



Motorcycle Helmets: Laws, Effectiveness, and Economic Benefits

Numerous researchers have estimated that motorcycle rider fatality risk, per vehicle-mile traveled, remains anywhere from 20 to 40 times that of passenger vehicle occupants. Head injuries continue to be the leading cause of death in U.S. motorcycle crashes. Since helmets remain the main occupant protection device available to motorcycle riders, it is important to review the role of helmets in preventing motorcyclist deaths and injuries.

The legitimacy of Washington State's motorcycle helmet law (RCW 46.37.530) depends on three main supporting pillars; legality, effectiveness, and cost benefits. This summary shall address each of these three areas in turn. The legality of motorcycle helmet laws in Washington State was established in *State v. Laitinen* (1969), wherein the Washington State Supreme Court ruled that "requiring motorcycle riders to wear protective helmets of a type approved by the state commission on equipment when riding upon the public highways is a reasonable exercise of the police power, and RCW 46.37.530 (3) is a constitutional declaration thereof."

The legality of helmet laws at the national level was later established in *Simon v. Sargent* (1972), in which the Massachusetts Federal Appeals Court ruled as follows: "From the moment of the injury, society picks the person up off the highway; delivers him to a municipal hospital and municipal doctors; provides him with unemployment compensation if, after recovery, he cannot replace his lost job, and, if the injury causes permanent disability, may assume the responsibility for his and his family's continued subsistence. We do not understand a state of mind that permits plaintiff to think that only he himself is concerned."

The effectiveness of motorcycle helmets in preventing or lessening head injuries among motorcyclists is now widely considered a settled matter by researchers. Estimates of the protective effects of helmets have risen over time, almost certainly as a result of progressive improvements in helmet design. A 2008 meta-analysis found that wearing a motorcycle helmet reduces the risk of incurring a fatal injury by 42 percent. This finding was generally echoed by even the poorer-quality studies excluded from the pooled analysis. The same meta-analysis also showed that wearing a motorcycle helmet lowers the risk of head injury by 69 percent. Studies included in the meta-analysis that examined head injury risk for full-face helmets and open-face helmets generally found small or nonsignificant differences, though both types were found protective against head injury.

Studies published since the 2008 Cochrane meta-analysis have substantially reached the same overall conclusion – that wearing a helmet reduces the risk that a motorcyclist will die from a head injury sustained in a crash. Significant risk reductions have been found across decades of research and have increased over time, mainly due to helmet design improvements. A 2010 evidence-based review of 45 studies concluded that unhelmeted riders face significantly higher death rates and greater percentages of fatal and severe head injuries. In addition, states with strong helmet laws have lower motorcyclist fatality and head-injury rates than states without helmet laws. A 2011 study found that unhelmeted motorcyclists were more than

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four times as likely to sustain head injuries and more than ten times as likely to incur brain injuries. Compared to riders wearing full-face helmets, riders wearing “half-helmets” were more than twice as likely to suffer head and/or brain injuries, and, compared to riders with securely-fastened helmets, riders who wore loosely-fastened helmets were twice as likely to suffer a head or brain injury.

Regardless of how effective motorcycle helmets are shown to be for preventing deaths and injuries to riders in crashes, they have no protective value if not worn while riding. Compulsory universal motorcycle helmet laws, where enforced, have proven to be highly effective for increasing rider helmet use rates on public roadways, thereby decreasing the number of motorcyclist fatalities in those jurisdictions. Since 2008, results from the annual National Occupant Protection Use Surveys (NOPUS) of motorcycle helmet use show that use rates in states with universal helmet laws ranged between 26 and 41 percentage points higher than use rates in states without such laws. Additionally, a recent Centers for Disease Control and Prevention (CDC) study (2012) found that in states without helmet laws, three of every four motorcyclists killed were unhelmeted when they crashed—compared to only one of every ten motorcycle fatalities in states with helmet laws. In other words, motorcyclists killed in states without universal helmet laws are roughly six times more likely to be unhelmeted than those killed in states with helmet laws.

As a consequence of such consistent helmet-use differences, the CDC study concluded that states with helmet laws realize crash-cost savings four times larger than states without such laws. In fact, not a single study has been able to refute the claim that costs for unhelmeted motorcyclists are higher than costs for helmeted motorcyclists. A 2006 study of nearly 6,000 motorcyclists who either died at the crash scene or were hospitalized with injuries concluded that unhelmeted motorcyclists were over twice as likely to die at the scene, to sustain a severe brain injury, or to suffer a facial injury. As a result, the average hospital charge per unhelmeted motorcyclist was 11% higher than for each helmeted motorcyclist.

The CDC estimated that during 2010, helmeted motorcyclists saved Washington State roughly \$350 in economic costs (per registered motorcycle). A joint study between the Washington Traffic Safety Commission, the Washington State Patrol, the Washington Department of Health, and Harborview Injury Prevention and Research Center concluded that average per-patient hospitalization injury costs for unhelmeted motorcyclists, in 2017 dollars, were 30% higher than those for helmeted motorcyclists. Finally, the CDC has concluded that Washington’s helmet law has benefited the State with nearly \$50 million in cost savings since the universal helmet law was implemented.



Reference Summaries:

Coben JH, Steiner CA, & Miller TR (2007). **Characteristics of motorcycle-related hospitalizations: comparing states with different helmet laws.** *Accident Analysis and Prevention*. 39:190-196.
<https://www.sciencedirect.com/science/article/abs/pii/S0001457506001229>

This study examined hospital discharge data from 33 states. Cross-sectional analysis showed that, compared to motorcyclists hospitalized in states with universal helmet laws, injured motorcyclists hospitalized in states without universal laws are more likely to die during hospitalization (2.5% to 1.8%), to have a principal diagnosis of traumatic brain injury (16.2% to 11.5%), to be discharged from the hospital to a long-term health care facility (10.9% to 8.8%), and to lack sufficient private or public health insurance coverage (16.0% to 13.8%). Researchers found no significant outcome differences between motorcyclists from no-law states and partial-law states (requiring only for those below either age 18 or age 21). The authors found that the percentage of injuries to the head and face (out of all motorcyclist injuries) in partial-law or no-law states was 77 percent larger than the percentage of such injuries in states with universal helmet laws. Moreover, motorcyclists in states without universal helmet laws were 41 percent more likely to suffer the most-severe type of traumatic brain injury. Motorcyclists hospitalized in these states were more likely to lack either private health insurance or government-funded insurance than motorcyclists hospitalized in states with full helmet laws.

Dee TS (2009). **Motorcycle helmets and traffic safety.** *Journal of Health Economics*. 28:398-412.
<https://www.sciencedirect.com/science/article/abs/pii/S0167629608001926>

This study examined the role of various factors on the effectiveness of motorcycle helmets in preventing fatalities and head, neck, or facial injuries to riders involved in crashes. After stating that motorcycle fatalities in the U.S. had doubled between 1997 and 2005, the author pointed out that many states had repealed or softened their universal helmet laws. Thus, this study proposed to re-examine the effectiveness of motorcycle helmets by repeating the double-pair comparison method used by Evans and Frick (1988) to reach their estimate of a 28 percent fatality-risk reduction for helmeted motorcyclists compared to unhelmeted ones. Using a more recent data set (1988-2005 FARS data), Dee found that his own repetition of this analysis resulted in an estimated fatality-risk reduction of 34%, an improvement that Dee attributed to technological changes in helmet design after 1986. Dee estimates that states without universal helmet laws would have saved approximately \$888 per year per registered motorcyclist if every motorcyclist had been compelled by such laws to wear a helmet during all motorcycle rides (\$1,090 in 2017 dollars). Over a 30-year period, assuming a 2009 discount rate of five percent, that saving works out to a social (cost) benefit of roughly \$14,000 for each rider in states with universal helmet laws. He concludes by pointing out that helmet advocates and opponents might be persuaded to agree on policies that replace monetary fines with signed forms consenting to be organ donors.

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Deutermann WV (2004). **Motorcycle helmet effectiveness revisited** (DOT HS 809 715). National Highway Traffic Safety Administration, Washington D.C.

<https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/809715>

This study analyzed FARS data on motorcyclist operator-passenger pairs involved in 1993-2002 fatal crashes where at least one rider in the pair was killed and where helmet use was known. The author replicated the double-pair comparison method pioneered by Evans and Frick (1988) and estimated that wearing a motorcycle helmet during a crash reduced fatality risk for operators by 37 percent and for passengers by 41 percent (compared to not wearing a helmet in a crash). Like other researchers, the author notes that technological improvements have occurred in helmets themselves – while smaller percentages of motorcyclists are actually wearing them: “On the one hand, real world crash experience and destructive testing both suggest that the protective value of helmets has improved over the years. On the other hand, NHTSA’s studies of helmet use indicate that the usage rate is falling, as more riders choose not to wear helmets and existing helmet laws are repealed or weakened”. The author also estimates that helmets saved the lives of 7,808 motorcyclists in crashes between 1993 and 2002, and calculates that numerous actual deaths could have been avoided: “If all riders consistently wore proper helmets, the number of additional fatalities that could have been prevented over the same ten-year period would have raised the total lives saved to 11,915 persons”.

Eastridge BJ, Shafi S, Minei JP, Culica D, McConnel CM, & Gentilello L (2006). **Economic impact of motorcycle helmets: from impact to discharge**. *Journal of Trauma, Injury, Infection, and Critical Care*. 60:978-984.

https://journals.lww.com/jtrauma/Abstract/2006/05000/Economic_Impact_of_Motorcycle_Helmets_From_Impact.8.aspx

Using 1994-2002 data from the General Estimates System (GES) and the National Trauma Data Bank (NTDB), the authors examined all cases where injury mechanism was recorded as a “motorcycle crash” and where data on age, sex, helmet use, scene factors, pre-crash alcohol and drug use, injury assessment, treatment costs, and other treatment factors were recorded. Their results showed that unhelmeted motorcyclists were at least twice as likely to die at the crash site (8.3% vs. 3.6%), or to suffer a severe brain injury (32.7% vs. 14.1%) or facial injury (39.2% vs. 19.6%). Unhelmeted riders were also nearly twice as likely to die in the hospital (7.0% vs. 4.3%) and to suffer a brain injury of any severity (54.1% vs. 30.7%). Finally, the authors found that hospitalization charges for unhelmeted riders averaged \$48,250, 11% higher than average hospitalization charges per helmeted riders (\$43,494; in 2017 dollars).

Evans L & Frick MC (1988). **Helmet effectiveness in preventing motorcycle driver and passenger fatalities**. *Accident Analysis and Prevention*. 20:447-458.

<http://www.sciencedirect.com/science/article/pii/0001457588900437>

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In this study the authors used 1975-1986 FARS data to estimate the fatality-risk reduction offered in fatal crashes to motorcyclists wearing helmets (compared with those who were not). Using a double-pair comparison the authors reviewed helmet use and injury data for all double-occupancy motorcyclists involved in fatal crashes and concluded that wearing a helmet reduced fatality risk to motorcyclists by 28 percent during involvement in a potentially fatal crash.

Fernandes FAO & Alves de Sousa RJ (2013). **Motorcycle helmets – a state of the art review**. *Accident Analysis and Prevention*. 56:1-21.

<https://www.sciencedirect.com/science/article/abs/pii/S0001457513001036>

This study reviews technological changes in the design, manufacture, and testing of motorcycle helmets before and after their use was urged by the pre-WWII research of a British neurosurgeon. Early helmets were made of stiff, treated leather fashioned in the style of aviator headgear. They offered little to no protection in the event of a crash. Until the turn of this century, helmet testing procedures largely centered on the capacity of helmets to cushion direct blows to the head by absorbing and diffusing the impact force over both a wider area and also a longer period of time. However, by the 1980s researchers had realized that oblique impacts were often more injurious to human brains than direct ones. For instance, when a motorcycle crash occurs, the rider is often thrown onto the roadway surface, and the helmet may strike the pavement or another object with rotational force that pushes or pulls the brain in a “sideways” or oblique manner. More recent innovation has resulted in the manufacture of helmets that are better able to resist such oblique-impact injuries largely due to the introduction of a lower-friction layer between the hard outer shell and the softer inner liner as well as a low-friction layer coating the surface of the outer shell.

National Center for Statistics and Analysis (2011). **Determining estimates of lives and costs saved by motorcycle helmets** (DOT HS 811 433). Washington DC: National Highway Traffic Safety Administration, March 2011. <https://crashstats.nhtsa.dot.gov/Api/Public/Publication/811433>

NCSA researchers used NOPUS, GES, and FARS data to examine the role of motorcycle helmets in saving lives and reducing economic costs in all states, D.C., Puerto Rico, and the U.S. as a whole during 2007 and 2008. They confirmed that unhelmeted motorcyclists are far more likely to die in the event of a crash. Specifically, for every thirteen non-fatally injured unhelmeted motorcyclists, one unhelmeted motorcyclist will die. Among helmeted motorcyclists, this ratio is one death for every twenty unhelmeted but injured motorcyclists. Thus, helmeted motorcyclists are significantly less likely to die in injury-causing crashes than unhelmeted ones. The authors conclude that Washington State saved 35 lives in 2007 and 46 in 2008 by passing and enforcing a universal motorcycle helmet law. The authors conclude that Washington State saved \$52.9 million in 2007 and \$90.3 million in 2008 by continuing to enforce its universal helmet law – or \$61.4 million and \$105 million in 2017 dollars.

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Lin M-R & Kraus JF (2009). **A review of risk factors and patterns of motorcycle injuries.** *Accident Analysis and Prevention*. 41:710-722.

<https://www.sciencedirect.com/science/article/abs/pii/S0001457509000578>

This study reviews findings from multiple studies and concludes that leg injuries, particularly tibial and femoral fractures, are the most common pattern in cases of nonfatal motorcycle injury. By comparison, head injuries are the leading cause of death in motorcycle crashes especially in head-on and single-motorcycle crashes; 53 percent of motorcycle fatalities between 1979 and 1986 resulted from head injuries. The authors also added that head injuries remain the leading cause of death, even among helmeted riders. By contrast, the lower extremities are the most common injury site in nonfatal motorcycle crashes, consistently found in 30 to 70 percent of injured riders. The authors reviewed nearly 20 published U.S. studies regarding helmet effectiveness and concluded, “[T]he results consistently indicate that nonhelmeted riders are more likely to have head injuries, die, require longer hospitalization, and have higher medical costs compared to helmeted riders”. Moreover, they reviewed evidence from nearly 30 studies on motorcycle helmet laws and found that “comprehensive helmet laws are significantly associated with an increase in helmet usage followed by declines in the total number of motorcycle deaths, head injuries, days of hospitalization, and medical costs”. The authors also recommend that BAC limits should be reconsidered in order “to reflect the need for greater coordination and balance when operating two-wheeled vehicles”.

Liu BC, Ivers R, Norton R, Boufous S, Blows S, & Lo SK (2008). **Helmets for preventing injury in motorcycle riders.** *Cochrane Database of Systematic Reviews*. Issue 1. Srt. No.: CD00433. DOI: 10.1002/14651858.CD004333.pub3.

<http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD004333.pub3/full>

This meta-analysis of 61 studies examined the effectiveness of motorcycle helmets in preventing fatalities and head, neck, or facial injuries to riders involved in crashes. Statistical analysis of combined study data resulted in pooled odds ratios for four controlled studies and for sixteen uncontrolled studies coincided: wearing a motorcycle helmet reduces the risk of incurring a fatal injury by 42 percent. The overall finding was generally echoed by even the poorer-quality studies excluded from the pooled analysis. The authors also found that “methodological quality was poor” among most of the included studies, mainly due to poor or missing controls for confounders; nonrandom case selection or related biases; and frequent instances of missing data, often for large percentages of study cases. The same Cochrane review also examined the effectiveness of motorcycle helmets against head injury, the largest single bodily injury contributing to motorcyclist deaths. Six studies controlling for confounders were combined to yield a pooled result showing that wearing a motorcycle helmet lowers the risk of head injury by 69 percent. Results were similar in an analysis of 18 remaining uncontrolled studies. For studies in the review that examined head injury risk for full-face helmets, open-face helmets, and no helmets generally found small or

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nonsignificant differences between full-face and open-face helmets, though both of these were protective against head injury.

Maartens NF, Wills AD, & Adams CBT (2002). **Lawrence of Arabia, Sir Hugh Cairns, and the origin of motorcycle helmets.** *Neurosurgery*. 50:176-180.

<https://doi.org/10.1097/00006123-200201000-00026>

This study traces the origin of motorcycle helmet laws to the early career of Hugh Cairns, a young British neurosurgeon who treated T.E. Lawrence ("of Arabia") for five days after he sustained a head injury (ultimately fatal) in a 1935 motorcycle crash. Deeply affected by that case, Cairns later worked as a consulting neurologist to the British Army before and during WWII. Recognizing the high mortality rates among motorcycle dispatch riders in the Army, Cairns recommended that British dispatch riders be required to wear motorcycle helmets. Motorcycle helmets became compulsory in November 1941. Cairns continued to analyze motorcycle injury data in Britain throughout the war and documented that (1) most of the injuries leading to motorcyclist deaths were to the head, and (2) fatalities resulting from head injuries declined dramatically after the dispatch rider helmet requirement was implemented. Cairns' findings were published in the *British Medical Journal* in 1946. Sadly, nationwide compulsory helmet use was not required in Britain until 1973, twenty-seven years after Cairns' study appeared.

MacLeod JBA, DiGiacomo JC, & Tinkoff G (2010). **An evidence-based review: helmet efficacy to reduce head injury and mortality in motorcycle crashes: EAST practice management guidelines.** *Journal of Trauma Injury, Infection, and Critical Care*. 69:1101-1111.

<http://www.east.org/tpp/MotorcycleHelmet.pdf>

This review examined 45 studies published between 1990 and 2009. The authors point out that despite the fact that research has quantified the consequences of not wearing a motorcycle helmet, many states have repealed their helmet laws. Of the 23 studies addressing motorcyclist death rates, 16 showed that unhelmeted riders are more likely to die in crashes than helmeted ones. Studies addressing motorcyclist head injury found unhelmeted riders showed higher rates of fatal head injuries. All studies showed that unhelmeted riders were much more likely to sustain nonfatal head injuries, and the comparative difference with helmeted riders was especially large. Finally, two multi-state studies showed that helmet laws lowered fatalities and serious injuries in the states implementing them. The authors caution readers, however, that poor or missing attempts to control for confounders, like age, sex, or the presence of alcohol or drugs, limited the value of these results. Moreover, the numeric results showed very large ranges in many cases, further limiting their statistical power.

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Naumann RB & Shults RA (2012). **Helmet use among motorcyclists who died in crashes and economic cost savings associated with state motorcycle helmet laws – United States, 2008-2010.** Centers for Disease Control and Prevention *Morbidity and Mortality Weekly Report* (6/15/2012). 61:425-430. <https://www.cdc.gov/mmwr/pdf/wk/mm6123.pdf>

In this study, researchers at the CDC analyzed 2008-2010 FARS data for the 14,283 motorcycle fatalities during that three-year period – 6,057 of whom were not helmeted in the crashes that killed them. After apportioning these fatalities by state helmet law status, researchers estimated that, compared to motorcyclist fatalities in states with universal helmet laws, fatally injured riders in states with partial helmet laws were more than five times as likely to be unhelmeted, and in states with no helmet laws they were over six times more likely to be unhelmeted. Researchers also used GES data for the same period to estimate the cost burden for unhelmeted and helmeted motorcyclists suffering nonfatal crash injuries during the same three-year period. Finally, using NHTSA's per-severity economic cost estimates, they calculated that in 2010 alone the U.S. saved about \$3 billion in costs as a result of motorcycle helmet use – \$3.42 billion in 2017 dollars.

Rowland J, Rivara F, Salzberg P, Soderberg R, Maier R, & Koepsell T (1996). **Motorcycle helmet use and injury outcome and hospitalization costs from crashes in Washington State.** *American Journal of Public Health*. 86:41-45. <http://ajph.aphapublications.org/doi/pdfplus/10.2105/AJPH.86.1.41>

This study linked 1989 crash, licensing, and hospital data in order to compare important outcomes for helmeted and unhelmeted motorcyclists injured in crashes and either admitted to hospital for treatment or deceased without hospital admission. No meaningful differences existed between comparison groups for either age or gender. Results of the analysis showed that, compared to helmeted riders, unhelmeted ones were 63 percent more likely to die in crashes, 2.9 times more likely to be hospitalized with a head injury and 3.7 times more likely to be diagnosed with a severe or critical head injury. Unhelmeted riders were also twice as likely to sustain a serious injury of any kind and over twice as likely to be readmitted to hospital for further treatment. Finally, the average per-patient medical costs were 30 percent higher for unhelmeted riders than helmeted ones – \$12,689 versus \$16,460 – though the difference did not reach statistical significance owing to extreme variability in the data. In 2017 dollars these figures would be \$22,267 and \$28,885, respectively.

Subramanian R (2007). **Bodily injury locations in fatally injured motorcycle riders: a brief statistical summary** (DOT HS 810 856). Washington DC: National Highway Traffic Safety Administration <https://crashstats.nhtsa.dot.gov/Api/Public/Publication/810856>

In this brief Research Note, the author used death certificates matched to 2000-2002 FARS motorcycle fatality cases to identify which body-part injuries were identified for fatalities where either one or two bodily injury locations were identified in the death certificates. Results showed that, among riders whose injuries were known for one or two injury-related axis codes, 51 percent

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of unhelmeted fatalities incurred head injuries, whereas only 35 percent of helmeted fatalities were observed with head injuries.

Simon v. Sargent, US District Court for the District of Massachusetts (1972). 346 F. Supp. 277.

<https://law.justia.com/cases/federal/district-courts/FSupp/346/277/1878636/>

"[W]hile we agree with plaintiff that the act's only realistic purpose is the prevention of head injuries incurred in motorcycle mishaps, we cannot agree that the consequences of such injuries are limited to the individual who sustains the injury.... From the moment of the injury, society picks the person up off the highway; delivers him to a municipal hospital and municipal doctors; provides him with unemployment compensation if, after recovery, he cannot replace his lost job, and, if the injury causes permanent disability, may assume the responsibility for his and his family's continued subsistence. We do not understand a state of mind that permits plaintiff to think that only he himself is concerned." This result was later confirmed by the US Supreme Court without comment.

State v. Laitinen (1969). WA State Supreme Court, 77 Wn.2d 130.

[https://advance.lexis.com/container/?pdmfid=1000516&crid=00d54559-d929-4262-a48b-167ff74ebb8c&pdsearchterms=State+v.+Laitinen+77+Wn.+2d+130+\(1969\)&pdstartin=hlct%3A1%3A1&pdtypeofsearch=searchboxclick&pdsearchtype=SearchBox&pdqtype=and&pdsf=&pdquerytemplateid=urn%3Aquerytemplate%3A9a92fc8e83b2afed5b012fd72a8eeac8~%5EWA+Courts&pdsourctype=all&pdparentqt=urn%3Aquerytemplate%3A9a92fc8e83b2afed5b012fd72a8eeac8~%5EWA+Courts&config=00JABjNzNiNmI0Yi03M2I5LTrhZjAtOTkyNi1NmZlYTA4NzIxY2IKAFBvZENhdGFsb2eb9o8Buc83BjKkJV0MpL27&ecomp=kg2_9kk&earg=pdsf&prid=f1b84522-bead-4dee-9401-c9e52cd4a61f](https://advance.lexis.com/container/?pdmfid=1000516&crid=00d54559-d929-4262-a48b-167ff74ebb8c&pdsearchterms=State+v.+Laitinen+77+Wn.+2d+130+(1969)&pdstartin=hlct%3A1%3A1&pdtypeofsearch=searchboxclick&pdsearchtype=SearchBox&pdqtype=and&pdsf=&pdquerytemplateid=urn%3Aquerytemplate%3A9a92fc8e83b2afed5b012fd72a8eeac8~%5EWA+Courts&pdsourctype=all&pdparentqt=urn%3Aquerytemplate%3A9a92fc8e83b2afed5b012fd72a8eeac8~%5EWA+Courts&config=00JABjNzNiNmI0Yi03M2I5LTrhZjAtOTkyNi1NmZlYTA4NzIxY2IKAFBvZENhdGFsb2eb9o8Buc83BjKkJV0MpL27&ecomp=kg2_9kk&earg=pdsf&prid=f1b84522-bead-4dee-9401-c9e52cd4a61f)

"[D]efendant and amici curiae contend that, since the helmet affords protection to the wearer only, it does not protect the public, and therefore, requiring that it be worn has no real, substantial or rational connection with the public peace, health, safety, morals or general welfare....The public has already assumed many burdens and responsibilities in helping ameliorate the effects of accidents. It has at public expense substantially provided emergency ambulance, medical, surgical and hospital care for persons injured on the public highways and supplied medical, surgical and hospital services for indigent persons so injured....The greater the number of serious injuries to the head and upper spine suffered by motorcycle riders, the greater the burdens it can reasonably be said are imposed on the publicly supplied or regulated medical, hospital, ambulance and police services. There thus exists a reasonably manifest connection between the use of protective helmets by motorcycle riders and the public health, welfare and safety. Accordingly, requiring motorcycle riders to wear protective helmets of a type approved by the state commission on equipment when riding upon the public highways is a legitimate and reasonable exercise of the police power, and RCW 46.37.530 (3) is a constitutional declaration thereof."

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Wilson DC (1989). **The effectiveness of motorcycle helmets in preventing fatalities.** NHTSA Technical Report DOT HS <https://rosap.ntl.bts.gov/view/dot/1515>

This study used the double-pair-comparison method pioneered by Evans and Frick to estimate the effectiveness of motorcycle helmets in preventing crash deaths. Using 1982-1987 FARS data, the author concluded that wearing a motorcycle helmet during a crash reduced fatality risk by 27 percent for motorcycle operators (one percentage point lower than the 28 percent estimate Evans and Frick calculated with 1975-1986 FARS data) and by 30 percent for motorcycle passengers, or a 29 percent overall fatality risk reduction estimate. The author estimated that the lives of 4,645 motorcyclists were saved during the period studied – roughly half of the 9,030 total lives that could have been saved if all motorcyclists involved in crashes between 1982 and 1987 had worn helmets.

Yu W-Y, Chen C-Y, Chiu W-T & Lin M-R (2011). **Effectiveness of different types of motorcycle helmets and effects of their improper use on head injuries.** *International Journal of Epidemiology*. 40:794-803. <https://academic.oup.com/ije/article/40/3/794/746475>

This case-control study investigated the relative effectiveness of different motorcycle helmet types – i.e., full-face shield, open-face, and half-helmet – in crashes in Taiwan. The authors studied 458 case-control pairs of motorcyclists killed or injured in Taiwanese crashes; cases had head injuries, and controls did not. The results of their logistic regression analysis showed that, compared to helmeted riders, unhelmeted motorcyclists were more than four times as likely to sustain head injuries and more than ten times as likely to incur brain injuries. Moreover, compared to riders wearing full-face helmets, riders wearing “half-helmets” were more than twice as likely to suffer head injuries and brain injuries. Finally, compared with riders with securely-fastened helmets, riders who wore loosely-fastened helmets were 94 percent more likely to suffer a head injury and over twice as likely to sustain a brain injury.