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Lives Saved by Child Restraints from 1982 through 1987

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16. Abstract

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69 percent for infants in child safety seats,
47 percent for toddlers in child safety seats, and
36 percent for toddlers in adult belts.

Because many restraints are incorrectly or incompletely used (as reported from detailed observation surveys), potential effectiveness is probably higher than the estimates provided here.

As child restraint use has increased, the annual number of lives saved has also increased. Based on the methods described here, child safety seats and adult belts used by infant and toddler passenger vehicle occupants saved an estimated:

75 lives in 1982,
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Summary

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As child restraint use has increased, the annual number of lives saved has also increased. Based on the methods described here, child safety seats and adult belts used by infant and toddler passenger vehicle occupants saved an estimated:

75 lives in 1982,
105 lives in 1983,
126 lives in 1984,
153 lives in 1985,
166 lives in 1986, and
213 lives in 1987.

Child restraints could save many more lives, but use is still low in serious accidents. Observations taken at shopping centers in nineteen cities indicate that about 80 percent of young children (under five years old) who visited these centers in 1987 were in child safety seats. In contrast, only 24 percent of young children who survived a fatal accident were in child safety seats. Observations taken by individual states produce results that vary widely between these two extremes. Despite the effectiveness of child restraints and the widespread use of safety seats in some areas, children in serious crashes are usually unprotected.

If all young children used child restraints, more lives could be saved. With 100 percent use, child seats (with the mix of correct and incorrect use during 1982 through 1987) could have saved an estimated:

369 lives in 1982,
380 lives in 1983,
355 lives in 1984,
378 lives in 1985,
405 lives in 1986, and
462 lives in 1987.

If child seats are to achieve anything like this potential, they must become more available to children involved in serious crashes.

The remainder of this report describes the data and methods on which these conclusions are based.

Data

Between 1982 and 1987 there were 7,060 vehicles reported to FARS that met the following three criteria. First, they were passenger cars built after front seat lap and shoulder belts were required (model years 1974 and later). Second, they had a driver for whom restraint use was reported. And third, they had a young child passenger (under five years old) for whom restraint use and type (adult belts or child safety seat) was reported. The definitions used to select and classify these cases are described in Appendix Table A.

Method

This paper uses the matched-pairs technique described in detail by Leonard Evans (for example, in "Driver Fatalities versus Car Mass Using a New Exposure Approach," Accident Analysis and Prevention, Volume 16, Number 1, 1984) and used by him in a variety of studies of fatal accidents. This technique has been used in previous agency analyses of child restraints ("Restraint Use and Fatality Risk for Infants and Toddlers," Susan Partyka, 1984; "An Evaluation of Child Passenger Safety: The Effectiveness and Benefits of Safety Seats," Charles Kahane, 1986).

The idea is to compute fatality odds from FARS data and treat them as if they were fatality rates. For example, there were 4,239 vehicles in which neither the driver nor the child passenger was restrained. In these vehicles, there were 1,341 driver fatalities and 1,290 child passenger fatalities, as shown in Table 1. The ratio of child to driver fatalities was:

$$1{,}290 / 1{,}341 = 0.962.$$

There were also 910 vehicles in which the driver was unrestrained, but the child passenger was in a child safety seat. There were 324 driver fatalities and 156 child passenger fatalities in these vehicles. The ratio of child to driver fatalities was:

$$156 / 324 = 0.481.$$

If these fatality odds are interpreted as fatality rates, they can be used to estimate the effectiveness of child safety seats in vehicles with an unrestrained driver. Children in safety seats were:

$$(0.962 - 0.481) / 0.962 = 50 \text{ percent}$$

less likely to be killed than were the unrestrained children in these fatal accidents. This result is shown in Table 2.

These estimates were made for each combination of driver and child restraint use, separately for front and rear seats, and separately for infants (those under one year old) and toddlers (those one through four years old). They are interpreted here as estimates of the effectiveness of child safety seats and adult belts in saving the lives of young children.

The method depends on three assumptions. First, that restraint use was correctly reported for fatalities and survivors of fatal accidents. Second, that unknown restraint use data were missing at random. And third, that the exposure of young children to potentially-fatal crashes was adequately represented by the number of fatalities among drivers of young children.

The data were also used to estimate the incremental benefits of rear (as opposed to front) seating for young children. For example, in vehicles with both the driver and child restrained, the fatality odds were:

716 / 603 = 1.187 for children in the front seat and
466 / 590 = 0.790 for children in the rear seat.

If these fatality odds are treated like fatality rates, the safety benefit of placing a young child in the rear seat can be estimated. Children in the rear seat were:

(1.187 - 0.790) / 1.187 = 33 percent

less likely to be killed than were children in the front seat. This result is shown in Table 3.

The combinations of driver restraint use, child restraint use, and child seating position produced multiple estimates of the effectiveness of adult belts and child safety seats in preventing fatalities among children and multiple estimates of the benefits of placing a child in the safer rear seat. In some cases there was good agreement among the estimates, but in others there was remarkable scatter.

Average effectiveness estimates were computed by weighting individual effectiveness estimates by a measure intended to reflect the relative reliability of the individual estimates. The reliability of the estimates usually was limited most by the small number of restrained children. So this measure (the number of vehicles with both a driver fatality and a restrained child passenger, used to calculate each individual estimate) was used to produce the weighted average estimate.

For example, child safety seat effectiveness in the front seats of passenger cars was estimated twice: once for vehicles with unrestrained drivers, and again for vehicles with restrained drivers. This produced estimates that child safety seats were 58 percent and 34 percent effective, respectively, in preventing fatality. The first estimate was based on data that included 114 vehicles with both a child in a child safety seat and an unrestrained driver fatality. The second estimate was based on data that included 35 vehicles with both a child in a child safety seat and a restrained driver fatality. The average of these estimates was computed as:

$$\frac{(58 \text{ percent} * 114 \text{ vehicles}) + (34 \text{ percent} * 35 \text{ vehicles})}{(114 \text{ vehicles} + 35 \text{ vehicles})} = 52 \text{ percent.}$$

Using a different weighting factor (or using straight averaging) would produce different results from the ones reported here. The estimates of the benefits of rear (as opposed to front) seating are most sensitive to the selection of the weighting factor because the effectiveness estimates produced for various categories of driver and child restraint status varied so widely.

Restraint Effectiveness

Table 1 shows the available data for children under five years old -- all seating positions, those known to have been in the front seat, and those known to have been in a rear seat. The seating position of some young children was not known. These children are included in the summary across all seats, but not in either of the two known seat areas.

The fatality odds shown in Table 1 were used to compare the fatality experiences of unrestrained children to the experiences of children using child safety seats and adult seat belts. Young children in safety seats were 54 percent less likely to be killed than were unrestrained children. This should not be interpreted as an estimate of child safety seat effectiveness because of confounding differences between unrestrained and restrained children. Children in rear seats and infants were more likely to be restrained than were children in front seats and toddlers. The biasing effects of these two differences can be removed statistically from the fatality data.

The first difference noted above is that unrestrained children more often rode in the front seat than in the rear seat, while children in safety seats more often rode in the safer rear seat. Because the rear seat is more protective, this difference produces a statistical bias in favor of child safety seats. To compensate for this difference, the data of Table 1 were used to produce separate estimates of fatality reductions for front seat and for rear seat occupants.

It is estimated from these data that child safety seats are 52 percent effective in preventing fatality in front seats and 47 percent effective in preventing fatality in rear seats (Table 2). The difference between these two estimates appears small enough to have resulted from chance. The weighted average of these two estimates is 49 percent. This is the estimated effectiveness of child safety seats in preventing fatality, controlling for differences in seating position between unrestrained children and children in safety seats.

Similar calculations produce an estimate that adult belts are 44 percent effective in preventing fatality, after controlling for seating position differences between unrestrained and belted children.

The data in Table 1 can also be used to compare the fatality odds of children in the front and rear seats, after controlling for driver and child restraint type. Table 3 shows that, on average, a young child was 26 percent less likely to be killed in a rear seat than in the front seat. However, there were large differences in the estimates produced by the various categories of driver and child restraint status. At this time, there appears to be no pattern in the variety of estimates. The variation may reflect reporting biases, the inherent variability of the data, or a physical process that is not yet understood.

Table 1: Fatalities of Drivers and their Young Child Passengers
(Children Under Five Years Old, 1982-1987 Data)

Child's Position	Restraint Used by Driver	Restraint Used by Child	Number of Deaths Driver	Number of Deaths Child	Ratio of Fatalities Driver/Child	Ratio of Fatalities Child/Driver
* All Seats	None	None	1,341	1,290	1.040	0.962
	None	Adult belt	84	42	2.000	0.500
	None	Child seat	324	156	2.077	0.481
	Belts	None	60	120	0.500	2.000
	Belts	Adult belt	87	88	0.989	1.011
	Belts	Child seat	178	137	1.299	0.770
Front	None	None	603	716	0.842	1.187
	None	Adult belt	28	14	2.000	0.500
	None	Child seat	114	57	2.000	0.500
	Belts	None	23	44	0.523	1.913
	Belts	Adult belt	34	39	0.872	1.147
	Belts	Child seat	35	44	0.795	1.257
Rear	None	None	590	466	1.266	0.790
	None	Adult belt	54	28	1.929	0.519
	None	Child seat	197	99	1.990	0.503
	Belts	None	34	63	0.540	1.853
	Belts	Adult belt	49	46	1.065	0.939
	Belts	Child seat	135	92	1.467	0.681

* Children with unknown seat position included in "All Seats."

Table 2: Estimated Percentage Benefits of Restraint Use by Young Children

Child Restrained by	Control Used	No Seat Position Control	Benefit in: Front	Benefit in: Rear	Average Benefit
Adult seat belt	Unrestrained driver	48	58	34	42
	Restrained driver	49	40	49	46
	Average	49	48	41	44
Child safety seat	Unrestrained driver	50	58	36	44
	Restrained driver	62	34	63	57
	Average	54	52	47	49

Table 3: Estimated Percentage Benefits of Rear Seating for Young Children within Categories of Driver and Child Restraint Use

	Restraint Use of Driver Control		
Child Restrained by	Unrestrained	Restrained	Average
None	33	3	32
Adult seat belt	-4	18	7
Child safety seat	-1	46	16
Average	25	31	26

The second difference between unrestrained and restrained children noted previously is that infants were more frequently restrained (especially in a child safety seat) than were toddlers. Because infants are more vulnerable to injury than are older children, this difference produces a statistical bias against child safety seats. To compensate for this difference, the data of Table 1 for all young children were separately tabulated for infants (Table 4) and toddlers (Table 7). The data from these two tables were used to produce separate estimates of fatality reductions for infants and toddlers, for front and for rear seat occupants.

The separate calculations performed are summarized for infants (those under one year old) in Tables 4 through 6 and for toddlers (those one through four years old) in Tables 7 through 9. The data for adult-belted infants are inadequate for meaningful estimates. The estimated fatality reductions from restraint use (controlling for differences in seat positions of unrestrained and restrained children) are:

69 percent for infants in child safety seats,
47 percent for toddlers in child safety seats, and
36 percent for toddlers in adult belts.

In each case, accounting for differences in seating positions of unrestrained versus restrained children produces estimated fatality benefits that are between three and five percentage points lower than the estimates produced without adjusting for this difference.

The estimated average benefit of sitting in a rear seat was 29 percent for infants and 19 percent for toddlers. For infants, the estimated benefits were higher for cases with a restrained driver but did not seem to depend on the restraint status of the child. The estimates derived for toddlers varied widely, depending on the restraint status of the driver and of the toddler. The reasons for these differences are not currently understood.

Table 4: Fatalities of Drivers and their Infant Passengers
(Children Under One Year Old, 1982-1987 Data)

Child's Position	Restraint Used by Driver	Restraint Used by Child	Number of Deaths Driver	Number of Deaths Child	Ratio of Fatalities Driver/Child	Ratio of Fatalities Child/Driver
* All Seats	None	None	196	332	0.590	1.694
	None	Adult belt	3	2	1.500	0.667
	None	Child seat	99	58	1.707	0.586
	Belts	None	3	26	0.115	8.667
	Belts	Adult belt	5	7	0.714	1.400
	Belts	Child seat	42	44	0.955	1.048
Front	None	None	122	237	0.515	1.943
	None	Adult belt	3	1	3.000	0.333
	None	Child seat	38	28	1.357	0.737
	Belts	None	1	11	0.091	11.000
	Belts	Adult belt	4	5	0.800	1.250
	Belts	Child seat	9	14	0.643	1.556
Rear	None	None	53	76	0.697	1.434
	None	Adult belt	0	1	0.000	-
	None	Child seat	57	30	1.900	0.526
	Belts	None	2	11	0.182	5.500
	Belts	Adult belt	0	1	0.000	-
	Belts	Child seat	32	30	1.067	0.938

* Children with unknown seat position included in "All Seats."

Table 5: Estimated Percentage Benefits of Restraint Use by Infants

Child Restrained by	Control Used	No Seat Position Control	Benefit in: Front	Benefit in: Rear	Average Benefit
Child safety seat	Unrestrained driver	65	62	63	63
	Restrained driver	88	86	83	84
	Average	72	67	70	69

Table 6: Estimated Percentage Benefits of Rear Seating for Infants with Categories of Driver and Child Restraint Use

Child Restrained by	Restraint Use of Driver Control: Unrestrained	Restraint Use of Driver Control: Restrained	Restraint Use of Driver Control: Average
None	26	50	27
Child safety seat	29	40	32
Average	27	40	29

Table 7: Fatalities of Drivers and their Toddler Passengers
(Children One through Four Years Old, 1982-1987 Data)

Child's Position	Restraint Used by Driver	Restraint Used by Child	Number of Deaths Driver	Number of Deaths Child	Ratio of Fatalities Driver/Child	Ratio of Fatalities Child/Driver
* All Seats	None	None	1,145	958	1.195	0.837
	None	Adult belt	81	40	2.025	0.494
	None	Child seat	225	98	2.296	0.436
	Belts	None	57	94	0.606	1.649
	Belts	Adult belt	82	81	1.012	0.988
	Belts	Child seat	136	93	1.462	0.684
Front	None	None	481	479	1.004	0.996
	None	Adult belt	25	13	1.923	0.520
	None	Child seat	76	29	2.621	0.382
	Belts	None	22	33	0.667	1.500
	Belts	Adult belt	30	34	0.882	1.133
	Belts	Child seat	26	30	0.867	1.154
Rear	None	None	537	390	1.377	0.726
	None	Adult belt	54	27	2.000	0.500
	None	Child seat	140	69	2.029	0.493
	Belts	None	32	52	0.615	1.625
	Belts	Adult belt	49	45	1.089	0.918
	Belts	Child seat	103	62	1.661	0.602

* Children with unknown seat position included in "All Seats."

Table 8: Estimated Percentage Benefits of Restraint Use by Toddlers

Child Restrained by	Control Used	No Seat Position Control	Benefit in: Front	Benefit in: Rear	Average Benefit
Adult seat belt	Unrestrained driver	41	48	31	36
	Restrained driver	40	24	43	36
	Average	41	35	37	36
Child safety seat	Unrestrained driver	48	62	32	43
	Restrained driver	59	23	63	55
	Average	52	52	45	47

Table 9: Estimated Percentage Benefits of Rear Seating for Toddlers within Categories of Driver and Child Restraint Use

	Restraint Use of Driver Control		
Child Restrained by	Unrestrained	Restrained	Average
None	27	-8	25
Adult seat belt	4	19	11
Child safety seat	-29	48	0
Average	17	28	19

Lives Saved by Restraints

Appendix Table B shows counts of young childrem killed as occupants of passenger vehicles (cars, pickups, vans, and multipurpose vehicles) by accident year, age, and reported restraint use. For each row of this table, the unknown data were prorated among the known data in two steps. First, fatalities with unknown restraint use were prorated between fatalities in child seats and adult seat belts. And second, fatalities for whom it was not known whether or not they were restrained were prorated across the resulting estimates of fatalities in child seats and in adult belts and fatalities reported as unrestrained. The results are shown in Appendix Table C.

The estimates of Appendix Table C were collapsed to produce estimates of restraint use by fatally-injured infants and toddlers, shown in Table 10. It is estimated that in 1982 there were 48 young children killed in a child safety seat (7.8 percent of young children killed in passenger vehicles that year). In 1987, there were an estimated 135 young children killed in a safety seat (20.6 percent of young child occupants killed that year).

Table 10: Estimated Type of Restraint Used by Fatalities Categorized into Infants and Toddlers

		Estimated Fatality Counts				Estimated Percent Use		
Year	Age	None Used	Child Seat	Adult Belt	Total	Child Seat	Adult Belt	Total Use
1982	0	145	19	0	164	11.6	0.0	11.6
	1-4	407	29	13	449	6.5	2.9	9.4
	0-4	552	48	13	613	7.8	2.1	10.0
1983	0	130	26	1	157	16.6	0.6	17.2
	1-4	387	42	16	445	9.4	3.6	13.0
	0-4	517	68	17	602	11.3	2.8	14.1
1984	0	103	28	1	132	21.2	0.8	22.0
	1-4	325	55	25	405	13.6	6.2	19.8
	0-4	428	83	26	537	15.5	4.8	20.3
1985	0	94	34	2	130	26.2	1.5	27.7
	1-4	327	67	30	424	15.8	7.1	22.9
	0-4	421	101	32	554	18.2	5.8	24.0
1986	0	91	33	6	130	25.4	4.6	30.0
	1-4	347	67	55	469	14.3	11.7	26.0
	0-4	438	100	61	599	16.7	10.2	26.9
1987	0	113	39	6	158	24.7	3.8	28.5
	1-4	333	96	67	496	19.4	13.5	32.9
	0-4	446	135	73	654	20.6	11.2	31.8
1982	0	676	179	16	871	20.6	1.8	22.4
-87	1-4	2,126	356	206	2,688	13.2	7.7	20.9
	0-4	2,802	535	222	3,559	15.0	6.2	21.3

These estimates of young restrained children killed in passenger vehicles were combined with the restraint effectiveness estimates produced in the previous section, to form estimates of lives saved by restraints. The estimated effectiveness of adult belts in preventing toddler fatality was used as the estimate for infants; a separate infant estimate could not be derived from the few available cases of adult-belted infants.

Child restraint benefits were calculated as:

$$\text{Lives Saved} = \text{Fatalities} * \frac{\text{Restraint Effectiveness}}{1 - \text{Restraint Effectiveness}}.$$

The results are shown in Table 11.

Table 11: Estimated Young Children Saved by Restraints

	Infants			Toddlers			Infants + Toddlers		
	Adult Belt	Child Seat	Total Use	Adult Belt	Child Seat	Total Use	Adult Belt	Child Seat	Total Use
Estimated Restrained Fatalities									
1982	0	19	19	13	29	42	13	48	61
1983	1	26	27	16	42	58	17	68	85
1984	1	28	29	25	55	80	26	83	109
1985	2	34	36	30	67	97	32	101	133
1986	6	33	39	55	67	122	61	100	161
1987	6	39	45	67	96	163	73	135	208
1982-1987	16	179	195	206	356	562	222	535	757
Estimated Percent Fatality Reduction	0.36	0.69	-	0.36	0.47	-	-	-	-
Estimated Lives Saved									
1982	0	42	42	7	26	33	7	68	75
1983	1	58	59	9	37	46	10	95	105
1984	1	62	63	14	49	63	15	111	126
1985	1	76	77	17	59	76	18	135	153
1986	3	73	76	31	59	90	34	132	166
1987	3	87	90	38	85	123	41	172	213
1982-1987	9	398	407	116	315	431	125	713	838

This procedure produces an estimate that 213 young child occupants of passenger vehicles were saved by restraint use in 1987 -- 172 in child safety seats and 41 in adult belts. Between 1982 and 1987, child safety seats saved an estimated 713 lives. Adult belts saved an additional 125 lives, for a total of 838 young children saved by restraints in these six years.

Potential Lives Saved by Restraints

If all young children had been using a child safety seat, more lives could have been saved. Estimates of the number savable each year were calculated from total fatalities (Table 10), lives saved by restraints (Table 11), and effectiveness of restraints as used during these six years, as follows:

Infant Lives That Could Be Saved
= (Total Fatalities + Lives Saved) * 0.69, and

Toddler Lives That Could Be Saved
= (Total Fatalities + Lives Saved) * 0.47.

At these effectiveness levels, safety seats could have saved an average of 400 lives a year. The potential benefits depend on the number of children involved in accidents each year and the mix of infants (for whom child safety seats are very effective) and toddlers (for whom effectiveness has been lower, perhaps because of more frequent incorrect use). The estimates are shown in Table 12.

More young children are being saved each year because of increased child seat use in serious crashes. In 1982, about one-fifth of the lives that could be saved with 100 percent use of child restraints were saved. By 1987, close to one-half of the potential lives saved (given the actual mix of correct and incorrect use modes) were actually saved. The data are shown in Table 13.

Table 12: Estimates of Lives Savable by Child Seats as Used during 1982 through 1987

Year	Infants	Toddlers	Total
1982	142	227	369
1983	149	231	380
1984	135	220	355
1985	143	235	378
1986	142	263	405
1987	171	291	462
Total	882	1,466	2,348

Table 13: Young Children Saved by Restraints as a Percentage of Those Savable, with Restraints as Used during 1982 through 1987

Year	Infants	Toddlers	Total
1982	30 %	15 %	20 %
1983	40 %	20 %	28 %
1984	47 %	29 %	35 %
1985	54 %	32 %	40 %
1986	54 %	34 %	41 %
1987	53 %	42 %	46 %
Total	46 %	29 %	36 %

Discussion

These estimates of restraint effectiveness for young children depend on three assumptions. First, that restraint use was correctly reported for young children and their drivers in fatal accidents. Second, that the unknown data on restraint use and type were missing at random. And third, that driver fatalities in passenger vehicles with young child occupants were an adequate exposure measure for the risks of death to young children.

It is not possible to test these assumptions directly. However, it seems that unrestrained people reported as restrained (the issue of the first assumption) would be more common for adult belts (whether used by drivers or by children) than for child seats. The presence of a child seat, if not the child in the seat and the correctness of its use, is obvious. The device has been bought specially, presumably because the child's parent believes in either its value or its legal necessity. In contrast, adult belts are standard in all passenger vehicles. Their presence in the vehicle does not indicate a committment to their use.

Unknown restraint use data (the issue of the second assumption) frequently reflects the police accident report form used in a particular state. Some states do not routinely report restraint use (there is no restraint use data element on the police report) or do not routinely report restraint type used (the restraint use data element includes only codes for yes and no). In these states, restraint use or restraint type is reported to FARS only if the police officer described it in the narrative portion of the police report. These unknown data resemble the known data on the FARS file to the extent that restraint use in these states resembles restraint use in states with more, or more-detailed, restraint use coding.

The adequacy of driver fatalities as a measure of child fatality risk (the issue of the third assumption) is unclear. It is possible that child restraints prevent fatalities in crashes that pose little risk to the driver. If child restraints are most effective in low-severity crashes (for example, by preventing ejections of small people through open windows), then this estimation method underestimates the value of child restraints. Lives saved by child seats will not be reported to FARS unless someone else in the accident dies. If this is the case, the estimates provided here may be better described as the effectiveness of child restraints in high-severity accidents.

As a check of the process as a whole, the data of Table 1 were used to calculate car driver seat belt effectiveness (with child fatalities as the standardizing factor). The results are shown in Table 14.

Table 14: Effectiveness of Seat Belts for Car Drivers
(Percentage Fatality Reduction)

	Child's Seat Position in Car			
Control Used	Overall	Front	Rear	Average
Unrestrained child	52	38	57	48
Adult belted child	51	56	45	51
Child seated child	37	60	26	43
Average	47	51	43	47

This method produced an estimate that driver seat belts were 47 percent effective in preventing driver fatality (on average, across the three categories of child restraint status). Individual estimates varied from 43 percent (for drivers with children in safety seats) to 48 percent (for drivers of unrestrained children) to 51 percent (for drivers with children in adult belts). These are within the agency's estimated range (40 to 50 percent) of lap and shoulder belt effectiveness.

There is a problem in reconciling the child restraint benefits (realized and potential) estimated here with the prevalent child safety seat use reported in some observation surveys. It is estimated that 213 children were saved by restraints in 1987, but that 462 could have been saved if all young children had used child safety seats. This implies that many children were unrestrained in accidents. Table 15 shows (based on the detailed data in Appendix Tables D and E) that it is estimated that only a half of all young children who survived a fatal traffic accident were using any kind of restraint in 1987.

Table 15: Estimated Type of Restraint Used by Survivors of Fatal Accidents Categorized into Infants and Toddlers

		Estimated Fatality Counts				Estimated Percent Use		
Year	Age	None Used	Child Seat	Adult Belt	Total	Child Seat	Adult Belt	Total Use
1982	0	173	55	5	233	23.6	2.1	25.8
	1-4	1,267	95	66	1,428	6.7	4.6	11.3
	0-4	1,440	150	71	1,661	9.0	4.3	13.3
1983	0	154	86	4	244	35.2	1.6	36.9
	1-4	1,155	241	83	1,479	16.3	5.6	21.9
	0-4	1,309	327	87	1,723	19.0	5.0	24.0
1984	0	130	119	1	250	47.6	0.4	48.0
	1-4	1,007	315	135	1,457	21.6	9.3	30.9
	0-4	1,137	434	136	1,707	25.4	8.0	33.4
1985	0	97	135	8	240	56.3	3.3	59.6
	1-4	967	393	187	1,547	25.4	12.1	37.5
	0-4	1,064	528	195	1,787	29.5	10.9	40.5
1986	0	127	133	8	268	49.6	3.0	52.6
	1-4	935	430	318	1,683	25.5	18.9	44.4
	0-4	1,062	563	326	1,951	28.9	16.7	45.6
1987	0	125	156	6	287	54.4	2.1	56.4
	1-4	944	496	412	1,852	26.8	22.2	49.0
	0-4	1,069	652	418	2,139	30.5	19.5	50.0
1982	0	806	684	32	1,522	44.9	2.1	47.0
-87	1-4	6,275	1,970	1,201	9,446	20.9	12.7	33.6
	0-4	7,081	2,654	1,233	10,968	24.2	11.2	35.4

In contrast, observations taken by the agency's 19-Cities Survey (managed by the Office of Driver and Pedestrian Research) indicate that restraint use near the shopping centers included in the survey was much higher. By 1987, the survey was reporting that four-fifths of young children (both infants and toddlers) were restrained.

Differences between infants and toddlers have disappeared in the survey data. In 1981, twice as many infants as toddlers were using child restraints: 40.4 percent of those under one year old, compared to only 19.4 percent of those aged one through four years old. By 1987, approximately four-fifths of each age group were observed using child restraints: 77.5 percent of those under one year old and 80.1 percent of those aged one through four years. The uniformly high child restraint use rates reported from observation surveys appear to conflict with the lower use rates reported for children (especially toddlers) in fatal accidents. The data for infants and for toddlers are shown in Tables 16 and 17, respectively.

Table 16: Changes in Infant Use of Child Restraints

		FARS Fatal Accidents	
Year	19-Cities	Survivors	Fatalities
1982	n/a	23.6	11.6
1983	60.4	35.2	16.6
1984	66.4	47.6	21.2
1985	66.4	56.3	26.2
1986	70.0	49.6	25.4
1987	77.5	54.4	24.7

Table 17: Changes in Toddler Use of Child Restraints

		FARS Fatal Accidents	
Year	19-Cities	Survivors	Fatalities
1982	n/a	6.7	6.5
1983	37.8	16.3	9.4
1984	44.3	21.6	13.6
1985	52.6	25.4	15.8
1986	72.3	25.5	14.3
1987	80.1	26.8	19.4

Table 18: Changes in Toddler Use of Adult Restraints

		FARS Fatal Accidents	
Year	19-Cities	Survivors	Fatalities
1982	n/a	4.6	2.9
1983	5.3	5.6	3.6
1984	7.4	9.3	6.2
1985	9.3	12.1	7.1
1986	5.9	18.9	11.7
1987	4.7	22.2	13.5

Large (and increasing) numbers of young children in fatal accidents were reported to have been using an adult belt (Table 18). By 1987, 22.2 percent of toddlers who survived a fatal accident were reported to have been using an adult belt. The accuracy of these data is not known. But even among toddler fatalities (whose restraint reporting is believed to be more accurate), adult belt use was reported as 13.5 percent in 1987. In contrast, even in recent years few toddlers (4.7 percent in 1987) were observed in adult belts in traffic near shopping centers.

Reported child restraint use in fatal accidents declined rapidly with the age of the child. While high levels of restraint use were reported for those under two years old, older children were less frequently reported to have been restrained in the accident. Fewer than 10 percent of four year olds were reported to have been using a child restraint in a fatal accident (whether the child survived or was killed). The 1987 data are shown in Table 19. The observation survey does not report the individual age of a toddler.

Table 19: Child Restraint Use in 1987, by Child Age

		FARS Fatal Accidents	
Age	19-Cities	Survivors	Fatalities
0	77.5	54.4	24.7
1-4	80.1	26.8	19.4
0	77.5	54.4	24.7
1	n/a	50.1	32.6
2	n/a	30.8	24.2
3	n/a	21.7	13.5
4	n/a	6.9	5.3

The low child restraint use reported for three and four year olds in fatal accidents (compared to the high use reported for younger children) suggests a possible reporting problem. It may be difficult to estimate the age of older toddlers under the observation conditions. A child in a child restraint may more obviously be a toddler than the same child riding unrestrained or in an adult belt. A particular child may look four years old when seated in a child restraint, but look five years old when using an adult belt. However, traffic observers used the same protocol in 1987 as in 1981, and many observers who collected the earlier data also collected the more recent data.

Another possibility is that the children observed by the 19-Cities Survey are not completely representative of children involved in serious accidents. This may be for either of at least two reasons. First, children in the areas surveyed may not adequately represent young children in traffic in all areas of the country. And second, young children in traffic may not adequately represent young children who become involved in serious accidents. These two possibilities are discussed further below.

First, the 19-Cities Survey of young children is based near shopping centers to increase the numbers observed. The survey may tend to include people who can afford to buy child restraints and to exclude people who feel they can only afford to put their children in the available adult seat belts. People for whom child restraints are very expensive may tend to shop elsewhere. The result would be an overestimate of child restraint use in traffic. The cost of the child restraint may be a particular problem for toddlers because they are less accessible to maternity-based information and loaner programs than they were as newborns.

This possibility is partially supported by child restraint use reported by individual states. Some states (such as California and North Carolina) report high rates of child restraint use, comparable to the rates observed by the 19-Cities Survey. However, many other states report child restraint use rates of less than 40 percent.

Second, it has been observed that adult restraint use in accidents is lower than restraint use observed in traffic. It is likely that child restraint use is also lower in serious accidents than it is in general traffic. People who put young children in child restraints may tend to get into fewer and less-serious accidents than people who drive with unrestrained children. The result would be optimistic estimates of child restraint use in accidents from the observation data. The unrestrained children in the observation surveys may be at greater risk of becoming involved in a serious accident than are the restrained children.

This possibility is partially supported by accident data. Restraint use by children who survived a fatal accident in 1987 was slightly higher in urban areas and during the day than in rural areas and at night. These conditions of higher child restraint use correspond to 19-Cities Survey observation conditions.

In summary, it appears clear than restraint use in accidents is much lower than reported in observation surveys, particularly in the agency's 19-Cities Survey. While child restraint use has increased over the last five years, children in serious accidents are still all too often unprotected. This situation is similar to that of the high risk adult population, who are less likely to use safety belts than is the general population. Further fatality reductions will require greater use of child safety seats where they are most needed -- in serious crashes.

Appendix Table A: Definitions

Category	FARS Data Element Coding
Vehicle Type:	
Passenger Vehicle	Body Types 1-12, 40-41, 48-51, 53-56, 58-58, 67-69
Passenger Car	Body Types 1-11, 67
Lap and Shoulder Belt Equipped	Model Years 74-88
Driver	Seat Position 11 and Age 5-99
Driver Restraint Use:	
Unrestrained	Manual Restraint 0 and Automatic Restraint not 1 and Automatic Restraint not 3
Restrained	Manual Restraint 1-8 or Automatic Restraint 1 or Automatic Restraint 3
Child Age:	
Young Child	Age 0-4
Infant	Age 0
Toddler	Age 1-4
Child Restraint Use:	
Unrestrained	Manual Restraint 0 and Automatic Restraint not 1 and Automatic Restraint not 3
Adult Belted	(Manual Restraint 1-7 or Automatic Restraint 1 or Automatic Restraint 3) and Manual Restraint not 4
Child Safety Seated	Manual Restraint 4
Child Seat Position:	
Front Seat	Seat Positions 12-19
Rear Seat	Seat Positions 21-49
Occupant Outcome:	
Killed	Injury Severity 4
Survived	Injury Severity not 4

Appendix Table B:
Fatalities by Police-Reported Restraint Use

		Type Restraint Used					
Year	Age	None Used	Child Seat	Adult Belt	Unknown Type	Unknown if Used	Total
1982	0	124	15	0	1	24	164
	1	80	13	2	2	13	110
	2	104	6	5	1	14	130
	3	92	4	1	1	13	111
	4	82	0	3	0	13	98
1983	0	117	23	1	0	16	157
	1	95	17	3	3	4	122
	2	98	10	2	1	8	119
	3	87	6	7	2	12	114
	4	77	2	1	0	10	90
1984	0	96	25	1	1	9	132
	1	48	22	1	1	8	80
	2	75	11	10	2	13	111
	3	84	5	3	1	15	108
	4	79	6	6	2	12	105
1985	0	85	29	2	2	12	130
	1	63	23	4	0	3	93
	2	83	23	13	2	7	128
	3	84	8	1	2	9	104
	4	71	5	8	1	13	98
1986	0	83	30	5	0	12	130
	1	84	25	3	2	9	123
	2	81	18	14	1	10	124
	3	81	8	10	3	9	111
	4	72	5	14	9	11	111
1987	0	109	35	5	3	6	158
	1	75	36	7	5	10	133
	2	69	25	17	4	9	124
	3	89	15	12	1	9	126
	4	75	5	22	2	10	114
1982 -87	0	614	157	14	7	79	871
	1	445	136	20	13	47	661
	2	510	93	61	11	61	736
	3	517	46	34	10	67	674
	4	456	23	54	14	69	616

All data as reported on FARS

Appendix Table C:
Fatalities by Estimated Restraint Use

		Estimated Use				Estimated Percent Use		
Year	Age	None Used	Child Seat	Adult Belt	Total	Child Seat	Adult Belt	Total Use
1982	0	145	19	0	164	11.6	0.0	11.6
	1	91	17	3	111	15.3	2.7	18.0
	2	117	7	6	130	5.4	4.6	10.0
	3	104	5	1	110	4.5	0.9	5.5
	4	95	0	3	98	0.0	3.1	3.1
1983	0	130	26	1	157	16.6	0.6	17.2
	1	98	20	4	122	16.4	3.3	19.7
	2	105	12	2	119	10.1	1.7	11.8
	3	97	8	9	114	7.0	7.9	14.9
	4	87	2	1	90	2.2	1.1	3.3
1984	0	103	28	1	132	21.2	0.8	22.0
	1	53	26	1	80	32.5	1.3	33.8
	2	85	14	12	111	12.6	10.8	23.4
	3	98	7	4	109	6.4	3.7	10.1
	4	89	8	8	105	7.6	7.6	15.2
1985	0	94	34	2	130	26.2	1.5	27.7
	1	65	24	4	93	25.8	4.3	30.1
	2	88	26	15	129	20.2	11.6	31.8
	3	92	11	1	104	10.6	1.0	11.5
	4	82	6	10	98	6.1	10.2	16.3
1986	0	91	33	6	130	25.4	4.6	30.0
	1	91	29	3	123	23.6	2.4	26.0
	2	88	20	16	124	16.1	12.9	29.0
	3	88	10	13	111	9.0	11.7	20.7
	4	80	8	23	111	7.2	20.7	27.9
1987	0	113	39	6	158	24.7	3.8	28.5
	1	81	43	8	132	32.6	6.1	38.6
	2	74	30	20	124	24.2	16.1	40.3
	3	96	17	13	126	13.5	10.3	23.8
	4	82	6	26	114	5.3	22.8	28.1
1982	0	676	179	16	871	20.6	1.8	22.4
-87	1	479	159	23	661	24.1	3.5	27.5
	2	557	109	71	737	14.8	9.6	24.4
	3	575	58	41	674	8.6	6.1	14.7
	4	515	30	71	616	4.9	11.5	16.4

Data estimated by prorating "unknown restraint type" across known types and "unknown whether or not restrained" across other restraint categories within accident year and individual year of occupant age

Appendix Table D:
Survivors of Fatal Accidents, by Police-Reported Restraint Use

		Type Restraint Used					
Year	Age	None Used	Child Seat	Adult Belt	Unknown Type	Unknown if Used	Total
1982	0	144	45	4	1	39	233
	1	221	37	17	2	59	336
	2	287	25	9	1	74	396
	3	272	5	10	2	73	362
	4	242	7	16	0	69	334
1983	0	130	70	3	3	38	244
	1	134	83	10	4	66	297
	2	262	56	10	4	64	396
	3	263	32	16	2	72	385
	4	287	14	28	3	69	401
1984	0	112	95	1	8	34	250
	1	131	112	7	8	32	290
	2	232	81	28	10	64	415
	3	229	44	36	8	53	370
	4	276	16	36	4	52	384
1985	0	87	116	7	6	24	240
	1	141	139	10	16	33	339
	2	241	81	36	11	51	420
	3	239	65	54	10	46	414
	4	229	28	43	20	54	374
1986	0	114	117	7	2	28	268
	1	138	160	17	15	33	363
	2	212	105	56	18	57	448
	3	225	60	82	14	65	446
	4	238	21	90	18	60	427
1987	0	116	135	5	10	20	286
	1	158	183	32	11	29	413
	2	245	125	62	23	42	497
	3	226	77	89	33	55	480
	4	229	22	122	49	41	463
1982	0	703	578	27	30	183	1,521
-87	1	923	714	93	56	252	2,038
	2	1,479	473	201	67	352	2,572
	3	1,454	283	287	69	364	2,457
	4	1,501	108	335	94	345	2,383

All data as reported on FARS

Appendix Table E:
Survivors of Fatal Accidents, by Estimated Restraint Use

		Estimated Use				Estimated Percent Use		
Year	Age	None Used	Child Seat	Adult Belt	Total	Child Seat	Adult Belt	Total Use
1982	0	173	55	5	233	23.6	2.1	25.8
	1	268	47	21	336	14.0	6.3	20.2
	2	353	32	11	396	8.1	2.8	10.9
	3	341	7	14	362	1.9	3.9	5.8
	4	305	9	20	334	2.7	6.0	8.7
1983	0	154	86	4	244	35.2	1.6	36.9
	1	172	111	13	296	37.5	4.4	41.9
	2	313	71	13	397	17.9	3.3	21.2
	3	323	41	21	385	10.6	5.5	16.1
	4	347	18	36	401	4.5	9.0	13.5
1984	0	130	119	1	250	47.6	0.4	48.0
	1	147	134	8	289	46.4	2.8	49.1
	2	274	105	36	415	25.3	8.7	34.0
	3	267	56	46	369	15.2	12.5	27.6
	4	319	20	45	384	5.2	11.7	16.9
1985	0	97	135	8	240	56.3	3.3	59.6
	1	156	171	12	339	50.4	3.5	54.0
	2	274	101	45	420	24.0	10.7	34.8
	3	269	79	66	414	19.1	15.9	35.0
	4	268	42	64	374	11.2	17.1	28.3
1986	0	127	133	8	268	49.6	3.0	52.6
	1	152	191	20	363	52.6	5.5	58.1
	2	243	134	71	448	29.9	15.8	45.8
	3	263	77	105	445	17.3	23.6	40.9
	4	277	28	122	427	6.6	28.6	35.1
1987	0	125	156	6	287	54.4	2.1	56.4
	1	170	207	36	413	50.1	8.7	58.8
	2	268	153	76	497	30.8	15.3	46.1
	3	255	104	121	480	21.7	25.2	46.9
	4	251	32	179	462	6.9	38.7	45.7
1982	0	806	684	32	1,522	44.9	2.1	47.0
-87	1	1,065	861	110	2,036	42.3	5.4	47.7
	2	1,725	596	252	2,573	23.2	9.8	33.0
	3	1,718	364	373	2,455	14.8	15.2	30.0
	4	1,767	149	466	2,382	6.3	19.6	25.8

Data estimated by prorating "unknown restraint type" across known types and "unknown whether or not restrained" across other restraint categories within accident year and individual year of occupant age

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