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Helmet Use, Helmet Use Laws, and Motorcyclist Fatalities

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In 1979, 4,907 motorcyclists died in crashes.* The fatality rate per mile of travel for motorcyclists exceeds the fatality rate for automobile occupants by more than seven-fold.[1] Fatalities per 10,000 motorcycles increased about 50 per cent between 1975 and 1979.[2] In spite of these facts, Perkins has only the following to say in "Perspective on the Public Good" about how the carnage should be reduced: "Prevention through rider and driver education may be considerably more cost-effective and save many more lives than mandatory helmet laws."[3] Perkins cites no evidence, however, that driver education in fact reduces fatalities.

In contrast to the unproven effects of education, the effectiveness of helmets in preventing fatal head injuries, and of helmet use laws in producing near universal compliance among motorcyclists, is supported by a vast quantity of painstakingly documented research.

According to Perkins, "vast amounts of information have been generated and reviewed" both in favor of and against helmet use laws. However, in making his case against these laws, Perkins dismisses all evidence supporting mandatory helmet use with a single statement: "The American Motorcycle Association[4] and the Motorcycle Safety Foundation[5] claim much of this evidence to be of questionable validity." Perkins presents no *scientific* evidence to show that helmet use laws are ineffective and the cited documents contain no evidence of this kind.

To reduce the impact of the case in favor of helmet use law effectiveness, Perkins also questions the methodology and by implication the findings by Watson, *et al,*[1] who showed that the repeal of these laws typically has been followed by a 38 per cent increase in motorcyclist fatalities. Perkins specifically queries: 1) the use of Michigan and Illinois seven times; 2) the fact that South Carolina and Tennessee were not used; 3) the choice of Arkansas, Florida and Georgia as a comparison group for New Mexico; 4) the use of absolute numbers of fatalities as opposed to fatality rates.** To investigate Perkins' remarks, a number of additional calculations were made.

As Watson, *et al,* stated, "there is some arbitrariness" in the choice of comparison states and the paper contained a method for checking the analysis. However, the conclusions of the original analysis are unchanged by any of the changes suggested by Perkins. Thus, the inclusion of South Carolina and Tennessee and a number of other reasonable changes in the matching of repeal and comparison states did not change the basic conclusions, although the per cent changes for individual repeal states changed—some up, some down. But the summary for all states never fell below 38 per cent. Thus, Perkins' specific criticisms are easily refuted, and Perkins' question as to whether or not the findings can be cited can clearly be answered yes.

Of course, we absolutely agree with Perkins that the efficacy of laws and regulations should be assessed. Indeed over 100 years ago Florence Nightingale tried very hard to establish a University Department of Statistics for this very reason.[6]

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Editor's Note: See also related articles this issue, pp. 294 and 295.

*Determined from the Fatal Accident Reporting System (FARS), National Highway Traffic Safety Administration.

**The meaning of Perkins' point (4) escapes us—numbers and percentages were used.

The present analysis will show that, contrary to Perkins' statements, the conclusion of Watson, *et al,*[1] accurately describes the consequences of repealing helmet use laws. The accuracy of the latter study will be demonstrated by comparing and reconciling three sets of related but independently obtained estimates dealing with different aspects of the helmet use problem. Moreover, the current argument requires no statistical subtleties at all.

Three questions have important bearing on the helmet and helmet use law effectiveness issue:

1. Are helmets effective in reducing fatal and serious head injuries?
2. Are helmet use laws effective in increasing helmet use?
3. Are helmet use laws effective in reducing fatal and serious head injuries?

Helmets and Fatal Head Injuries

According to Perkins, "If the overriding question is how to best reduce motorcycle fatalities, then . . . we might profitably ask about the effects of wearing a helmet, *given involvement in an accident.*" Table 1 presents seven separate data sets from which the protective effect of helmets in preventing fatal head injuries can be estimated. If helmeted and non-helmeted riders have similar crashes, the totals in Table 1 suggest that when helmets are not worn head injury deaths are twice (202 compared to 103) as frequent as deaths due to other causes. Whereas, when helmets are worn these two causes of death are equally likely (200 compared to 212). The summary percentage, 38 per cent, in Watson, *et al,* may be written schematically as:

$$100\left[\frac{\text{(observed) no-law deaths} - \text{(estimated) law deaths}}{\text{(estimated) law deaths}}\right]$$

To get a corresponding percentage from Table 1 we may argue that had helmets been worn only about 100 of the 202 deaths would have occurred; i.e., the estimated total number of deaths with helmets would have been approximately 200 rather than the observed approximate figure of 300. This gives an increase of 50 per cent in the fatalities from not wearing helmets in fatal accidents.

It is assumed here that the other injuries were not so serious that they would have led to death had not the head injury caused death first. Looking at the entries in Table 1, the most striking feature is the near equality, in each state, of "Head" and "Other" injuries among helmeted riders. The figures for non-helmeted riders are much more variable. The anomalous state is Minnesota where also the head injury classification seems broadest.

This suggests that we try to argue from the unhelmeted to the helmeted data. Before we essentially said that if all riders had worn helmets the Table would have been not as follows:

	Head injury	Other
Helmet used	202	103
Helmet not used	200	212

TABLE 1—Classification of Fatally Injured Riders by Cause of Death and Helmet Use

	Helmet Used	Cause of Death: Head Injury	Cause of Death: Other
New Jersey[a]	No	69	26
	Yes	157	167
Minnesota[b]	No	64	62
	Yes	21	25
North Dakota[c]	No	17	1
	Yes	1	2
South Dakota[d]	No	11	2
	Yes	8	6
Oklahoma[e]	No	22	5
	Yes	5	5
Colorado[f]	No	19	7
	Yes	8	7
All Combined	No	202	103
	Yes	200	212

[a]Data from Table V-10 in (2). Helmet use law has been in force in New Jersey since 1/1/68. Use of helmets was imputed to all riders after the law became effective and to none prior to 1/1/68.

[b]Data from Table V-9 in (2). "Head Injury" combines Head Injury, Head and Neck Injury and Multiple Injuries with Head Injury. "Other" refers to Multiple Injuries and Other Injury.

[c]Data from Table V-12 in (2). "Head Injury" combines Head or Neck Injury "Other" refers to Multiple Injuries or Crushing.

[d]Data from Table 7 in (7). Cause of death determined from location of most severe injury.

[e]Data from Table 45 in (8). Cause of death determined from location of most severe fatal injury.

[f]Data from Table G-1 in (7). Cases counted include all riders involved in fatal accidents. Cause of death determined from location of most severe injury.

but instead:

	Head injury	Other
Helmet used	202−x	103
Helmet not used	200	212

where (202−x)/103 = 200/212 so 202−x = 97, or x = 105. The expected number of unhelmeted deaths, had helmets been worn is 97 + 103 = 200 instead of 305—a decrease of ((305 − 200)/305)100 = 34 per cent. Similarly, had no riders worn helmets, the Table would be as follows:

	Head injury	Other
Helmet used	202	103
Helmet not used	200+y	212

where 202/103 = (200+y)/212. We find 200+y = 415 so that y = 215, so the per cent increase for deaths among helmeted riders from not wearing their helmets is (215/412)x100 = 52 per cent. Or we might say that the percentage of lives saved from using helmets is

$$\frac{\text{Estimated-Actual}}{\text{Actual}}\,100 = \frac{215}{412}\,100 = 52\%,$$

the same figure because these two percentages describe the same increase.

Helmet Use Laws and Helmet Use

A total of 17 helmet use surveys were conducted in 13 states during 1975-1978.[1] In the five survey states where these laws applied to all motorcyclists, helmet use rates were found to be over 98 per cent. In the absence of universal helmet use laws, rates varied between 25 and 61 per cent in the nine*** states surveyed; 48 per cent was the average use rate.

Helmet Use Laws and Fatalities

Figure 1 displays the variation in fatalities per 10,000 motorcycles between 1960 and 1980.[2] Adoption of 40 helmet use laws between 1966 and 1969 coincided with a drop in the rate of fatalities per 10,000 motorcycles from 12.7 to 8.1, a 36 per cent drop in the fatality rate. Subsequently, the repeal of 27 state helmet use laws between 1976 and 1979 coincided with a rise in the fatality rate from 6.7 to 9.7, a 31 per cent increase.

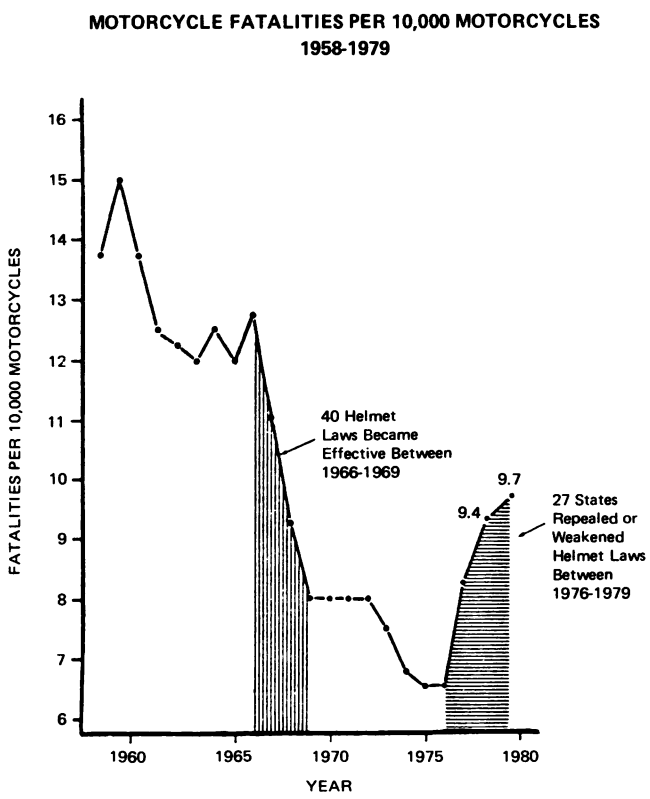
To assess the role of helmet use laws as a factor in reducing motorcyclist fatalities, Robertson compared fatality rates between eight states that adopted helmet use laws and eight matched states that did not adopt such laws. Robertson found that:

> "The average fatal involvement rate for eight states that enacted helmet use laws declined from more than 10 per 10,000 registered motorcycles the year before the laws' enactment to about seven per 10,000 registered motorcycles both in the years of enactments and the following years. In contrast the average fatal involvement rate in the eight matched states that enacted no helmet laws at the time that their comparison states did so remained at about 10 per 10,000 registered motorcycles throughout the period studied."[10]

The effect on motorcyclist fatalities of a total of 26 instances of complete or weakened helmet use law repeals by 24 state legislatures was assessed by Watson, *et al.*[1] This study concluded that "the weakening of the laws has coincided with an increase of about 40 per cent in the motorcyclist fatalities." Also noted was "the finding of a 38 per cent increase . . . following repeal is in close agreement with the earlier finding of a 30 per cent decrease . . . following the enactment of helmet use laws, since a 38 per cent *increase* is equivalent to a 28 per cent decrease (38 ÷ 138 = 0.28)."

In contrast to the unproven effects of rider/driver education programs, the effectiveness of helmet use laws is clear from the independent studies discussed above. A summary of the above without giving details of the accuracy of the estimates is as follows:

1. In crashes of comparable severity, the death rate of unhelmeted riders exceeds the crash rate of helmeted riders by 52 per cent;
2. Helmet use laws result in nearly 100 per cent helmet use and the typical helmet use is about 50 per cent without such laws;
3. Adoption of helmet use laws coincides with a 30 per cent *decrease* in fatality rates and their repeal with a 38 per cent *increase* in fatality rates.



SOURCE: National Highway Traffic Safety Administration, 1979

FIGURE 1—Motorcycle Fatalities per 10,000 Motorcycles, 1958–1979

Are these assertions consistent? Let r_H be the death rate for helmeted riders and r_o that for unhelmeted riders. In a law state summary estimate 2 above suggests that the death rate should be about r_H. If a state repeals a law, about one-half of the riders will continue to wear helmets (rate r_H) and one-half will start riding unprotected by helmets (r_o). Hence, the percentage increase in the fatality rate due to repealing a helmet law is 100 times

$$\frac{(1/2)(r_o + r_H) - r_H}{r_H} = \frac{r_o - r_H}{2r_H}$$

If this is equated to 0.38 (by summary estimate 3), we find

$$\frac{r_o - r_H}{r_H} = .76$$

Thus, this calculation predicts that 76 per cent of the lives lost by unhelmeted riders in fatal crashes would be saved by wearing helmets. The 95 per cent confidence region for the estimated 38 per cent increase in fatality rates was also calculated by Watson, *et al.*[1] Performing similar calculations with the lower confidence bound (0.247) and the upper confidence bound (0.547) in place of 0.38 give lower and upper

***In two states there were before and after repeal surveys. In these states helmet use dropped from 100 per cent to 58 per cent after the repeal.

confidence bounds for the estimated percentage of lives saved by weaing helmets. These are 49 per cent and 101 per cent. This confidence region contains the estimated percentage of lives saved by wearing a helmet stated in summary estimate 1. These calculations demonstrate that the three summary statements above were entirely consistent.

Helmet use laws reduce motorcyclist fatalities by about 30 per cent and their repeal increases fatal injuries by about 40 per cent. If such laws were repealed by all states, over 1,100 additional motorcyclists would die each year. If helmet use laws were reinstated in all states, there would be 600 fewer fatalities annually. Which way lies the public good? The answer is obvious!

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