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Determining Estimates of Lives and Costs Saved by Motorcycle Helmets

Helmets worn by motorcyclists[1] saved an estimated 1,829 lives in 2008, and an additional 822 lives could have been saved had all motorcyclists worn helmets (42% of fatally injured motorcyclists in 2008 were unhelmeted). The economic cost savings due to helmet use was approximately $2.9 billion in 2008, and an additional $1.3 billion could have been saved if all motorcyclists had worn helmets. According to the National Occupant Protection Use Survey (NOPUS), the use of DOT-compliant helmets increased to 67 percent in 2009, from 63 percent the previous year. Helmet use has been increasing slowly but steadily over the past five years.

While the number of fatalities in every other type of vehicle has decreased over the past several years, motorcyclist fatalities nearly doubled over the past decade. Although motorcycle registrations have increased over the past decade, the increase in motorcyclist fatalities rose even more steeply, reaching 5,290 in 2008, making up 14 percent of all traffic fatalities. This has occurred despite the fact that motorcycles make up less than 3 percent of registered vehicles in the United States, and account for only 0.4 percent of vehicle miles traveled. Over the past decade, the age group with the largest increase in motorcyclist fatalities (from 760 in 1998 to 2,687 in 2008) was the 40-and-older age group. During this same time period, the largest motorcycles (those with engine size 1,000 cc and above) saw the largest increase in fatalities.

This Research Note describes and quantifies the impact of motorcycle crashes, looking not only at the over-representative number of fatalities, but also at injured motorcyclists, and the economic impact of motorcyclist crashes. NHTSA's methodology to determine these is based on the number of motorcyclist fatalities, which is known from the Fatality Analysis Reporting System (FARS) database, a census of all traffic fatalities in the United States. Each year, the National Highway Traffic Safety Administration's National Center for Statistics and Analysis (NCSA) provides estimates of lives saved and cost savings attributable to motorcycle helmets. These include:

- The number of fatalities prevented (*lives saved*, an estimate of the number of helmeted motorcyclists who were in crashes in which they would have died had they not worn their helmets);
- Additional fatalities preventable at 100-percent use (an estimate, in addition to the lives saved above, of the number of lives that could have been saved had all motorcyclists worn helmets);
- Cost savings (the estimated amount of money, based on current-year dollars, that was saved by motorcyclists wearing helmets which prevented them from receiving fatal, serious, or minor injuries); and
- Additional costs savable at 100-percent helmet use (an estimate, in addition to the costs saved above, which could have been attained if all motorcyclists wore helmets).

This Research Note provides information on how NHTSA determines these estimates. Because all of these calculations are based on motorcyclist fatalities, they all increase (or decrease) as the number of fatalities increases (or decreases). For lives saved, which are determined from the number of helmeted motorcyclist fatalities, there is a given estimate of helmeted survivors per helmeted fatality. Similarly, if the number of unhelmeted motorcyclist fatalities increase, the number savable at 100 percent helmet use increases, as there are more lives that could have been saved if only they had worn helmets. Motorcyclists whose injuries were prevented by helmets, as well as those that could have been prevented, are determined in a similar manner. The costs saved by helmets used (as well as costs that could have been saved had all motorcyclists worn helmets) reflect increases or decreases in motorcyclist fatalities as well.

[1] Motorcyclist is the term used to reference both the motorcycle rider (operator) and the motorcycle passenger.

Motorcyclist Fatalities and Lives Saved

NCSA has published a Research Note titled *Calculating Lives Saved by Motorcycle Helmets* (DOT HS 809 861), which can be found online at http://www-nrd.nhtsa.dot.gov/Pubs/809861.PDF. While this document was published in 2005, the effectiveness estimates (37% for riders [operators] and 41% for passengers) and methods used are current. The Research Note presents the formulas and calculations for determining the number of lives saved by helmets.

The first step in determining the number of lives that were saved by motorcycle helmets is to ascertain the number of motorcyclists who died while wearing a helmet. This can be done because the effectiveness of helmets in saving lives is known. (For step-by-step calculations used in determining the number of lives and the costs saved and savable presented in this Research Note, along with the corresponding formulas, see Appendix: Calculations to Determine Nationwide Lives and Costs Saved by Motorcycle Helmets, 2008.)

The number of lives that could have been saved if every motorcyclist involved in a fatal crash had been wearing a helmet can also be determined. This additional calculation of lives saved by 100-percent helmet use multiplies the corresponding effectiveness estimate by the number of unhelmeted riders or passengers. This provides the number of these motorcyclists that would have lived had they been wearing a helmet. These calculations are also found in the appendix.

It is important to note that the status of helmet use during crashes, as well as in the determination of effectiveness estimates (37% for riders [operators] and 41% for passengers), is determined from original information as recorded on the police accident reports (PARs). The accuracy of reporting on the PARs directly affects the accuracy of the estimates presented here. Helmet use during a crash can be coded in FARS as either "Motorcycle Helmet" (FMVSS 218-compliant helmet or helmet with no further specification of type) or "Helmets Used Improperly" (noncompliant helmet or FMVSS 218-compliant helmet worn improperly). For FARS data coded as "Helmet Used Improperly," the motorcyclist is considered to not be wearing a helmet. A limitation of the crash data, which influences the effectiveness estimates, is introduced when a noncompliant helmet is considered as "helmet use" due to lack of specification on the PAR. This situation would potentially produce an overcount of helmeted fatalities, as well as an undercount of unhelmeted fatalities. Another consequence of this would be underestimating the effectiveness of motorcycle helmets; since noncompliant helmets would mistakenly be considered helmets in determining the effectiveness estimate, it would be lower than if it had been based solely on compliant helmets. (The effectiveness estimates used can be seen as a lower bound on the ability of helmets to save the lives of motorcyclists.) In addition, costs saved by helmets would be overestimated, and lives savable at 100 percent would be underestimated.

Table 1 of this Research Note presents for 2007 and 2008 the number of fatally injured motorcyclists as well as the percent that wore helmets, by State. It is this number, fatally injured helmeted motorcyclists, on which the estimates of costs saved and numbers of motorcyclists prevented from being killed and injured are based. Also presented in the table are the number of lives saved by helmets, and the number that could have been saved at 100-percent helmet use. Note that, because in 2008 100 percent of the 7 motorcyclist fatalities in Vermont wore helmets, there are no additional lives that could have been saved at 100 percent helmet use.

Estimates of Motorcyclists Injured, and Those Prevented From Being Injured

Not every motorcycle crash involves a fatality. For every motorcyclist traffic fatality, a number of other motorcyclists receive serious or minor injuries. Helmets are effective at preventing injuries as well as fatalities, and these must also be accounted for when determining the economic costs saved by helmets. Because NHTSA does not have current nationwide data on the number and severity of motorcyclists injured in each State, the number of motorcyclists receiving serious and minor injuries must be estimated, based on the number of fatalities. To determine this, the estimated number of injured motorcyclists is based on a five-year average ratio of the total nationwide number of motorcyclists injured (estimated from the General Estimates System [GES]) to motorcyclist fatalities (from FARS), separately for those helmeted and unhelmeted. GES, part of the National Automotive Sampling System (NASS), is a sample of traffic crashes to which weights are applied in order to obtain national estimates. For the most recent five years for which data is available (2004 – 2008), there were about 20 helmeted motorcyclists injured for each one that died in a traffic crash. For unhelmeted motorcyclists, there were about 14 injured per fatality. These estimates of injured motorcyclists are then proportioned into serious (37%) and minor (63%) injuries, as established in *Estimating the Benefits from Increased Motorcycle Helmet Use*.

Next, the estimates of motorcyclists prevented from being injured, both minor and serious, are calculated in the same manner as lives saved, using effectiveness estimates of 0.13 and 0.08, respectively. There are not differing helmet

effectiveness estimates for riders and passengers for those who are non-fatally injured. The number of motorcyclists injured that could have been prevented (both minor and serious) at 100-percent helmet use is determined using the method described above for fatalities, substituting the appropriate injury preventing effectiveness estimate.

Economic Impact

Cost savings are determined by multiplying the number of motorcyclists who were prevented from being injured (separately by minor, serious, and fatally injured, as estimated above) by the corresponding economic costs. The cost savings estimated here include those that result from helmet use, and exclude costs such as property damage, travel delay, and quality of life. The costs were most recently published in the report *Economic Impact of Motor Vehicle Crashes 2000*, which determined a cost to society of $5,941 per minor (MAIS 1) injury, $135,634 per serious (MAIS 2-5) injury, and $957,787 per fatality. These dollar amounts would then be converted to current-year dollars, available from within NHTSA. The current costs (in year 2008 dollars) are $7,927 per minor injury, $179,296 per serious injury, and $1,248,086 per fatality. The costs savings associated with the estimates of lives saved and injured prevented by helmet use are presented in Table 2 at the end of this report, for each State as well as for the Nation as a whole. The computations are shown in the appendix. While the costs presented in Table 2 use the most current fatality and injury cost estimates, instructions for converting earlier year estimates to current year dollars are also provided.

Table 2 presents cost data from 2007 as well as 2008, in order to provide some insight in the year to year changes in motorcycle fatalities. There was a 2.2-percent increase in the number of motorcyclist fatalities nationwide in 2008, the eleventh straight year to see an increase. Notice, however, that there was no change in the percentage of motorcyclists in fatal crashes wearing helmets. Since all additional estimates, such as lives and costs saved and savable, are based on the number (not percentage) of motorcyclist fatalities, these numbers also see a slight increase over the previous year. Also note that, because Vermont had 100 percent helmet use in the 7 fatalities in 2008, there is no *additional* cost savings at 100-percent helmet use, as it was already achieved.

For further information on how NCSA estimates the number of lives saved by additional safety measures, see *Lives Saved FAQs* at http://www-nrd.nhtsa.dot.gov/Pubs/811105.PDF. This report answers questions regarding the lives saved estimates produced annually by NHTSA, including lives saved by seat belts, frontal air bags, motorcycle helmets, child safety seats, and the minimum legal drinking age; what these lives saved estimates mean; what effectiveness is and how it is used to estimate lives saved; and examples of how lives saved estimates are calculated.

Lives Saved Calculations for Seat Belts and Frontal Air Bags, available online at http://www-nrd.nhtsa.dot.gov/Pubs/811206.PDF, explains how NHTSA produces the lives saved estimates for seat belts and frontal air bags. The methodology is described in detail, including the use of effectiveness ratings for seat belts and frontal air bags. This report does not contain information or calculations on motorcyclists, but the methodology for determining the number of lives saved based on an effectiveness estimate is the same.

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Table 1
Motorcyclist Fatalities, Helmet Use, Lives Saved, and Additional Savable at 100% Helmet Use, 2007 and 2008

State	Motorcyclist Fatalities		Percent Helmeted Fatalities		Lives Saved by Helmets		Additional Fatalities Preventable at 100% Use	
	2007	2008	2007	2008	2007	2008	2007	2008
Alabama	85	99	91%	85%	46	50	3	6
Alaska	6	8	80%	50%	3	2	0	1
Arizona	135	141	43%	50%	35	42	29	26
Arkansas	80	68	38%	42%	18	17	19	15
California	518	560	87%	88%	266	291	26	25
Colorado	90	98	37%	31%	20	18	21	25
Connecticut	43	57	35%	36%	9	12	10	14
Delaware	16	16	33%	50%	3	5	4	3
DC	2	8	50%	88%	1	4	0	0
Florida	566	556	51%	52%	170	171	104	100
Georgia	163	177	87%	92%	84	97	8	5
Hawaii	29	25	21%	28%	4	4	9	7
Idaho	29	29	41%	62%	7	11	6	4
Illinois	157	133	19%	25%	18	20	48	37
Indiana	122	131	19%	25%	14	19	37	37
Iowa	62	55	13%	15%	5	5	20	17
Kansas	48	46	28%	27%	8	7	13	13
Kentucky	112	101	36%	41%	24	25	27	22
Louisiana	89	80	76%	60%	40	29	8	12
Maine	21	18	29%	24%	4	2	6	5
Maryland	96	91	87%	89%	50	48	5	4
Massachusetts	62	42	95%	97%	35	24	1	0
Michigan	123	128	90%	88%	65	67	5	6
Minnesota	61	71	20%	17%	7	7	18	22
Mississippi	51	40	65%	80%	20	19	7	3
Missouri	92	107	77%	78%	42	49	8	9
Montana	36	36	46%	38%	10	8	7	8
Nebraska	15	19	73%	84%	7	9	1	1
Nevada	51	59	86%	75%	26	26	3	6
New Hampshire	25	30	40%	37%	6	6	6	7
New Jersey	85	82	82%	87%	42	42	6	4
New Mexico	50	49	18%	4%	5	1	15	18
New York	168	184	86%	80%	86	87	9	14
North Carolina	201	170	93%	91%	111	92	5	6
North Dakota	8	13	13%	23%	1	2	3	4
Ohio	189	213	35%	30%	39	38	46	55
Oklahoma	76	86	30%	26%	13	13	20	24
Oregon	51	48	94%	98%	29	28	1	0
Pennsylvania	225	239	46%	49%	61	70	45	45
Rhode Island	13	7	25%	71%	2	3	4	1
South Carolina	131	123	24%	24%	19	18	37	35
South Dakota	29	15	21%	27%	4	2	9	4
Tennessee	149	145	87%	89%	77	76	7	6
Texas	407	516	40%	38%	96	115	91	120
Utah	33	36	53%	33%	11	7	6	9
Vermont	7	7	71%	100%	3	4	1	0
Virginia	129	86	91%	93%	69	47	4	2
Washington	69	81	86%	95%	35	46	4	1
West Virginia	40	52	84%	78%	20	24	2	4
Wisconsin	109	89	25%	22%	16	12	30	26
Wyoming	20	20	45%	40%	5	5	4	5
Nation	**5,174**	**5,290**	**58%**	**58%**	**1,788**	**1,829**	**805**	**822**
Puerto Rico	94	78	31%	36%	17	17	24	19

Source: Fatality Analysis Reporting System
Shaded States are those with laws requiring helmet use for all motorcyclists

Table 2
Costs Saved by, and Savable at 100%, Helmet Use, 2007 and 2008

State	Costs Saved*		Additional Costs Savable at 100% Helmet Use*	
	2007	2008	2007	2008
Alabama	$68,835,020	$70,270,446	$4,875,982	$7,857,629
Alaska	$4,258,880	$5,136,606	$724,212	$3,214,722
Arizona	$51,979,459	$67,999,401	$46,592,029	$42,411,411
Arkansas	$26,880,570	$22,527,227	$30,228,271	$19,163,999
California	$400,863,734	$562,758,250	$41,883,108	$49,086,935
Colorado	$29,408,672	$32,903,339	$34,639,584	$46,976,831
Connecticut	$13,437,871	$27,220,420	$17,089,889	$30,566,490
Delaware	$4,753,215	$8,589,817	$6,470,973	$5,375,899
DC	$887,267	$9,353,835	$603,510	$819,554
Florida	$255,591,367	$280,683,703	$169,206,580	$163,849,006
Georgia	$126,507,357	$158,900,321	$12,817,417	$8,722,786
Hawaii	$5,323,600	$7,233,333	$14,072,338	$11,640,727
Idaho	$11,033,812	$16,334,180	$10,259,673	$6,247,190
Illinois	$26,442,539	$34,856,074	$77,568,844	$65,325,904
Indiana	$21,252,331	$29,355,433	$59,643,477	$55,803,965
Iowa	$7,568,450	$7,514,790	$32,772,119	$26,281,749
Kansas	$12,036,207	$11,738,799	$21,196,396	$19,963,026
Kentucky	$35,619,540	$36,240,620	$43,740,138	$32,920,451
Louisiana	$60,726,269	$39,716,120	$13,251,944	$16,467,591
Maine	$5,323,600	$4,034,310	$9,196,356	$8,205,779
Maryland	$75,073,932	$93,438,699	$7,406,505	$7,131,415
Massachusetts	$52,466,383	$54,653,556	$1,905,822	$977,955
Michigan	$98,574,698	$117,297,612	$7,445,172	$10,274,957
Minnesota	$10,680,682	$12,935,230	$29,692,927	$40,478,094
Mississippi	$29,666,413	$23,642,618	$10,911,084	$3,682,703
Missouri	$63,143,528	$77,015,302	$13,115,554	$13,890,858
Montana	$14,741,044	$11,814,347	$11,883,110	$11,907,748
Nebraska	$10,017,675	$14,083,393	$2,414,041	$1,652,630
Nevada	$39,297,477	$49,103,995	$4,272,472	$10,476,654
New Hampshire	$8,872,667	$12,358,665	$9,148,455	$13,419,500
New Jersey	$62,466,916	$90,584,860	$9,207,505	$8,797,942
New Mexico	$7,985,401	$1,651,454	$24,791,817	$24,464,084
New York	$128,796,261	$185,039,301	$14,620,557	$28,543,039
North Carolina	$166,692,101	$139,938,559	$8,449,142	$8,448,569
North Dakota	$887,267	$2,620,909	$4,320,373	$5,514,043
Ohio	$58,946,215	$60,137,112	$74,662,859	$86,720,739
Oklahoma	$20,196,756	$18,695,854	$32,456,298	$33,269,185
Oregon	$42,985,982	$48,474,357	$1,890,998	$651,270
Pennsylvania	$92,443,024	$114,491,692	$73,867,992	$73,973,292
Rhode Island	$2,883,617	$5,734,999	$5,884,224	$1,435,690
South Carolina	$28,552,001	$25,538,554	$60,205,706	$50,403,772
South Dakota	$5,452,471	$3,558,424	$14,072,338	$6,171,593
Tennessee	$115,871,138	$111,542,422	$11,546,880	$9,056,784
Texas	$144,662,963	$188,234,643	$148,562,411	$194,621,592
Utah	$15,898,481	$10,494,474	$9,364,813	$13,027,104
Vermont	$4,436,334	$6,753,302	$1,207,020	$0
Virginia	$103,989,869	$82,046,796	$7,343,132	$3,874,581
Washington	$52,864,219	$90,338,434	$6,035,102	$2,920,764
West Virginia	$30,129,054	$31,667,694	$3,822,231	$5,548,884
Wisconsin	$24,271,832	$18,716,743	$49,631,915	$41,989,783
Wyoming	$8,114,271	$7,550,019	$6,686,513	$7,061,820
Nation	**$2,695,802,605**	**$2,931,133,404**	**$1,309,588,599**	**$1,306,789,864**
Puerto Rico	$25,988,476	$29,228,815	$39,659,270	$32,445,184

*Note: State costs are adjusted for relative per-capita income; dollar amounts for the nation will not equal the sum of the States.
Source: Fatality Analysis Reporting System; Bureau of Labor Statistics
Shaded States are those with laws requiring helmet use for all motorcyclists

Appendix: Calculations to Determine Nationwide Lives and Costs Saved by Motorcycle Helmets, 2008

Motorcyclist Fatalities and Lives Saved

Motorcyclist fatalities and distributing unknown helmet use

The first step is to determine the number of motorcycle riders and passengers fatally injured, and the helmet use of each. This data is available in NCSA's FARS data file.

Table A1
Motorcyclist Fatalities by Person Type and Helmet Use, 2008

	Operator	Passenger	All Motorcyclists
Helmeted	2,842	160	3,002
Unhelmeted	1,979	167	2,146
Unknown	137	5	142
Total	**4,958**	**332**	**5,290**

Source: FARS 2008

Those motorcyclists with unknown helmet use are, within each person type (operator or passenger), distributed in the same percentage as those with known use. The percentage of operators with known helmet use is first determined:

$$\frac{OperatorFatalities_{Helmeted}}{(OperatorFatalities_{Helmeted} + OperatorFatalities_{Unhelmeted})}$$

$$= \frac{2{,}842}{(2{,}842 + 1{,}979)} = 0.5895$$

This is the proportion of unknowns that is added to the known helmet users:

$$(0.5895 \times 137) = 80.76$$

$$2{,}842 + 80.76 = 2{,}922.76$$

This is rounded to 2,923. In this same manner, the remaining motorcyclist fatalities with unknown helmet use are distributed among the known helmeted and unhelmeted fatalities for both operators and passengers separately.

Table A2
Motorcyclist Fatalities by Person Type and Helmet Use Unknowns Distributed, 2008

	Operator	Passenger	All Motorcyclists
Helmeted	2,923	162	3,085
Unhelmeted	2,035	170	2,205
Total	**4,958**	**332**	**5,290**

Estimating the number of lives saved by motorcycle helmets

The formulas needed to determine the number of lives saved by motorcycle helmets are taken from *Calculating Lives Saved by Motorcycle Helmets* (DOT HS 809 861). Calculations shown in this Appendix are meant to provide the formulas and serve as examples only. For further details on these and any other formulas presented here, please see the corresponding original document. For motorcycle operators, helmets have an estimated effectiveness of 0.37. First, the potential operator fatalities are determined:

$$OperatorFatalities_{Potential} = \frac{OperatorFatalities_{Helmeted}}{(1 - 0.37)}$$

Using the number of helmeted operator fatalities above (2,923), this is:

$$OperatorFatalities_{Potential} = \frac{2{,}923}{(1 - 0.37)} = 4{,}640$$

The number of potential fatalities less the number actual fatalities gives the number of lives saved by helmets. In this case, 4,640 – 2,923 = 1,717

For motorcycle passengers, helmets have an effectiveness of 41 percent. So, in 2008, the calculations for the number of motorcycle passenger lives saved are:

$$PassengerFatalities_{Potential} = \frac{162}{(1 - 0.41)} = 275$$

The number of motorcycle passenger fatalities prevented is 275 – 162 = 113

Therefore, the total number of lives saved by motorcycle helmets nationwide in 2008 is 1,717 + 113 = 1,830. Note that, according to Table 1, the total number of lives saved by helmets is 1,829. The difference is due to rounding in the above calculations. If the calculations above are performed without rounding, the result would indeed be 1,829.

For ease of presentation, values are rounded at each step calculated in examples in this Appendix. For the values in Tables 1 and 2, as well as for the annual estimates of lives and costs saved and injured prevented, values are not rounded until the final calculations are performed. Therefore small differences may occur between values calculated here and those presented elsewhere.

Estimating additional preventable fatalities at 100-percent helmet use

The additional lives that could be saved if all motorcyclists had worn helmets are determined using the number of unhelmeted fatally injured motorcyclists and the effectiveness estimate.

$$MotorcyclistFatalities_{Unhelmeted} \times Effectiveness_{role}$$

For operator fatalities, using the number of unhelmeted operator fatalities from Table A1, this is

$$2{,}035 \times 0.37 = 753$$

Had all of these 2,035 riders that died in crashes been wearing helmets, 753 (37%) of them would have survived.

The number of additional lives that could have been saved if all passengers had worn helmets is:

$$170 \times 0.41 = 70$$

Therefore, a total of 823 additional lives (753 operators and 70 passengers) could have been saved had all motorcyclists worn helmets.

Estimates of Motorcyclists Injured, and Those Prevented From Being Injured

Estimating the number of motorcyclists injured

The method used to estimate costs saved by motorcycle helmets (below) requires information on injury severity. NCSA maintains a number of crash data files. The Fatality Analysis Reporting System (FARS) is a census of fatal crashes in the United States. The General Estimates System (GES), part of the National Automotive Sampling System (NASS), is a sample of traffic crashes to which weights are applied in order to obtain national estimates. Data from both of these systems are combined to estimate the number of motorcyclists by role (passenger or operator), helmet use, and injury severity (minor or severe). This method allows for lives and cost saved estimates for each State, rather than only on a nationwide basis. The initial step is to determine the total number of motorcyclist fatalities (from FARS) and those injured (from GES), separately by helmet use, over the most recent five years. Fatality counts in Table A3 have had unknown helmet use distributed.

The ratio of injured motorcyclists to fatalities, by helmet use, is determined for each year, and then the average of the five injury-to-fatality ratios is calculated. The numbers presented in Table A3 are rounded, while the actual calculations are based on unrounded numbers.

For helmeted motorcyclists, this is:

$$\frac{19.96 + 20.18 + 18.90 + 21.67 + 18.98}{5} = 19.94$$

For unhelmeted motorcycles, this is:

$$\frac{13.98 + 14.78 + 13.20 + 14.21 + 13.87}{5} = 13.97$$

Table A3
Total Motorcyclist Fatalities and Injured, 2004 - 2008

Year	Fatalities		Injured		Injury to Fatality Ratio	Injury to Fatality Ratio
	Helmeted	Unhelmeted	Helmeted	Unhelmeted	Helmeted	Unhelmeted
2004	2,227	1,801	44,446	25,184	19.96	13.98
2005	2,617	1,959	52,800	28,948	20.18	14.78
2006	2,812	2,025	53,144	26,355	18.90	13.02
2007	3,016	2,157	65,366	30,650	21.67	14.21
2008	3,085	2,205	58,537	30,586	18.98	13.87
Total					**19.94**	**13.97**

Source: FARS and GES

The appropriate ratio is then used to determine the estimate of injured motorcyclists, by helmet use as well as role (rider or passenger). Multiplying each of the helmeted values in Table A2 by 19.94, and each unhelmeted value by 13.97 results in:

Table A4
Estimates of Motorcyclists Injured, by Person Type and Helmet Use, 2008

	Operator	Passenger	All Motorcyclists
Helmeted	58,271	3239	61,510
Unhelmeted	28,433	2369	30,801
Total	86,704	5,607	92,311

Determining estimates of motorcyclists with minor or serious injuries

The report *A Model for Estimating the Economic Savings From Increased Motorcycle Helmet Use* provides the method for estimating the number of minor and seriously injured motorcyclists. Given the overall estimate of motorcyclists injured (by helmet use status, presented in Table A4), 37 percent of these are estimated to have been seriously injured, and the remaining 63 percent minor. Therefore, given 58,271 helmeted operators injured:

Number of minor injured helmeted motorcycle operators: $0.63 \times 58{,}271 = 36{,}711$

Number of seriously injured helmeted motorcycle operators: $0.37 \times 58{,}271 = 21{,}560$

Determining the number of motorcyclists prevented from getting serious or minor injuries, due to motorcycle helmets

The number of motorcyclists whose serious or minor injuries were prevented by helmets is estimated using the same process that was used for determining the number of lives saved. Recall that the effectiveness estimates for saving lives were 37% for operators and 41% for passengers. No difference for operators and passengers has been determined for estimating the injured that were prevented by motorcycle helmets. The effectiveness estimate for preventing a motorcyclist from receiving a minor injury is 8%, and for preventing a seriously injured motorcyclist, 13%. To estimate the number of motorcyclists prevented from receiving a serious injury (because of helmets), the number of helmeted motorcyclists is used.

$$Seriously\ Injured_{Potential} = \frac{Seriously\ Injured_{\ Helmeted}}{(1 - 0.13)}$$

Using the estimate of helmeted seriously injured motorcyclists above (22,758), this is:

$$Seriously\ Injured_{Potential} = \frac{22{,}758}{(1 - 0.13)} = 26{,}159$$

The number of potential seriously injured, less the number actual seriously injured, gives the number of seriously injured prevented by helmets. In this case, 26,159 – 22,758 = 3,401. Again, these calculations are being shown using rounded numbers, whereas during the actual calculations rounding would not occur until presenting the final value.

The number of potential minor injured motorcyclists is:

$$Minor\ Injured_{Potential} = \frac{Minor\ Injured_{\ Helmeted}}{(1 - 0.08)}$$

Using the estimate of helmeted minor injured motorcyclists above (36,597), this is:

$$Minor\ Injured_{Potential} = \frac{38{,}751}{(1 - 0.08)} = 42{,}121$$

The number of potential minor injured, less the number actual minor injured, gives the number of minor injured prevented by helmets. In this case, 42,121 – 38,751 = 3,370.

Estimating additional motorcyclists prevented from becoming injured at 100-percent Helmet Use

The number of injured motorcyclists that could have been prevented at 100-percent helmet use is determined using the same method as previously shown for motorcyclist fatalities. Again, there are not different effectiveness estimates for riders and passengers. There are, however, dif-

Table A5
Estimates of Motorcyclists Injured, by Person Type and Helmet Use, 2008

	Operator Minor Injury	Operator Serious Injury	Passenger Minor Injury	Passenger Serious Injury	Total Minor Injury	Total Serious Injury
Helmeted	36,711	21,560	2,040	1,198	38,751	22,758
Unhelmeted	17,913	10,520	1,492	876	19,405	11,396

ferent effectiveness estimates for the two levels of injury. So, for seriously injured, the number that could have been prevented is determined as:

$$MotorcyclistsInjured(level)_{Unhelmeted} \times Effectiveness_{InjuryLevel}$$

From Table A5, there were 11,396 unhelmeted motorcyclists who were seriously injured. The estimate of the number of additional motorcyclists whose serious injuries could have been prevented is:

$$11{,}396 \times 0.13 = \$1{,}481$$

And for those with minor injuries, this is:

$$19{,}405 \times 0.08 = 1{,}552$$

Economic Impact

The current economic costs (in year 2008 dollars) are $7,927 per minor injury, $179,296 per serious injury, and $1,248,086 per fatality. If only earlier year costs are available, the dollar amounts must be converted from the base year dollars to current-year dollars by the use of an inflation factor. The procedures for estimating the costs saved by motorcyclists wearing helmets and the potential costs that could have been saved had 100 percent of motorcyclists worn helmets, illustrated below, also show the method used to inflate dollars from an earlier year to current year dollars. In *Economic Impact of Motor Vehicle Crashes 2000,* the economic cost to society for traffic injuries and fatalities was determined to be $957,787 per fatality, $135,634 per serious injury, and $5,941 per minor injury. The required inflation factor is obtained using data from the Department of Labor's Bureau of Labor Statistics, at their Web site:

http://data.bls.gov/cgi-bin/surveymost?cu

To obtain the needed values, place a check in the first item's box ("U.S. All items, 1982-84=100 – CUUR0000SA0") then scroll to the bottom and click "Retrieve data." For the inflation factor, divide the value for "Annual" for the current year (2008) by that of the base year index (2000 for our calculations, since the known value is the cost per fatality and injured in year 2000 dollars). For example, to convert 2000 dollars to 2008, the values are 215.303/172.2, or about 1.25. The cost for each injured motorcyclist is multiplied by the inflation factor to get the current-year cost per fatal, serious, and minor injured. The 2008 cost per fatality, then, is inflated from year 2000 dollars to year 2008 dollars by:

$$\$957{,}787 \times 1.25 = \$1{,}197{,}234$$

The cost savings are then determined by multiplying the number of motorcyclists who were prevented from being killed or injured (separately by minor, serious, and fatally injured) by the corresponding economic costs.

Earlier it was determined that an estimated 1,830 lives were saved by motorcycle helmets in 2008. This resulted in a cost savings of:

$$\$1{,}197{,}234 \times 1{,}830 = \$2{,}190{,}938{,}220$$

that can be attributed to helmets having prevented fatalities. (Again, calculations shown here are on rounded numbers and may differ if unrounded numbers are used. If calculations are performed, for example, in a spreadsheet without rounding, results may differ slightly.). The current year cost savings of minor and severely injured motorcyclists is determined in the same way, using the corresponding dollar amounts.

Cost savings per seriously injured motorcyclist (inflating year 2000 to year 2008 dollars):

$$\$135{,}634 \times 1.25 = \$169{,}543$$

Total costs savings for preventing serious injury to motorcyclists due to wearing helmets:

$$\$169{,}543 \times 3{,}401 = \$576{,}615{,}743$$

Cost savings per minor injured motorcyclist (inflating year 2000 to year 2008 dollars):

$$\$5{,}941 \times 1.25 = \$7{,}426$$

Total cost savings for preventing minor injury to motorcyclists, due to wearing helmets:

$$\$7{,}426 \times 3{,}370 = \$25{,}025{,}620$$

The savings due to preventing fatalities, and minor and seriously injured is summed to ascertain the total dollar amount in cost savings to society attributable to motorcycle helmets:

$$\$2{,}190{,}938{,}220 + \$576{,}615{,}743 + \$25{,}025{,}620 = \$2{,}792{,}579{,}583$$

Again, the above is shown to illustrate the method for inflating dollars of a given year to current year dollars. The process of inflating the dollar amounts is not necessary when current year dollar estimates are available.

Finally, to determine the total costs that could have been saved had all motorcyclists been wearing helmets, the cost savings for each injury level is multiplied by the number of lives that could have been saved, or the number of those who were injured that could have been prevented.

Cost savings for fatalities that could have been prevented by 100 percent helmet use:

$$\$1{,}197{,}234 \times 823 = \$985{,}323{,}582$$

Cost savings for seriously injured that could have been prevented by 100 percent helmet use:

$$\$169{,}543 \times 1{,}481 = \$251{,}093{,}183$$

Cost savings for minor injured that could have been prevented by 100 percent helmet use:

$$\$7{,}426 \times 1{,}152 = \$11{,}525{,}152$$

Therefore, the additional cost savings for fatalities and injured motorcyclists preventable at 100 percent helmet use (using year 2000 dollars inflated to year 2008 dollars) is estimated to be:

$$\$985{,}323{,}582 + \$251{,}093{,}183 + \$11{,}525{,}152 = \$1{,}247{,}941{,}917$$

Again, because of rounding used for ease of presentation, the additional dollar amount that could have been saved had all motorcyclists worn helmets differs from the amount presented in Table 2 as well as other published values. These same calculations done without any rounding would produce results identical to the values in Table 2.

The above cost savings are determined on a national basis. For data presented in Table 2 for individual States, the dollar amount is adjusted for each state using a ratio of the per-capita personal income in the specific state to the national average per-capita personal income. The rationale for this method is explained in *A Model for Estimating the Economic Savings From Increased Motorcycle Helmet Use*. Depending on the number of motorcyclist fatalities in each State, summing the State costs may differ from the cost estimate based on the national total. The national totals presented in Table 2 are determined directly from the national counts and cost estimates, and are calculated without intermediate rounding.

U.S. Department of Transportation
National Highway Traffic Safety Administration

This research note and other general information on highway traffic safety may be accessed by Internet users at: www-nrd.nhtsa.dot.gov/CATS/index.aspx