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The Effectiveness of Motorcycle Helmets in Preventing Fatalities

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16. Abstract

Based on data from 1982 through 1987 FARS, motorcycle helmets are estimated to be 29% effective in preventing fatalities. A matched-pairs technique was used to produce the effectiveness estimates of motorcycle helmets by comparing the probability of fatalities of drivers and passengers under helmeted and unhelmeted conditions. The general methodology employed in this analysis has been utilized in numerous reports to estimate the effectiveness of various restraint systems, for example, Evans and Frick (1988) and Partyka (1988).

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THE EFFECTIVENESS OF MOTORCYCLE HELMET USE IN REDUCING FATALITIES

Donna C. Wilson

SUMMARY

Based on data from NHTSA's Fatal Accident Reporting System (FARS), helmets are estimated to be 27% effective in preventing driver fatalities and 30% effective in preventing passenger fatalities in crashes in which both a motorcycle driver and a passenger were involved. On average, helmets are estimated to be 29% effective in reducing fatalities in motorcycle crashes, which is an average of driver and passenger effectiveness. For the years 1982 through 1987, it is estimated that 4,645 motorcyclists' lives were saved as a result of helmet usage. In total, if all motorcylists had worn helmets, both drivers and passengers, an estimated 9,030 lives could have been saved over this six year period.

BACKGROUND AND METHODOLOGY

To calculate helmet effectiveness and estimate the number of lives saved by helmet usage, a matched-pairs procedure was employed. In this procedure, the ratio of driver fatalities to passenger fatalities, and passenger fatalities to driver fatalities, are calculated for each of four possible helmet use groups (i.e. both driver and passenger helmeted; both driver and passenger unhelmeted; driver helmeted and passenger unhelmeted; and driver unhelmeted and passenger helmeted). These ratios were calculated for each year individually (1982 through 1987) and for all years combined. Collectively, they provide the basic data used to assess the effectiveness of helmets in preventing fatalities.

This same general procedure has been used previously by Evans (1984)[1], Evans and Frick (1988)[2], Kahane (1986)[3] and Partyka (1988)[4,5] to estimate the effectiveness of various restraint systems. Evans and Frick also used the procedure to assess the effectiveness of motorcycle helmets in reducing fatalities. A complete explanation of the analytic technique can be found in their paper. A brief example of the technique is provided below:

> In total, there were 1,610 driver fatalities and 1,427 passenger fatalities in crashes involving both an unhelmeted driver and an unhelmeted passenger. The fatality ratio for these crashes is:
>
> $$1{,}610/1{,}427 = 1.128$$
>
> Thus, about 11 motorcycle drivers are killed for every 10 passengers killed in crashes in which both are unhelmeted.
>
> There were also 168 driver fatalities and 197 passenger fatalities in crashes involving a helmeted driver and an unhelmeted passenger. The fatality ratio for these crashes is:
>
> $$168/197 = 0.853$$

In other words, about 9 drivers are killed for every 10 passengers killed in crashes in which the driver was helmeted, but the passenger was not.

Assuming that helmet use of the driver accounts for the reduction in fatality ratios (1.128 to 0.853), an estimate of the effectiveness of helmets is calculated as:

$$\frac{(1.128-0.853)}{1.128} * 100 = 24\%$$

By interpreting these odds as fatality rates, helmets are estimated to be 24% effective in preventing driver fatalities in motorcycle accidents when examining total fatalities and helmet usage from 1982 through 1987. In comparison, an estimate of the effectiveness of helmet use in preventing passenger fatalities can be obtained by comparing the fatality ratio of unhelmeted passengers to unhelmeted drivers (0.886) to the fatality ratio of the helmeted passengers to unhelmeted drivers (0.590) (using the former as the base). This produces an effectiveness estimate of 33%.

The matched-pairs method used in this analysis assumes that the only factor causing the reduction in fatalities in these fatal crashes is helmet usage. Another possible shortcoming of the technique is its limitation to motorcycle crashes involving both a driver and a passenger on the same vehicle in which one or both were killed. These fatal crashes represent only a small portion of total motorcycle fatalities.

RESULTS

The number of driver and passenger fatalities in motorcycle crashes and the corresponding fatality ratios for each helmet use group is shown in Table 1 for each year (1982 through 1987), as well as the total for all years. As can be seen, the number of fatalities in each of these years is not distributed equally among the four groups of occupants. The greatest number of deaths occur in crashes where neither the driver nor the passenger are wearing a helmet. The next greatest number occurs when both the driver and the passenger are helmeted. In examining the data, it is evident there is a consistency in helmet usage patterns between the driver and the passenger, such that when the driver is helmeted so tends to be the passenger. This is also true when the driver is unhelmeted. Thus, on the average, approximately 58% of the deaths occur when there is no helmet usage; 32% of the deaths occur when both driver and passenger are helmeted; 7% when the driver is helmeted and the passenger is unhelmeted and 4% of the deaths occur when the driver is unhelmeted and the passenger is helmeted.

The estimates of effectiveness derived from this data may be affected by the small number of deaths in these latter two categories. The variety of

estimates produced by a single year's data indicates the sensitivity of the estimates to the sample size. However, even though the results within the analysis reflect a fluctuation from year to year due to these differences, overall averages from year to year show that there is reliability in the data since a number of the years produce an average of or near 29%.

TABLE 1
DRIVER/PASSENGER FATALITIES IN MOTORCYCLE CRASH INVOLVEMENTS*
BY HELMET USE STATUS
1982-1987

	Helmet Used		Number of Deaths		Drivers/	Passengers/
	Driver	Passenger	Driver	Passenger	Passengers	Drivers
1982	No	No	297	237	1.253	0.798
	No	Yes	19	15	1.267	0.789
	Yes	No	37	44	0.841	1.189
	Yes	Yes	183	155	1.181	0.847
1983	No	No	263	224	1.174	0.852
	No	Yes	25	12	2.083	0.480
	Yes	No	24	31	0.774	1.292
	Yes	Yes	160	131	1.221	0.819
1984	No	No	243	232	1.047	0.955
	No	Yes	21	13	1.615	0.619
	Yes	No	30	36	0.833	1.200
	Yes	Yes	147	123	1.195	0.837
1985	No	No	265	236	1.123	0.891
	No	Yes	17	9	1.889	0.529
	Yes	No	31	36	0.861	1.161
	Yes	Yes	144	143	1.007	0.993
1986	No	No	263	247	1.065	0.939
	No	Yes	20	12	1.667	0.600
	Yes	No	26	31	0.839	1.192
	Yes	Yes	158	125	1.264	0.791
1987	No	No	279	251	1.112	0.900
	No	Yes	20	11	1.818	0.550
	Yes	No	20	19	1.053	0.950
	Yes	Yes	125	102	1.225	0.816
Total	No	No	1,610	1,427	1.128	0.886
	No	Yes	122	72	1.694	0.590
	Yes	No	168	197	0.853	1.173
	Yes	Yes	917	779	1.177	0.850

*Crash must involve both a driver and a passenger on the same motorcycle.

Presented in Table 2 are the calculated effectiveness rates of both driver and passenger for each year, and the averages for all years, using the data presented in Table 1.

TABLE 2
HELMET USE EFFECTIVENESS (PERCENT)
FOR MOTORCYCLE DRIVERS AND PASSENGERS
1982-1987

Effectiveness for	Control	1982	1983	1984	1985	1986	1987	Total
Driver:	Unhelmeted passenger	33	34	20	23	21	05	24
	Helmeted passenger	07	41	26	47	24	33	31
Passenger:	Unhelmeted driver	01	44	35	41	36	39	33
	Helmeted driver	29	37	30	14	34	14	28
Driver:	Average	20	38	23	35	23	19	27
Passenger:	Average	15	40	33	28	35	26	30
Both:	Unhelmeted control	17	39	28	32	29	22	29
	Helmeted control	18	39	28	31	29	23	29
Both:	Average	17	39	28	31	29	23	29

As can be seen, driver effectiveness estimates range from 5% to 47%, while passenger estimates range from a low of 1% to a high of 44%. Much of this variation is likely due to the small number of occupants in those groups where only one occupant is helmeted. On average, the estimated effectiveness of helmets in preventing driver fatalities for all years considered in this analysis is 27%. The corresponding estimate for passengers is 30%. All averages for drivers and passengers, as well as, unhelmeted and helmeted controls were computed by using straight averages.

The number of crashes involving small children was also examined to ascertain the degree to which helmet effectiveness estimates were influenced by the presence of small children. There were only 31 small children under the age of six involved in these crashes. Analyses that excluded young children indicated that the helmet effectiveness estimates are not sensitive to the inclusion of children under six or children under thirteen.

ESTIMATED LIVES SAVED BY HELMET USE

Assuming that the estimated effectiveness rates are applicable to all motorcycle fatalities, estimates of the number of lives saved and the number of potential lives that could have been saved can be calculated. A complete explanation of the methodology employed in this section can be found in Partyka (1988). Listed in Table 3 are motorcycle fatalities by helmet use for the years 1982 through 1987. Unknown helmet use has been prorated between known use categories.

TABLE 3
MOTORCYCLE FATALITIES BY HELMET USE STATUS
1982-1987

	FATALITIES		
Year	Helmeted	Unhelmeted	Total
1982	2,002	2,451	4,453
1983	1,805	2,460	4,265
1984	2,003	2,605	4,608
1985	1,933	2,631	4,564
1986	1,989	2,577	4,566
1987	1,640	2,391	4,031
Total	11,372	15,115	26,487

By applying the overall average effectiveness rate of 29% to the helmeted fatality counts, the number of lives saved by helmet usage can be estimated. The formula is as follows:

$$\text{Lives Saved} = \text{Helmeted Fatalities} * \frac{\text{Helmet Use Effectiveness}}{1 - \text{Helmet Use Effectiveness}}$$

For example, there were a total of 2,002 helmeted fatalities in 1982. The above formula is applied as follows:

$$2{,}002 * \frac{.29}{1 - .29} = 818$$

Thus it is estimated that 818 lives were saved by helmet usage in 1982.

The results for 1982-1987 are shown in Table 4.

TABLE 4
ESTIMATED LIVES SAVED BY HELMET USAGE
1982-1987

Year	Estimated Lives Saved
1982	818
1983	737
1984	818
1985	790
1986	812
1987	670
Total	4,645

This procedure estimates that during 1982 through 1987, helmet usage saved 4,645 lives in fatal motorcycle crashes.

POSSIBLE LIVES THAT COULD HAVE BEEN SAVED BY HELMET USE

More lives could have been saved if all motorcyclists had been wearing helmets. Estimates of the number savable are calculated each year from total fatalities (Table 3), the number of lives saved (Table 4) and overall helmet use effectiveness (Table 2) in the following formula:

Lives That Could Have Been Saved =

(Total Fatalities + Lives Saved) * Helmet Use Effectiveness

The following example shows the number of lives which could have been saved in 1982 if all motorcyclists had worn helmets. There were a total of 4,453 fatalities in 1982 and an estimated 818 lives that were saved by helmet usage. Using the same 29% effectiveness rate, the calculation is:

(4,453 + 818) * .29 = 1,529

Thus, if the unhelmeted fatalities had also been wearing helmets, it is estimated that a total of 1,529 lives could have been saved. Table 5 shows lives of all motorcyclists that could have been saved from 1982 to 1987.

TABLE 5
ESTIMATES OF LIVES SAVABLE BY HELMET USAGE
1982-1987

Year	Potential Lives
1982	1,529
1983	1,451
1984	1,574
1985	1,553
1986	1,560
1987	1,363
Total	9,030

Thus, an estimated 9,030 lives could have been saved as a result of helmet use from 1982 to 1987.

In summary, although the effectiveness of helmet use depends on many factors (e.g. driver age, speed, crash direction) and the matched-pairs technique has limitations in assessing effectiveness, motorcycle helmets are estimated to be 29% effective in preventing motorcycle rider fatalities. Further, although motorcycle helmets saved an estimated 670 lives in 1987, they could have prevented an additional 693 fatalities if 100% of motorcycle riders wore helmets.

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