-	1.013	-	-0.112	-
		rear	-	-	-	-	-	-
		left	2.000	-	1.944	2.083	-0.056	-
		all	0.783	0.251	0.776	0.240	-0.007	0.071
>65	m/m	other	-	-	-	-	-	-
		front	-	-	-	-	-	-
		right	0.667	-	0.667	-	0.000	-
		rear	-	-	-	-	-	-
		left	-	-	-	-	-	-
		all	0.121	-	0.138	-	0.017	-
	m/f	other	0.875	-	1.313	-	0.438	-
		front	0.625	0.134	0.663	0.132	0.038	0.049
		right	1.024	0.441	1.191	0.610	0.167	0.272
		rear	0.436	-	0.357	0.296	-0.079	-
		left	1.017	0.349	1.108	0.364	0.091	0.103
		all	0.731	0.083	0.804	0.088	0.074	0.033

Continuation of Table A.3-10

f/m	other	2.000	-	2.000	-	0.000	-
	front	0.902	0.392	1.086	0.495	0.184	0.171
	right	0.889	-	0.783	-	-0.106	-
	rear	0.313	-	0.278	-	-0.035	-
	left	1.250	0.689	1.300	0.704	0.050	0.060
	all	0.971	0.243	1.034	0.270	0.063	0.085
f/f	other	-	-	-	-	-	-
	front	0.435	0.324	0.478	0.323	0.043	0.187
	right	-	-	-	-	-	-
	rear	-	-	-	-	-	-
	left	0.571	-	0.571	-	0.000	-
	all	0.708	0.282	0.725	0.266	0.017	0.097

Table A.3-11. Air bag factors by sex and age of occupants and seating position; ages of occupants are over 15 years old and differ by no more than 15 years. Age is the average of the two occupant's ages.

age	driver/ passenger	side	good states factor	good states error	all states factor	all states error	difference factor	difference error
			driver					
16-25	m/m	other	0.786	0.205	0.803	0.200	0.017	0.049
		front	1.033	0.133	0.951	0.120	-0.082	0.043
		right	0.750	0.172	0.703	0.152	-0.047	0.053
		rear	0.972	0.445	0.860	0.378	-0.112	0.176
		left	0.920	0.254	0.905	0.227	-0.015	0.065
		all	0.933	0.076	0.893	0.070	-0.040	0.025
	m/f	other	1.058	0.678	1.082	0.555	0.024	0.297
		front	0.714	0.135	0.679	0.124	-0.035	0.031
		right	1.007	0.370	0.966	0.341	-0.041	0.055
		rear	1.750	-	1.597	-	-0.153	-
		left	0.911	0.483	0.868	0.462	-0.043	0.032
		all	0.808	0.103	0.783	0.093	-0.025	0.029
	f/m	other	0.844	0.343	1.200	0.529	0.356	0.273
		front	0.806	0.244	0.771	0.204	-0.035	0.089
		right	0.705	0.370	0.680	0.346	-0.025	0.072
		rear	0.818	-	0.818	-	0.000	-
		left	2.143	-	1.270	-	-0.873	-
		all	0.684	0.117	0.722	0.111	0.038	0.045
	f/f	other	2.833	3.286	2.766	2.443	-0.067	1.491
		front	0.596	0.147	0.701	0.162	0.105	0.076
		right	1.133	0.495	0.977	0.428	-0.156	0.112
		rear	-	-	-	-	-	-
		left	1.211	1.077	1.308	1.251	0.097	0.241
		all	1.041	0.161	1.064	0.163	0.023	0.062
25-65	m/m	other	1.142	0.532	0.992	0.448	-0.150	0.203
		front	0.964	0.155	0.965	0.142	0.001	0.041
		right	1.895	0.534	1.992	0.528	0.097	0.176
		rear	2.000	-	1.156	0.904	-0.844	-
		left	0.876	0.323	0.935	0.316	0.060	0.080
		all	1.103	0.134	1.085	0.118	-0.018	0.041
	m/f	other	1.091	0.516	0.962	0.386	-0.129	0.223
		front	0.765	0.081	0.793	0.085	0.028	0.032
		right	0.581	0.178	0.638	0.173	0.057	0.059
		rear	0.722	0.234	0.870	0.285	0.148	0.098
		left	2.136	0.702	1.816	0.500	-0.320	0.366
		all	0.846	0.073	0.863	0.071	0.016	0.024
	f/m	other	0.750	0.357	0.932	0.464	0.182	0.165
		front	1.001	0.161	1.001	0.156	0.000	0.058
		right	0.887	0.323	0.922	0.338	0.035	0.058
		rear	0.600	0.477	0.633	0.511	0.033	0.054
		left	0.690	0.263	0.697	0.264	0.007	0.107
		all	0.932	0.108	0.980	0.110	0.048	0.035

Continuation of Table A.3-11

	f/f	other	0.706	1.219	0.684	1.096	-0.022	0.189
		front	0.706	0.203	0.670	0.181	-0.036	0.071
		right	1.279	0.529	1.068	0.445	-0.212	0.127
		rear	0.389	0.281	0.429	0.348	0.040	0.136
		left	3.305	-	2.687	-	-0.619	-
		all	0.880	0.160	0.832	0.137	-0.047	0.053
>65	m/m	other	0.000	-	0.167	-	0.167	-
		front	0.909	0.517	0.676	0.348	-0.232	0.269
		right	3.150	-	2.400	-	-0.750	-
		rear	1.000	-	0.800	-	-0.200	-
		left	1.013	0.551	1.344	0.770	0.332	0.312
		all	0.994	0.259	0.951	0.224	-0.042	0.108
	m/f	other	0.476	0.319	0.426	0.293	-0.050	0.056
		front	0.947	0.135	0.919	0.121	-0.028	0.042
		right	0.974	0.226	1.034	0.232	0.061	0.094
		rear	0.909	0.471	0.817	0.450	-0.092	0.125
		left	0.885	0.178	0.916	0.180	0.031	0.048
		all	0.961	0.084	0.959	0.079	-0.002	0.028
	f/m	other	1.714	-	1.000	-	-0.714	-
		front	1.040	0.238	1.111	0.237	0.071	0.098
		right	0.798	0.366	0.902	0.406	0.104	0.193
		rear	0.833	-	0.875	-	0.042	-
		left	1.183	0.470	1.341	0.543	0.157	0.145
		all	1.032	0.150	1.071	0.151	0.039	0.052
	f/f	other	-	-	-	-	-	-
		front	0.535	0.176	0.604	0.197	0.070	0.054
		right	1.120	0.480	1.017	0.431	-0.103	0.101
		rear	3.000	-	2.889	-	-0.111	-
		left	0.762	0.359	0.638	0.320	-0.124	0.144
		all	0.834	0.154	0.851	0.151	0.017	0.046

right-front-seat occupant

16-25	m/m	other	0.878	0.308	0.884	0.305	0.006	0.051
		front	0.999	0.184	0.939	0.168	-0.060	0.061
		right	0.729	0.227	0.727	0.227	-0.002	0.048
		rear	1.120	0.549	0.871	0.374	-0.249	0.281
		left	1.486	0.452	1.308	0.385	-0.178	0.141
		all	0.976	0.124	0.907	0.109	-0.069	0.039
	m/f	other	2.063	1.501	1.773	1.060	-0.289	0.716
		front	0.668	0.175	0.654	0.162	-0.015	0.034
		right	1.029	0.515	1.067	0.530	0.038	0.083
		rear	2.667	-	3.750	-	1.083	-
		left	0.309	-	0.427	0.224	0.117	-
		all	0.792	0.136	0.797	0.134	0.005	0.035
	f/m	other	0.844	0.985	1.313	1.248	0.469	0.407
		front	1.520	0.847	1.375	0.575	-0.145	0.422
		right	0.720	-	0.779	-	0.059	-

		rear	1.000	-	1.000	-	0.000	-
		left	4.571	-	2.500	-	-2.071	-
		all	1.027	0.303	1.070	0.294	0.043	0.078
	f/f	other	1.322	1.457	1.063	0.978	-0.260	0.629
		front	0.487	0.168	0.545	0.183	0.059	0.073
		right	0.591	0.302	0.544	0.284	-0.047	0.047
		rear	-	-	-	-	-	-
		left	1.583	-	1.667	-	0.083	-
		all	0.835	0.178	0.820	0.170	-0.016	0.050
25-65	m/m	other	0.847	0.433	0.772	0.391	-0.075	0.152
		front	0.809	0.166	0.870	0.176	0.061	0.057
		right	1.966	0.829	1.987	0.809	0.021	0.208
		rear	1.429	1.635	1.143	1.200	-0.286	0.607
		left	0.786	0.382	1.000	0.433	0.214	0.121
		all	0.954	0.130	0.988	0.133	0.034	0.042
	m/f	other	0.708	0.390	0.704	0.349	-0.005	0.116
		front	0.743	0.134	0.730	0.128	-0.013	0.057
		right	0.671	0.247	0.741	0.248	0.070	0.083
		rear	0.990	0.563	1.136	0.629	0.146	0.141
		left	1.758	0.668	1.402	0.467	-0.356	0.321
		all	0.832	0.094	0.832	0.092	-0.000	0.033
	f/m	other	1.219	0.776	1.412	0.849	0.193	0.184
		front	0.685	0.198	0.661	0.175	-0.023	0.073
		right	0.636	0.446	0.582	0.356	-0.055	0.138
		rear	0.400	-	0.800	-	0.400	-
		left	0.800	-	0.697	-	-0.103	-
		all	0.773	0.144	0.800	0.141	0.026	0.046
	f/f	other	0.250	-	0.250	-	0.000	-
		front	0.750	0.354	0.741	0.330	-0.009	0.114
		right	0.909	0.788	0.833	0.772	-0.076	0.068
		rear	-	-	-	-	-	-
		left	2.206	-	2.000	-	-0.206	-
		all	0.662	0.169	0.655	0.172	-0.007	0.050
>65	m/m	other	-	-	-	-	-	-
		front	0.346	-	0.265	-	0.081	-
		right	0.900	-	0.900	-	0.000	-
		rear	-	-	-	-	-	-
		left	-	-	-	-	-	-
		all	0.387	-	0.347	0.150	-0.040	-
	m/f	other	0.900	-	1.350	-	0.450	-
		front	0.636	0.128	0.675	0.124	0.039	0.042
		right	1.074	0.401	1.218	0.379	0.144	0.204
		rear	0.509	-	0.417	-	-0.092	-
		left	0.916	0.249	1.010	0.264	0.094	0.081
		all	0.733	0.100	0.804	0.106	0.070	0.031

Continuation of Table A.3-11

f/m	other	3.000	-	2.000	-	-1.000	-
	front	0.792	0.336	0.931	0.397	0.140	0.113
	right	0.872	-	0.857	-	-0.015	-
	rear	0.278	-	0.250	-	-0.028	-
	left	1.227	-	1.318	-	0.091	-
	all	0.938	0.237	1.000	0.250	0.062	0.069
f/f	other	-	-	-	-	-	-
	front	0.344	0.210	0.377	0.194	0.033	0.083
	right	1.667	-	1.552	-	-0.115	-
	rear	-	-	-	-	-	-
	left	0.711	0.491	0.691	0.527	-0.020	0.179
	all	0.582	0.159	0.604	0.166	0.022	0.049

Table A.3-12. Air bag factors by car weight for occupants over 15 years old.

weight	impact	good states factor	good states error	all states factor	all states error	difference factor	difference error
				driver			
<2500	other	1.180	0.345	1.115	0.293	-0.065	0.121
	front	0.713	0.076	0.717	0.073	0.004	0.032
	right	0.797	0.197	0.864	0.189	0.067	0.084
	rear	1.017	0.544	0.993	0.525	-0.024	0.141
	left	0.823	0.158	0.829	0.140	0.005	0.061
	all	0.847	0.068	0.862	0.065	0.015	0.028
2500-3099	other	1.191	0.250	1.152	0.230	-0.039	0.074
	front	0.879	0.058	0.869	0.051	-0.011	0.019
	right	0.928	0.112	0.928	0.108	-0.000	0.034
	rear	1.024	0.259	0.981	0.232	-0.043	0.085
	left	1.176	0.149	1.214	0.150	0.038	0.044
	all	0.962	0.048	0.954	0.044	-0.008	0.014
>3099	other	0.780	0.219	0.848	0.235	0.067	0.088
	front	0.876	0.080	0.875	0.079	-0.001	0.027
	right	1.117	0.190	1.069	0.170	-0.049	0.056
	rear	1.029	0.287	0.929	0.236	-0.100	0.093
	left	1.063	0.164	1.042	0.151	-0.022	0.055
	all	0.929	0.055	0.933	0.056	0.005	0.019
				right-front-seat occupant			
<2500	other	1.110	0.371	1.046	0.342	-0.065	0.105
	front	0.725	0.121	0.691	0.113	-0.034	0.041
	right	0.714	0.256	0.807	0.243	0.092	0.093
	rear	0.711	10.005	0.582	9.980	-0.129	0.208
	left	0.835	0.223	0.872	0.220	0.038	0.059
	all	0.795	0.086	0.799	0.086	0.003	0.029
2500-3099	other	1.511	0.373	1.414	0.324	-0.098	0.109
	front	0.726	0.095	0.719	0.094	-0.006	0.021
	right	0.887	0.179	0.888	0.177	0.001	0.041
	rear	1.504	0.625	1.503	0.633	-0.002	0.174
	left	1.424	0.310	1.438	0.297	0.014	0.096
	all	0.918	0.073	0.897	0.072	-0.021	0.019
>3099	other	0.559	0.161	0.635	0.173	0.076	0.054
	front	0.734	0.070	0.745	0.071	0.011	0.031
	right	1.022	0.168	1.013	0.166	-0.009	0.046
	rear	0.951	0.291	0.838	0.242	-0.113	0.099
	left	1.002	0.186	0.997	0.182	-0.005	0.062
	all	0.814	0.055	0.827	0.057	0.012	0.020

Table A.3-13. Air bag factors by speed limit for occupants over 15 years old.

speed limit	impact	good states factor	good states error	all states factor	all states error	difference factor	difference error
				driver			
<41	other	0.663	0.197	0.730	0.212	0.067	0.065
	front	0.882	0.118	0.892	0.107	0.010	0.033
	right	0.965	0.173	0.914	0.159	-0.051	0.041
	rear	1.442	0.654	1.317	0.578	-0.125	0.226
	left	1.197	0.232	1.299	0.251	0.101	0.074
	all	0.977	0.071	1.005	0.068	0.028	0.022
41-55	other	1.147	0.193	1.150	0.186	0.003	0.060
	front	0.800	0.045	0.806	0.044	0.006	0.016
	right	0.942	0.091	0.951	0.084	0.010	0.031
	rear	1.002	0.207	0.957	0.197	-0.045	0.057
	left	1.097	0.135	1.055	0.124	-0.042	0.038
	all	0.886	0.035	0.887	0.034	0.001	0.012
>55	other	1.193	0.355	1.102	0.317	-0.091	0.105
	front	1.081	0.121	0.946	0.108	-0.134	0.043
	right	0.957	0.293	0.915	0.283	-0.042	0.102
	rear	0.762	0.269	0.731	0.268	-0.031	0.104
	left	0.960	0.260	1.033	0.274	0.073	0.043
	all	1.074	0.101	0.986	0.090	-0.088	0.033
				right-front-seat occupant			
<41	other	0.681	0.264	0.695	0.278	0.015	0.056
	front	0.650	0.116	0.618	0.100	-0.032	0.034
	right	1.036	0.278	1.110	0.286	0.074	0.063
	rear	1.731	3.768	1.714	2.327	-0.016	2.318
	left	0.918	0.306	1.005	0.321	0.088	0.076
	all	0.834	0.091	0.850	0.087	0.016	0.028
41-55	other	0.899	0.190	0.923	0.191	0.024	0.058
	front	0.708	0.064	0.726	0.064	0.018	0.020
	right	0.867	0.120	0.868	0.109	0.001	0.033
	rear	0.796	0.184	0.655	0.152	-0.141	0.061
	left	1.142	0.185	1.127	0.165	-0.015	0.054
	all	0.792	0.047	0.796	0.047	0.005	0.013
>55	other	1.059	0.323	1.004	0.290	-0.055	0.095
	front	0.845	0.134	0.806	0.123	-0.039	0.043
	right	1.563	0.707	1.505	0.656	-0.057	0.158
	rear	1.194	0.596	1.066	0.537	-0.127	0.194
	left	0.804	0.258	0.779	0.249	-0.024	0.031
	all	0.993	0.111	0.930	0.098	-0.063	0.035

Table A.3-14. Air bag factors by crash type for occupants over 15 years old.

crash type	impact	good states factor	good states error	all states factor	all states error	difference factor	difference error
				driver			
single	other	1.023	0.135	1.020	0.134	-0.003	0.039
	front	0.942	0.067	0.920	0.066	-0.023	0.025
	right	1.156	0.188	1.133	0.178	-0.024	0.054
	rear	1.163	0.425	0.978	0.351	-0.185	0.169
	left	0.983	0.190	0.960	0.178	-0.022	0.045
	all	0.996	0.055	0.975	0.052	-0.022	0.018
multi	other	1.500	1.042	1.400	1.041	-0.100	0.509
	front	0.807	0.051	0.809	0.047	0.002	0.016
	right	0.886	0.093	0.879	0.083	-0.007	0.026
	rear	0.957	0.168	0.938	0.161	-0.019	0.046
	left	1.155	0.110	1.175	0.115	0.020	0.042
	all	0.899	0.035	0.905	0.034	0.007	0.013
				right-front-seat-occupant			
single	other	0.957	0.136	0.949	0.131	-0.008	0.040
	front	0.767	0.077	0.778	0.078	0.011	0.026
	right	0.945	0.201	0.980	0.206	0.035	0.043
	rear	1.882	0.817	1.499	0.618	-0.383	0.339
	left	1.022	0.225	0.973	0.194	-0.049	0.054
	all	0.859	0.059	0.853	0.056	-0.006	0.018
multi	other	0.545	9.970	0.636	0.410	0.091	9.923
	front	0.711	0.058	0.699	0.057	-0.011	0.020
	right	0.978	0.138	0.979	0.131	0.001	0.036
	rear	0.711	0.178	0.649	0.145	-0.063	0.074
	left	1.044	0.142	1.085	0.147	0.042	0.055
	all	0.845	0.048	0.846	0.046	0.001	0.015