Community Preventive Services Task Force

Motor Vehicle-Related Injury Prevention: Use of Motorcycle Helmets, Universal Helmet Laws

Task Force Finding and Rationale Statement

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Task Force Finding and Rationale Statement

Context

In the U.S., motorcycles account for about 3% of registered vehicles, 0.6% of vehicle miles traveled, and a disproportionate 14% of all road traffic fatalities (DOT, 2013).

Intervention Definition

Motorcycle helmet laws require motorcycle riders to wear a helmet while riding on public roads. In the U.S., these laws are implemented at the state level with varying provisions and fall into two categories:

- **Universal helmet laws** apply to all motorcycle operators and passengers.
- **Partial helmet laws** apply only to certain motorcycle operators such as those under a certain age (usually 18); novices (most often defined as having less than one year of experience); or those who do not meet the state's requirement for medical insurance coverage. Passengers on motorcycles are not consistently covered under partial helmet laws.

Universal or partial motorcycle helmet laws may contain provisions that:

- Require use of helmets approved by regulatory agencies (e.g., U.S. Department of Transportation)
- Cover all motorized cycles (including motorcycles and low-powered cycles such as mopeds or scooters), or cover only those meeting specific criteria (most often defined by engine capacity, horsepower, or ability to exceed certain speeds)
- Specify penalties for violators (usually monetary fines)

Task Force Finding (August 2013)

The Community Preventive Services Task Force recommends universal motorcycle helmet laws (laws that apply to all motorcycle operators and passengers) based on strong evidence of effectiveness. Evidence indicates that universal helmet laws increase helmet use; decrease motorcycle-related fatal and non-fatal injuries; and are substantially more effective than no law or than partial motorcycle helmet laws, which apply only to riders who are young, novices, or have medical insurance coverage below certain thresholds.

States in the U.S. that repealed universal helmet laws and replaced them with partial laws or no law consistently experienced substantial:

- Decreases in helmet use, and
- Increases in fatal and non-fatal injuries.

States that implemented universal helmet laws in place of partial laws or no law consistently experienced substantial:

- Increases in helmet use, and
- Decreases in fatal and non-fatal injuries.

Economic evidence shows that universal motorcycle helmet laws produce substantial economic benefits that greatly exceed costs. Most benefits come from averted healthcare and productivity losses.

Rationale

Basis of Finding

The Task Force recommendation is based on strong evidence of effectiveness from 71 studies with 78 study arms; 67 study arms evaluated motorcycle helmet laws in the U.S. (search period through August 2012). Comparison of universal and partial helmet law effectiveness came from 48 study arms. Evidence from included studies indicated that universal motorcycle helmet laws resulted in more helmet use and fewer fatal and non-fatal injuries than either partial laws or no law (Table).

Given that all partial laws in the U.S. cover helmet use among youth, law effectiveness in this population group might be expected to be roughly equivalent in states with either partial or universal helmet laws. However, 12 included U.S. studies examined helmet law impact on youth and found that, although partial helmet laws did offer some protection compared to no law, universal helmet laws were much more effective than partial laws in increasing helmet use and reducing fatalities and head injuries among youth (Table 1).

States with universal helmet laws showed substantial reductions in fatal and non-fatal injuries compared to states with partial laws or no law, even when outcome measures accounted for potential differences in motorcycle registration or use (i.e., injuries per registered motorcycle, per vehicle miles traveled, or per crash). Reductions in fatal and non-fatal head injuries were greater than reductions in overall fatal and non-fatal injuries because motorcycle helmets protect the head area (See table).

Effectiveness of Motorcycle Helmet Laws in Increasing Helmet Use and Reducing Motorcycle-Related Fatal and Non-Fatal Injuries

Outcomes (# of Study Arms)	Results

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Helmet Use* (44)	**Law Comparison Studies** Universal compared to partial laws or no law (6 study arms) Median of 53 pct pts higher (IQI: 51 to 60 pct pts) Universal compared to partial laws only (4 study arms) Median of 53 pct pts higher (Range: 48 to 73 pct pts) Partial compared to no law (4 study arms) Median of 5 pct pts higher (Range: 0 to 19 pct pts) **Youth Only** Universal compared to partial or no law (2 study arms with 4 effect estimates) Median of 41 pct pts higher (Range: 31 to 59 pct pts) Universal compared to partial law (2 study arms) Increase of 31 and 42 pct pts Partial compared to no law (3 study arms) Median of 10 pct pts higher (Range: 5 to 17 pct pts) **Law Implementing Studies** No or partial to universal law (16 study arms) Median increase of 54 pct pts (IQI: 43 to 74 pct pts) Partial to universal law (13 study arms) Median increase of 52 pct pts (IQI: 42 to 68 pct pts) **Law Repealing Studies** Universal to partial or no law (21 study arms) Median decrease of 41 pct pts (IQI: -48 to -31 pct pts) Universal to partial law (18 study arms) Median decrease of 42 pct pts (IQI: -50 to -36 pct pts) **Youth Only** Law implementing Partial to universal law (1 study arm) Increase of 31 pct pts Law repealing Universal to partial law (5 study arms) Median decrease of 17 pct pts (IQI: -19 to -3 pct pts)

Outcomes (# of Study Arms)	Results
Fatalities, Total† (40)	**Law Comparison Studies** Universal compared to partial or no law (7 study arms) Median of 24% fewer fatalities (IQI: -29% to -22%) **Youth Only** Universal compared to no law (1 study arm) 31% fewer fatalities Partial compared to no law (2 study arms) -1% and 0.1% differences in fatalities **Law Implementing Studies** No or partial to universal law (14 study arms) Median decrease of 31% (IQI: -43% to -23%) Partial to universal law (9 study arms) Median decrease of 28% (IQI: -33% to -20%) **Law Repealing Studies** Universal to partial or no law (20 study arms) Median increase of 42% (IQI: 26% to 67%) Universal to partial law (16 study arms) Median increase of 46% (IQI: 28% to 70%) **Youth Only** Law implementing Partial to universal law (1 study arm) Decrease of 48% Law repealing Universal to partial law (3 study arms) Median increase of 125% (Range: 116% to 189%)

Outcomes (# of Study Arms)	Results
Fatalities per Registered Motorcycle† (35)	**Law Comparison Studies** Universal compared to partial or no law (7 study arms) Median of 12% fewer fatalities per registered motorcycle (IQI: -19% to -8%) Partial compared to no law (2 study arms) -10% and 43% differences in fatalities **Youth Only** Partial compared to no law (1 study arm) No difference, 0% **Law Implementing Studies** No or partial to universal law (12 study arms) Median decrease of 34% (IQI: -47% to -23%) Partial to universal law (6 study arms) Median decrease of 25% (IQI: -36% to -16%) **Law Repealing Studies** Universal to partial or no law (18 study arms) Median increase of 24% (IQI: 9% to 42%) Universal to partial law (17 study arms) Median increase of 21% (IQI: 7% to 38%)

Outcomes (# of Study Arms)	Results
Fatalities per Vehicle Miles Traveled (VMT)† (6)	**Law Comparison Studies** Universal compared to partial or no law (2 study arms with 3 effect estimates) Median of 27% fewer fatalities per VMT (Range: -32% to -22%) Partial compared to no law (1 study arm) 8% fewer fatalities per VMT **Law Implementing Studies** Partial to universal law (1 study arm) Decrease of 43% **Law Repealing Studies** Universal to partial law (3 study arms) Median increase of 23% (Range: 14% to 38%)
Fatalities per Crash† (17)	**Law Comparison Studies** Universal compared to partial or no law (1 study arm) 14% fewer fatalities per crash **Law Implementing Studies** No or partial to universal law (5 study arms) Median decreases of 17% (IQI: -27% to -8%) Partial to universal law (2 study arms) Decrease of 25%, 12% **Law Repealing Studies** Universal to partial or no law (12 study arms) Median increase of 23% (IQI: 41% to 36%) Universal to partial law (10 study arms) Median increase of 22% (IQI: -4% to 36%) **Youth Only** Law implementing Partial to universal law (1 study arm) Decrease of 48%

Outcomes (# of Study Arms)	Results
Fatalities, Head Injury- Related† (12)	**Law Comparison Studies** Universal compared to partial or no law (1 study arm) 47% fewer fatal head injuries **Law Implementing Studies** No or partial to universal law (9 study arms) Median decrease of 50% (IQI: -55% to -38%) Partial to universal law (5 study arms) Median decrease of 50% (IQI: -54% to -43%) **Law Repealing Studies** Universal to partial law (2 study arms) Increase of 6%, 65%
Non-Fatal Injuries, Total† (20)	**Law Comparison Studies** Universal compared to partial or no law (1 study arm) 20% fewer non-fatal injuries **Youth Only** Universal compared to partial or no law (1 study arm) 8% more non-fatal injuries **Law Implementing Studies** No or partial to universal law (9 study arms) Median decrease of 31% (IQI: -37% to -14%) Partial to universal law (6 study arms) Median decrease of 21% (IQI: -33% to -3%) **Law Repealing Studies** Universal to partial law (10 study arms) Median increase of 41% (IQI: 19% to 61%)

Outcomes (# of Study Arms)	Results
Non-Fatal Injuries, Head-Related† (20)	**Law Comparison Studies** Universal compared to partial or no law (3 study arms) Median of 33% fewer non-fatal head injuries as proportion of total injuries (Range: -44% to -12%) Universal compared to partial laws only (2 study arms) 27% and 12% fewer non-fatal head injuries as proportion of total injuries Partial compared to no law (1 study arm) 15% fewer non-fatal head injuries as proportion of total injuries **Youth Only** Universal compared to partial law (1 study arm) 12% fewer non-fatal head injuries as proportion of hospitalized motorcyclists **Law Implementing Studies** No or partial to universal law (10 study arms) Median decrease of 51% (IQI: -56% to -40%) Partial to universal law (6 study arms) Median decrease of 54% (IQI: -61% to -36%) **Law Repealing Studies** Universal to partial law (4 study arms) Median increase of 74% (Range: 53% to 83%) **Youth Only** Law implementing No or partial to universal law (3 study arms) Median decrease of 27% (Range: -60% to -19%) Partial to universal law (2 study arms) Decrease of 60% and 27%

*Effectiveness measurement: absolute percentage point change (pct pts)
†Effectiveness measurement: relative percent change (%)
IQI=Interquartile interval

Applicability and Generalizability Issues

Most included studies evaluated helmet laws in the U.S. (67 study arms). Remaining studies were conducted in Australia (1 study arm), Italy (4 study arms), New Zealand (2 study arms), Spain (2 study arms), and Taiwan (2 study arms). Implementing universal helmet laws from no or partial laws was evaluated in 25 study arms, repealing universal helmet laws to partial or no law was assessed in 32 study arms, and impact of universal helmet laws vs. partial or no helmet laws was compared in 24 study arms.

Twenty-six study arms provided demographic information on motorcyclists who were involved in fatal or non-fatal crashes (25 study arms) or observed during a helmet use observational study (1 study arm). Age and gender differences were found between U.S. (23 study arms) and non-U.S. (3 study arms) motorcyclist populations. In the U.S., motorcyclists had a mean age of 36.5 years and were predominantly male (median: 91%). Outside the U.S., motorcyclists were slightly younger (mean age of 33.8 years) with fewer males (median: 66.9%).

Studies examined the impact of universal helmet laws in different settings and on different population groups. These laws were equally effective in the U.S. (67 study arms) and other countries (11 study arms) and for male and female riders (6 study arms). Universal helmet laws were also shown to be effective across all age groups (9 study arms). Fifteen study arms from U.S. (12 study arms) and other countries (3 study arms) specifically examined the effect of helmet laws on young motorcycle operators and passengers and found universal helmet laws were more effective than partial helmet laws in increasing helmet use and decreasing fatalities among youth. Comparison of law effectiveness in rural vs. urban areas (2 study arms) was inconclusive. Compared to motorcycle operators, passengers usually had a lower prevalence of helmet use under both universal and partial helmet laws, though universal laws increased helmet use for both operators and passengers (7 study arms).

Data Quality Issues

Study designs included in the review were interrupted time series (6 study arms), panel (14 study arms), time-series or before-after with concurrent comparison groups (12 study arms), before-after (40 study arms), and cross-sectional (6 study arms). Although each study design comes with unique risks of bias, effect estimates across multiple study types, population groups, and outcome measures were remarkably consistent for this body of evidence. No plausible source of bias could account for this consistency.

Although the best measures of helmet law effectiveness from a public health perspective would be motorcycle-related fatal or non-fatal injuries, total injury counts are affected by the amount of motorcycle use ("riding exposure"), which could change in response to the presence or absence of universal helmet laws. Many included studies attempted to account for driving exposure by dividing total counts of fatal and non-fatal injuries by the number of registered motorcycles, vehicle miles traveled, or crashes. Regardless of the specific measure used, universal helmet laws were shown to be more effective than partial laws or no law in increasing helmet use and reducing fatal and non-fatal injuries.

Other Benefits and Harms

No additional benefits of motorcycle helmet laws were identified in the included studies or in the broader literature.

Although one of the postulated harms associated with helmet use is increased risk of neck injuries, the ten included studies that assessed this outcome found that fatal and non-fatal neck injuries accounted for a small proportion of motorcycle-related injuries (median: 1.8%) and the type of helmet law had no noticeable effect on neck injury prevalence. One study found that implementing a universal helmet law resulted in a reduction of 0.5 percentage points in neck injury-related fatalities. Studies reporting non-fatal injuries found little difference in the prevalence of neck

injuries between states that had universal laws and states that had partial laws or no law (median: -0.6 percentage points; range: -0.6 to 0.1 percentage points 3 studies), and minimal changes in prevalence of neck injuries when universal helmet laws were repealed (0.1 percentage point, 0.2 percentage point increases, 2 studies) or implemented (median: 0.0 percentage points; range: -0.3 to 0.6 percentage points, 4 studies).

Other postulated harms of helmet use include hearing or vision impairment, though evidence from laboratory and field research does not substantiate these claims (McKnight & McKnight, 1995). Finally, some researchers have raised concerns about risk compensation, postulating that riders wearing helmets feel safer and increase their risk-taking behaviors (reviewed in Hedlund 2000). Evidence on this issue is limited, though in one available study, researchers analyzed data from on-scene, in-depth investigations of motorcycle-related crashes in Los Angeles and concluded helmet use was not associated with riskier behaviors (Ouellet 2011).

Economic Evidence

The economic review included 22 studies, with 21 studies from the U.S. All monetary values are reported in 2012 U.S. dollars. In summary, evidence indicates that universal motorcycle helmet laws produce substantial economic benefits that greatly exceed the costs. The majority of these benefits come from averted healthcare costs and productivity losses.

Of the included studies, 18 provided data on benefits only.

- All 12 studies that looked specifically at universal helmet laws reported increased economic benefits after implementation, with four directly comparable studies reporting benefits ranging from $29.3 million to $96.1 million per 100,000 registered motorcycles per year.
- All five studies that examined repeal of universal helmet laws found higher healthcare costs after repeal, with three directly comparable studies reporting increased costs ranging from $1.8 million to $27.2 million per 100,000 registered motorcycles per year. There was no evidence to suggest that these cost increases were due to an increase in the number of motorcycle crashes.

Three studies in the economic review performed cost-benefit comparisons and found that benefits of universal motorcycle helmet laws exceeded costs of implementation. In these studies, costs were defined as the cost of motorcycle helmets, and reported benefits were defined as averted healthcare costs, productivity losses, and other non-income losses.

Productivity and other non-income losses were estimated with either job market valuation of productivity or willingness-to-pay valuation, which considers an individual's willingness-to-pay to reduce their probability of death or injury.

- One cost-benefit study addressed only averted healthcare costs and found a benefit-to-cost ratio ranging from 1.9:1 to 2.3:1 and net benefits from $2.7 million to $3.2 million per 100,000 motorcyclists per year.
- Two cost-benefit studies addressed all three benefit types. The benefit-to-cost ratio for universal helmet laws using a market valuation of productivity loss ranged from 5.3:1 to 10.8:1 and net benefits ranged from $5.9 million to $19.4 million per 100,000 motorcyclists per year. Using a willingness-to-pay valuation, the benefit-to-cost ratio ranged from 10.6:1 to 20.2:1 and net benefits ranged from $12.8 to $86.9 million per 100,000 motorcyclists per year. Additionally, results from one study showed that estimated benefits were greatest when states converted from no law to a universal law (benefit-to-cost ratio ranged from 6.3:1 to 20:1, and net benefits ranged from $6.9 million to $25.4 million per 100,000 motorcyclists per year), though benefits were almost as

great when states converted from partial law to universal law (benefit-to-cost ratio ranged from 5.5:1 to 17.9:1, and net benefits ranged from $5.9 million to $22.0 million per 100,000 motorcyclists per year).

One study in the economic review found evidence of cost-effectiveness of universal motorcycle helmet laws. However, this study was conducted in Australia in 1964, limiting its usefulness and applicability to the contemporary U.S. setting.

Considerations for Implementation

In the U.S., the trend over the past few decades has been to repeal universal helmet laws. Among the arguments made by opponents of those laws are assertions that helmet effectiveness is not certain and data on helmet law effectiveness are inconclusive. A Cochrane systematic review assessed motorcycle helmet effectiveness and found helmet use led to a 42% reduction in risk for fatal injuries and a 69% reduction in risk for head injuries (Liu et al., 2008). Evidence from the present review addresses the second assertion by demonstrating the effectiveness of universal helmet laws when compared to no law or partial laws.

Universal helmet laws, in addition to being more effective than partial laws, are easier to enforce. The characteristics specified in partial helmet laws (e.g., age, experience, level of medical insurance) are not easily evaluated by police officers monitoring traffic, making it difficult to identify violators. In contrast, universal helmet laws apply to all motorcycle operators and passengers so anyone riding without a helmet is easily identified. Evidence from the present review shows that when states transition from partial to universal helmet laws, there are substantial increases in helmet use and reductions in fatal and non-fatal injuries, not only for motorcyclists in general, but also for motorcyclists previously covered by partial helmet laws, such as young people.

In 2012, approximately 9% of U.S. motorcyclists wore unapproved helmets (Pickrell & Ye, 2013). Laboratory testing has shown that these helmets do not protect motorcyclists effectively from head injuries: they may cover only a minimal area of the head, come off easily during a crash, or lack impact-absorbing material. Some states require the use of helmets approved by the U.S. Department of Transportation (DOT). Training traffic law enforcement officers in these states to recognize unapproved helmets, and thereby enforce existing laws, may improve helmet law effectiveness.

Evidence Gaps

Nearly six decades of research on this topic have answered primary research questions and demonstrated the effectiveness of universal helmet laws across population groups in various settings. Additional research could answer some lingering questions.

No included study assessed the role of enforcement on helmet law effectiveness, and very few reported on use of unapproved helmets. More studies are needed on the impact of helmet law enforcement, especially in connection with use of unapproved helmets. More studies also are needed to examine the impact of universal helmet laws in rural areas.

More research is needed to better understand the impact of helmet laws on riders of low-powered motorized cycles (e.g., scooters, mopeds) which have been gaining popularity, especially in urban settings. In 2013, all types of low-powered cycles were covered in 12 of 19 states with universal helmet laws and 11 of 28 states with partial helmet laws; the remaining states with helmet laws covered motorized cycles above certain thresholds, such as engine displacement greater than 50cc or those designed to go over 30 mph (Insurance Institute for Highway Safety, 2013).

Available evidence for economic benefits of universal helmet laws, including averted healthcare costs and productivity losses, are calculated from a societal perspective. More evidence is needed to understand the economic benefits for individual motorcycle riders. Healthcare costs and productivity losses after a motorcycle crash can often add up to more than the coverage provided by health and disability insurance, especially for head injuries, which can create an excessive economic burden for the rider. Riders often realize economic benefits from universal motorcycle helmet laws because helmets substantially reduce the probability of costly injury and death.

The data presented here are preliminary and are subject to change as the systematic review goes through the scientific peer review process.

References

DOT. Traffic Safety Facts 2011 Data. (Report No. DOT HS 811 765). 2013 Washington, DC: National Highway Traffic Safety Administration. Available at URL: http://www-nrd.nhtsa.dot.gov/Pubs/811765.pdf.

Hedlund J. Risky business: safety regulations, risk compensation and individual behavior. *Injury Prevention* 2000;6:82-90.

Insurance Institute For Highway Safety. Motorcycle helmet use.Washington (DC): IIHS; 2013 [December 2013] Available at URL: http://www.iihs.org/iihs/topics/laws/helmetuse?topicName=motorcycles.

Liu BC, Ivers R, Norton R, Boufous S, Blows S, Lo SK. Helmets for preventing injury in motorcycle riders. Cochrane database of systematic reviews 2008, Issue 1. Art. No.: CD004333. DOI: 10.1002/14651858.CD004333.pub3.

McKnight AJ & McKnight AS. The effects of motorcycle helmets upon seeing and hearing. *Accident Analysis and Prevention* 1995;27(4):493-501.

Ouellet JV. Helmet use and risk compensation in motorcycle accidents. *Traffic Injury Prevention* 2011;12(1):71-81.

Pickrell TM & Ye TJ. Motorcycle helmet use in 2012—overall results. (Report No. DOT HS 811 759). Washington (DC): National Highway Traffic Safety Administration; May 2013. Available at URL: http://www-nrd.nhtsa.dot.gov/Pubs/811759.pdf.

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