Health Impact Review of SB 5622
Modifying the operation of motorcycles on roadways laned for traffic
(2022 Legislative Session)

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WASHINGTON STATE BOARD OF HEALTH

HEALTH EQUITY
Governor's Interagency Council on Health Disparities

Full review
The full Health Impact Review report is available at:
https://sboh.wa.gov/Portals/7/Doc/HealthImpactReviews/HIR-2022-03-SB5622.pdf

Acknowledgements
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SB 5622, Modifying the operation of motorcycles on roadways laned for traffic
(2022 Legislative Session)

Evidence indicates that SB 5622 would likely result in some motorcyclists overtaking and passing a vehicle in the same lane and operating between lanes of traffic in specified circumstances. However, since it is not well researched whether this would impact traffic collisions, the pathway to health impacts could not be completed.

BILL INFORMATION

Sponsors: Randall, Warnick, Gildon, Lovelett, Nguyen, Sheldon, Short

Summary of Bill:

- Allows motorcycles to overtake and pass in the same lane occupied by the vehicle overtaken.
- Allows a motorcycle to operate between lanes of traffic or between adjacent rows of vehicles if the motorcycle operator is traveling no more than 10 miles per hour (mph) over the speed of traffic flow and no more than 35 mph.
- Adds a traffic infraction if an operator of a motor vehicle intentionally impedes or prevents a motorcycle from operating as the law permits.
- Strikes specific language requiring a motorcycle operator to maintain a passing distance of 3 feet when overtaking a pedestrian or bicyclist.

HEALTH IMPACT REVIEW

Summary of Findings:
This Health Impact Review found the following evidence for provisions in SB 5622:

- **Informed assumption** that allowing motorcyclists to overtake and pass a vehicle in the same lane and to operate between lanes of traffic in specified circumstances will result in some motorcyclists doing so. This assumption is based on information shared by key informants representing motorcyclists, Washington State Patrol, the Washington Traffic Safety Commission, and Washington State Departments of Licensing and Transportation.
- **Not well researched** whether lane-splitting/sharing/filtering may impact traffic collisions. Since this relationship is not well researched, the pathway to health impacts could not be completed.

Introduction and Methods

A Health Impact Review is an analysis of how a proposed legislative or budgetary change will likely impact health and health disparities in Washington State (RCW 43.20.285). For the purpose of this review 'health disparities' have been defined as differences in disease, death, and other adverse health conditions that exist between populations (RCW 43.20.270). Differences in health conditions are not intrinsic to a population; rather, inequities are related to social determinants (e.g. access to healthcare, economic stability, racism, etc.). This document provides summaries of the evidence analyzed by State Board of Health staff during the Health Impact Review of Senate Bill 5622 (SB 5622).

Staff analyzed the content of SB 5622 and created a logic model depicting possible pathways leading from the provisions of the bill to health outcomes. We consulted with experts and contacted key informants about the provisions and potential impacts of the bill. We conducted an objective review of published literature for each pathway using databases including PubMed, Google Scholar, and University of Washington Libraries. We evaluated evidence using set criteria and determined a strength-of-evidence for each step in the pathway. More information about key informants and detailed methods are available upon request.

The following pages provide a detailed analysis of the bill, including the logic model, summaries of evidence, and annotated references. The logic model is presented both in text and through a flowchart (Figure 1). The logic model includes information on the strength-of-evidence for each pathway. The strength-of-evidence has been established using set criteria and summarized as:

- **Very strong evidence:** There is a very large body of robust, published evidence and some qualitative primary research with all or almost all evidence supporting the association. There is consensus between all data sources and types, indicating that the premise is well accepted by the scientific community.
- **Strong evidence:** There is a large body of published evidence and some qualitative primary research with the majority of evidence supporting the association, though some sources may have less robust study design or execution. There is consensus between data sources and types.
- **A fair amount of evidence:** There is some published evidence and some qualitative primary research with the majority of evidence supporting the association. The body of evidence may include sources with less robust design and execution and there may be some level of disagreement between data sources and types.
- **Expert opinion:** There is limited or no published evidence; however, rigorous qualitative primary research is available supporting the association, with an attempt to include viewpoints from multiple types of informants. There is consensus among the majority of informants.
- **Informed assumption:** There is limited or no published evidence; however, some qualitative primary research is available. Rigorous qualitative primary research was not possible due to time or other constraints. There is consensus among the majority of informants.

- **No association:** There is some published evidence and some qualitative primary research with the majority of evidence supporting no association or no relationship. The body of evidence may include sources with less robust design and execution and there may be some level of disagreement between data sources and types.
- **Not well researched:** There is limited or no published evidence and limited or no qualitative primary research and the body of evidence has inconsistent or mixed findings, with some supporting the association, some disagreeing, and some finding no connection. There is a lack of consensus between data sources and types.
- **Unclear:** There is a lack of consensus between data sources and types, and the directionality of the association is ambiguous due to potential unintended consequences or other variables.

This review was completed during Legislative Session and was subject to the 10-day turnaround required in statute. This review was subject to time constraints, which influenced the scope of work for this review. The annotated references are only a representation of the evidence and provide examples of current research. In some cases, only a few review articles or meta-analyses are referenced. One article may cite or provide analysis of dozens of other articles. Therefore, the number of references included in the bibliography does not necessarily reflect the strength-of-evidence. In addition, some articles provide evidence for more than one research question, so are referenced multiple times.

Analysis of SB 5622 and the Scientific Evidence

Summary of relevant background information

- RCW 46.04.330 defines "motorcycle" as a motor vehicle designed to travel on not more than three wheels, not including any stabilizing conversion kits, on which the driver either rides on a seat or saddle or rides on a seat in a partially or completely enclosed seating area that is equipped with safety belts.[1] A "'[m]otorcycle' excludes a farm tractor, a power wheelchair, an electric personal assistive mobility device, a motorized foot scooter, an electric-assisted bicycle, and a moped."[1]
- RCW 46.61.526(11)(c) defines a vulnerable user of a public way to mean a pedestrian, a person riding an animal, or a person operating or riding a farm tractor or farm equipment without an enclosed shell, a bicycle, an electric-assisted bicycle, an electric personal assistive mobility device, a moped, a motor-driven cycle, a motorized foot scooter, or a motorcycle.[2]
- RCW 46.61.110 governs how a driver of a vehicle may overtake and pass (i.e., on the left) vehicles proceeding in the same direction.[3] It also includes rules for how a driver of a vehicle may pass "an individual who is traveling as a pedestrian or on a bicycle […] in the right lane of a roadway or on the right-hand shoulder or bicycle lane of the roadway".[3] On roadways with only one lane of travel in each direction, a driver of a vehicle shall "reduce speed to a safe speed […] and pass at a safe distance, where practicable of at least three feet, to clearly avoid coming into contact with the individual…".[3] This RCW was last amended in 2019.
- The U.S. Department of Transportation's (DOT) National Highway Traffic Safety Administration (NHTSA) defines a motorcycle as "a motor vehicle with motive power having a seat or saddle for the use of the rider and designed to travel on not more than three wheels in contact with ground;" the definition is inclusive of motor scooters, mopeds, and motorized bicycles.[4]
- Vision Zero is a national safety initiative with the goal of zero deaths and serious injuries from traffic crashes.[5] The initiative is focused on design and safety systems, and implemented at the local level.[5] Seattle and Bellevue, Washington are Vision Zero cities.[5]
- Target Zero is Washington State's Strategic Highway Safety Plan (SHSP), required by federal law, built on the belief that not one death is acceptable on the state's roadways.[6] Washington is the first state in the country to set a goal of zero serious injuries and fatalities (personal communication, Washington State Department of Transportation [WSDOT], January 2022). The plan sets statewide priorities for all safety partners, provides resources, guides funding, and monitors priority-area outcomes.[6] The vision is to realize zero deaths and serious injuries on Washington State roadways by 2030.[6] The state has local Target Zero Managers to guide local county and tribal task forces, who together with local partners, develop traffic safety programs, services, and community outreach.[6]
    - Washington State has 17 Regional Transportation Planning Organizations (RTPOs) created as part of the 1990 Growth Management Act. Both RTPOs and Metropolitan Planning Organizations (MPOs) are Target Zero partners. They are

    - required to conduct transportation planning, inclusive of the goal of safety, and to identify areas of improvement.[6]
    - In Target Zero reporting, the definition of motorcyclists was expanded to include motor scooters, mopeds, and motorized bicycles to align with NHTSA's definition of motorcycles.[6]
- Washington State requires a motorcycle endorsement to operate two-wheeled and three-wheeled motorcycles. Two-wheeled motorcycles require a "Class 3" endorsement or Endorsement L with restriction; three-wheeled motorcycles (i.e., sidecar rig, trike, reverse trike) require a "Class 5" endorsement or Endorsement L with restriction; and both two-wheeled and three-wheeled motorcycles must have a "Class 7" endorsement or Endorsement L with restriction.[7] No endorsement is required if the vehicle is a two-wheeled motorcycle or scooter with a 50 cubic centimeter (cc) or smaller engine and has a maximum speed of 30 mph.[6]
- Three states have passed legislation allowing motorcyclists to use some version of lane-splitting/sharing/filtering.
    - In 2017, Section 21658.1 was added to California Vehicle Code, allowing legal lane-splitting. The law defines lane-splitting as driving a motorcycle between rows of stopped or moving vehicles in the same lane, on both divided and undivided streets, roads, or highways.[8] Prior to this change, California law did not explicitly prohibit lane-splitting (personal communications, January 2022).
    - In 2019, Utah passed HB 149 amending the Traffic Code to allow lane filtering by a motorcycle.[9] The law stipulates that a motorcyclist may only engage in lane filtering when all of the following conditions are met: they are on a roadway that is divided into 2 or more adjacent traffic lanes in the same direction of travel; they are on a roadway with a speed limit of 45 mph or less; the vehicle being overtaken in the same lane is stopped; the motorcyclist is traveling at a speed of 15 mph or less; and the movement may be made safely.[9]
    - In 2021, Montana passed SB0009 allowing lane filtering for motorcyclists. SB0009 defines lane filtering as "the act of overtaking and passing another vehicle that is stopped or traveling at a speed not in excess of 10 [mph] in the same direction of travel and in the same lane."[10] Lane filtering is permitted when the rider is on a road with wide enough lanes to pass safely, when the overtaking motorcyclist is operating at a speed of 20 mph or less while overtaking a stopped or slow-moving vehicle, and when conditions are reasonable and prudent.[10]

Summary of SB 5622

- Allows motorcycles to overtake and pass in the same lane occupied by the vehicle overtaken.
- Allows a motorcycle to operate between lanes of traffic or between adjacent rows of vehicles if the motorcycle operator is traveling no more than 10 mph over the speed of traffic flow and no more than 35 mph.
- Adds a traffic infraction if an operator of a motor vehicle intentionally impedes or prevents a motorcycle from operating as the law permits.

- Strikes specific language requiring a motorcycle operator to maintain a passing distance of 3 feet when overtaking a pedestrian or bicyclist.

Health impact of SB 5622

Evidence indicates that SB 5622 would likely result in some motorcyclists overtaking and passing a vehicle in the same lane and operating between lanes of traffic in specified circumstances. However, since it is not well researched whether this would impact traffic collisions, the pathway to health impacts could not be completed.

Pathway to health impacts

The potential pathway leading from the provisions of SB 5622 to decreased health inequities is depicted in Figure 1. This review made the informed assumption that allowing motorcyclists to overtake and pass a vehicle in the same lane and to operate between lanes of traffic in specified circumstances will result in some motorcyclists doing so. This assumption is based on information shared by key informants representing motorcyclists, Washington State Patrol, the Washington Traffic Safety Commission, and Washington State Departments of Licensing and Transportation. It is not well researched whether lane-splitting/sharing/filtering may impact traffic collisions.[11-18] Therefore, since this relationship is not well researched, the pathway to health impacts could not be completed.

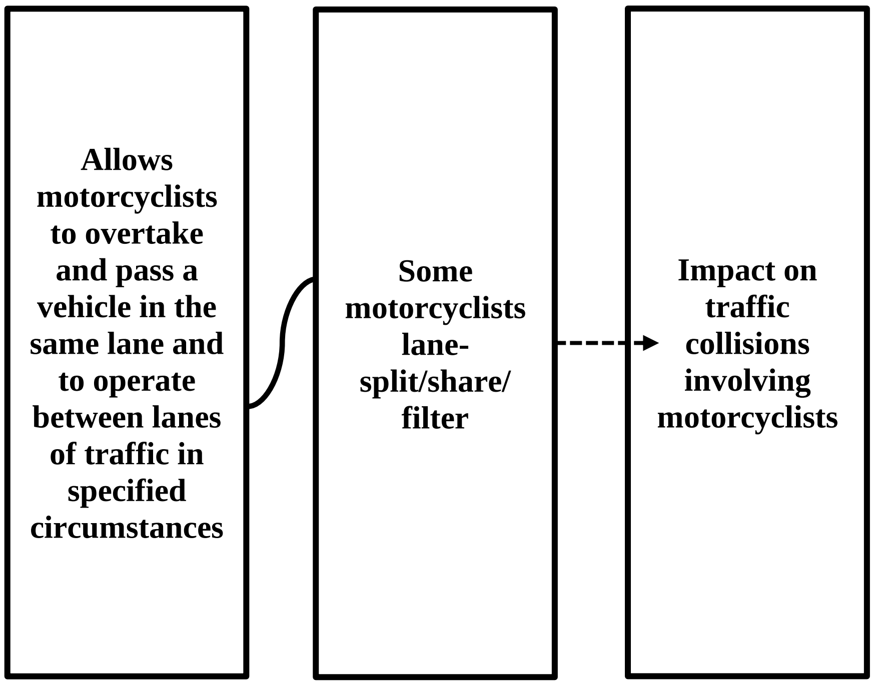
Magnitude of impact

SB 5622 would likely impact all road users in Washington State.

Motorcycles comprise 3% of registered vehicles in Washington State.[6] As of January 2017, 413,113 people had an active motorcycle endorsement in Washington State.[19] Riders aged 45-54 years and 55-64 years represented the highest percentage of endorsed riders.[19] As of 2017, the number of motorcycle registrations had remained consistent over the previous 8 years.[19] However, the number of endorsements increased over the previous 8 years, suggesting riders are maintaining endorsement, but no longer owning motorcycles.[19] It is unknown how many riders are operating motorcycles in the state and are unendorsed (personal communication, Department of Licensing [DOL], January 2022).

While provisions of the bill most directly impact motorcyclists, all other road users (e.g., drivers of other motor vehicles, bicyclists, pedestrians) would need to know how to safely operate under the new rules of the road. Therefore, SB 5622 would likely impact all road users in Washington State.

Logic Model



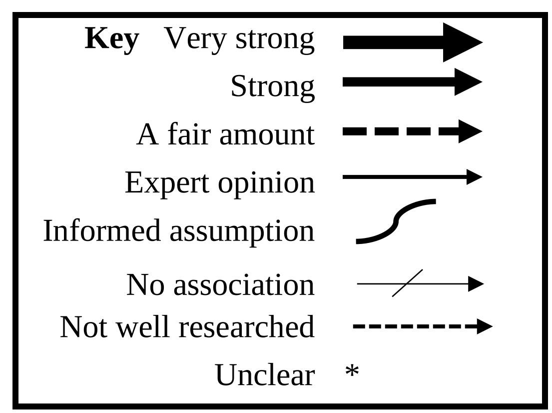
Since the relationship between lane-splitting/sharing/filtering and traffic collisions is not well researched, the pathway to health impacts could not be completed.

See discussion in Summaries of Findings.

Figure 1:

Modifying the operation of motorcycles on roadways laned for traffic

SB 5622



Summaries of Findings

Would allowing motorcyclists to overtake and pass a vehicle in the same lane and to operate between lanes of traffic in specified circumstances result in some motorcyclists doing so?

This review made the informed assumption that allowing motorcyclists to overtake and pass a vehicle in the same lane and to operate between lanes of traffic in specified circumstances will result in some motorcyclists doing so. This assumption is based on information shared by key informants representing motorcyclists, Washington State Patrol (WSP), the Washington Traffic Safety Commission (WTSC), and Washington State Departments of Licensing (DOL) and Transportation (WSDOT).

Current Washington State law (RCW 46.61.608) prohibits an operator of a motorcycle from: 1) overtaking and passing in the same lane occupied by the vehicle being overtaken and 2) operating between lanes of traffic or between adjacent lines or rows of vehicles. Together these provisions prohibit three variations on a riding technique: lane-splitting, lane-sharing, and lane-filtering.* The term "lane-splitting" is used to describe overtaking and passing a vehicle in the same lane or operating between lanes at speeds generally considered highway speeds (i.e., greater than 35 miles per hour (mph). "Lane-sharing" refers to the same riding technique when traffic flow is moving at a rate of 25 mph or less and the motorcyclist is traveling no more than 10 mph faster than the speed of traffic (i.e., maximum 35 mph). Finally, "lane-filtering" refers to a variation on this technique used by motorcyclists when traveling on municipal surface streets to move/filter through stopped or nearly stopped traffic at traffic control devices (i.e., traffic lights or stop signs).

While prohibited by law, key informants indicated that some motorcyclists riding in Washington State do currently overtake and pass a vehicle in the same lane or operate between lanes of traffic (i.e., lane-split/share/filter) (personal communications, January 2022). Some of the reasons riders currently use these practices are to move through congested traffic, to save time commuting, to limit exposure to air pollution on roadways, to prevent their motorcycles from overheating (i.e., older models that are air-cooled rather than water-cooled), to prevent themselves from overheating, or to move away from potentially dangerous situations (e.g., to avoid being rear-ended) (personal communications, January 2022). A key informant representing motorcyclists shared that lane-filtering to the front of traffic at traffic lights or stop signs, specifically, "allows [riders] to safely take advantage of their quicker acceleration to move ahead of larger vehicles in the flow [of traffic]" (personal communications, ABATE of Washington, January 2022).

If passed, SB 5622 would amend RCW 46.61.608 to allow a motorcyclist to overtake or pass a vehicle in the same lane (Section 2[2]). Additionally, it would amend the law to outline circumstances in which a motorcyclist would be allowed to ride between lanes of traffic or between adjacent lines or rows of vehicles (Section 2[3]). Specifically, the motorcyclist would be allowed to do so if they are "traveling at a rate of speed no more than 10 [mph] over the speed of

* While these practices are defined differently and at times used interchangeably in research and in law, when discussing the implications of the SB 5622 this review uses the terms and meanings as discussed by a key informant representing motorcyclists in Washington State (personal communication, ABATE of Washington, January 2022). When discussing specific research findings, we use the terminology used in the original research article.

traffic flow and not more than 35 [mph]". However, the prohibition of riding between lanes of traffic would still apply in instances that do not meet these two criteria. Key informants stated that the bill does not specify on which roadways these practices would be allowed (personal communications, January 2022). However, since RCW 46.61.608 outlines the rules of the roads, all key informants assumed that the provisions would apply to all road types (interstates, state routes, highways, arterials, streets, etc.) (personal communications, January 2022).

Moreover, key informants offered two different interpretations of the provisions in SB 5622. Specifically, it is unclear whether the proposed changes in Sections 2(2) and 2(3) of the bill function interdependently or independently of one another (personal communications, January 2022). Based on information from key informants, this ambiguity makes it unclear whether lane-sharing and lane-filtering would be legal but lane-splitting at higher speeds would be prohibited or if all three practices would be legally allowed (personal communications, January 2022).

Interpretation 1: Legalizes lane-sharing and lane-filtering in specified circumstances
Some key informants stated that Sections 2(2) and 2(3) of the bill were intended to operate together. Specifically, they would allow a motorcyclist to overtake and pass a vehicle in the same lane as the vehicle being overtaken (Section 2[2]) and to travel between lanes of traffic or between adjacent lines or rows of vehicles if the motorcyclist was traveling at a rate of speed no more than 10 mph over the speed of traffic flow and not more than 35 mph (Section 2[3]). The understanding that the two sections are interdependent implies that the bill legalizes lane-sharing and lane-filtering. However, lane-splitting at speeds greater than 35 mph would still be prohibited, as it would not meet the criteria outlined in Section 2(3).

Based on this interpretation, the ability to lane-share or lane-filter would primarily apply in congested areas on interstates, freeways, arterial roads, and downtown cores (personal communications, January 2022). Key informants specified that lane-sharing would likely occur in Western Washington (e.g., sections of I-5, I-90, and Hwy-101) and in urban areas where congestion is most prevalent (personal communications, January 2022). Lane-filtering could be applied on any surface street where traffic control devices are used.

Interpretation 2: Legalizes lane-splitting, lane-sharing, and lane-filtering
Other key informants stated that the current proposed language does not indicate that Sections 2(2) and 2(3) are interdependent. Rather, their interpretation is that subsections 2 and 3 are standalone subsections. Based on this understanding of the bill, Section 2(2) could be interpreted to imply that lane-splitting, where a motorcycle operates in the same lane of traffic to overtake and pass a vehicle, is generally permissible, regardless of speed parameters. Meanwhile, Section 2(3) could be interpreted to allow lane-sharing and lane-filtering, according to the specified speed parameters.

Key informants representing WSP expressed concern that because the proposed language allows the two sections to be read separately it would also permit motorcyclists to pass in circumstances currently prohibited (e.g., across a double striped roadway) (personal communications, WSP, January 2022). WTSC also expressed concern that the proposed language could permit lane-splitting/sharing/filtering in construction zones, which could also pose safety concerns (personal communications, WTSC, January 2022).

All key informants agreed that some Washington State motorcyclists currently lane-split/share/filter (personal communications, January 2022). If passed, some key informants would expect some riders to operate in accordance with the new law. However, as the provisions in SB 5622 and the application of those provisions are ambiguous, it is unknown whether riders would lane-split, lane-share, and/or lane-filter based on their interpretation of the law.

Would allowing motorcyclists to lane-split/share/filter affect traffic collisions involving motorcycles?

It is not well researched whether motorcycles lane-splitting/sharing/filtering would impact traffic collisions. While some published literature is available, the majority of studies are descriptive and therefore do not assess association. Studies that were able to assess association focused on lane-filtering (not lane-splitting or lane-sharing), which is only one technique which would be allowed by SB 5622. Studies primarily sourced collisions through police databases; therefore, collisions were only included in the studies if they were reported and could reflect an undercount of total collisions throughout the study periods. The available body of evidence is also only slightly generalizable to Washington State. For example, available research has largely occurred outside of the U.S. (e.g., France, Australia); occurred in different environments or contexts (e.g., weather, road conditions, driving culture); studied conditions under different or specific policies that do not align with provisions of SB 5622 (e.g., lane-filtering at controlled, interurban intersections in a city in France); or rely on outdated data (i.e., prior to 2010). Additionally, the policies recently implemented in California, Utah, and Montana have not been evaluated to determine how they affected collisions. Therefore, since the body of evidence is largely descriptive in nature and has mixed finding about the potential impact of motorcycle lane-splitting/sharing/filtering on traffic collisions, the relationship is not well researched. This section presents a discussion of some studies that have found no change in collisions or an increase in collisions as a result of lane-splitting/sharing/filtering.

No change in collisions

The Australian Capital Territory (ACT) conducted a two-year trial evaluation of lane-filtering, where a motorcyclist is permitted to pass between two lanes of traffic that are stopped or slowly moving under certain conditions.[11] Lane-filtering during the ACT trial evaluation was not permitted at speeds greater than 30km/h, or approximately 18.6 mph.[11] The ACT study found that when examining pre-trial collisions with trial collisions, there were no clear fluctuations on injuries or fatalities; no change in the rate of lane change crashes; non-significant change in casualty patterns for lane change crashes; and not significantly different casualty severity for rear-end crashes.[11]

In 2013, Transport for New South Wales (TfNSW) conducted an 8-week Motorcycle Lane Filtering trial in the northern sector of Sydney, Australia's central business district.[14] TfNSW reported that "[lane-filtering] was a relatively low risk riding activity for motorcyclists under the conditions of the trial," there were no reported collisions in the trial period, and no rear-end collisions were reported for motorcyclists who did not participate in lane-filtering maneuvers during the trial period.[14] TfNSW's definition of lane-filtering was reflective of the lane-filtering definition used in this report, where a motorcyclist can move in between stopped vehicles, however, lane-splitting/sharing were not included in TfNSW's 8-week analysis.

Together, these two studies suggest that lane-filtering does not impact injury and fatality collisions. However, the studies are only slightly generalizable to the Washington State context.

Increase in collisions

While the ACT trial evaluation of lane-filtering found no change in side swipe crash casualty rates,[11] side swipe crashes (not involving injuries and fatalities) did increase from a pre-trial Powered Two-Wheel Vehicles (PTW)[†] crash composition of 2.6% to 5.7% during the lane-filtering trial.[11] The increase of PTW side swipe crashes was found to be statistically significant, increasing from a pre-trial rate of 0.58 of side swipe crashes per month to 1.38 side swipe crashes per month during the trial.[11]

A study of urban arterial roads in Marseille, France, concluded that PTWs lane-filtering on urban roads had a 3.94 times greater risk of being in injury collisions than riders who were not filtering.[17] The research considered the three most common lane-filtering techniques: filtering forward along the axis of the carriage way, filtering forward in a bus lane, and filtering forward in the space between traffic lanes going the same direction.[17] During the study time period, there were 345 PTW riders involved in collisions within the study area.[17] Researchers were able to determine the absence or use of lane-filtering in 309 of the collisions: 160 collisions (55%) involved lane-filtering.[17] Researchers conducted meta-analyses which showed that moped operators had a greater associated risk of crashing while lane-filtering compared to light or heavy motorcycle riders.[17] Results also showed that among the spaces studied for lane-filtering (i.e., carriage way, bus lane, and between traffic lanes), no space appeared to be safer than others.[17]

Independent of the above, the researchers specifically examined the impact of legal lane-filtering on pedestrians and concluded that lane-filtering would adversely affect pedestrian safety in urban areas.[16] Lane-filtering was again examined on urban arterial roads in Marseille, France, with broad examination of filtering that included filtering forward in a bus lane and filtering forward in the space between traffic lanes going the same direction.[16] Over the 6-year study period, there were 67 collisions involving both a PTW and a pedestrian, with 33 cases (49%) specifically involving lane-filtering.[16] Because of the small number of collisions between pedestrians and PTW riders, researchers were only able to calculate relative risk to pedestrians and PTW filtering when considering all manners of filtering and all spaces where a motorcyclist could filter.[16]

Two additional studies were unable to be reviewed due to publication in French. Both were summarized to find that certain lane-splitting/sharing/filtering adversely impacted collisions. The first was conducted by the same researchers who examined urban arterials roads in Marseille, France. Within discussion of filtering and urban arterial roads, they cite their previous research, which concluded that filtering on urban expressways is associated with a 2.5 times greater risk of collisions compared to not filtering on urban expressways.[17] The second was published by The Centre for Studies and Expertise on Risks, Environment, Mobility and Planning (CEREMA).[20] CEREMA conducted a 5-year study in 11 French departments (counties).[20] The Skilled Motorcyclist Association (SMARTER), a motorcyclist association summarized, “over the five-

[†] The term “Powered Two-Wheeler” (PTW) refers to a wide variety of vehicles. “The products are divided into different segments such as moped, scooter, street, classic, super-sport, touring, custom, supermoto, and off-road motorcycles.”[31]

year period, motorcycle crashes in the 11 departments where lane-splitting was allowed increased by 12[%] while the crash rate on roads outside the testing area decreased by 10[%]."[20]

Overall, while some studies have found that lane-splitting/sharing/filtering increases collisions involving motorcycles, the studies used older datasets and were only slightly generalizable to the Washington State context.

Descriptive studies

One white paper and two additional studies provided descriptive context related to lane-filtering. In 2016, the Safe Transportation Research and Education Center (SafeTREC) at the University of California, Berkeley, conducted an analysis using data from the California Enhanced Motorcycle Collision Data Project.[18] Overall, "[b]oth traffic speed and motorcycle speed differential were significantly associated with the occurrence of head, torso, and extremity injury."[18] Authors noted a major limitation of the study was the lack of exposure data.[18] Specifically, the "data set cannot be used to compare the collision risks for lane-splitting or non-lane-splitting riders."[18] Authors could not "estimate how the risk of being involved in a collision changes when motorcyclists [choose] to lane-split."[18]

A 2004 study focused on motorcycle collisions between 1997 and 2002 in Great Britain.[13] In the accidents where fault was fully or partially attributed to the motorcyclist (n=919), 16.5% involved the motorcyclist overtaking the other vehicles.[13] Authors found 5% of the entire collision sample identifiably involved lane-filtering (passing slow-moving or stationary traffic) and showed an increased proportion of combined fault, where the other drivers did not see or did not expect the motorcyclist involved.[13]

A naturalistic study conducted in Paris, France, evaluated 85 hours of video recordings in which 11 expert riders lane-split while commuting or riding for leisure.[12] Based on recordings and interviews with riders, authors concluded, "[t]he safest situation for the studied riders is when the traffic is stopped: the distance headway is so small that [other vehicles] changing lanes are rare. When traffic restarts, lane changes are frequent and not indicated. This is the most risky situation in case of lane splitting for the participants."[12] Researchers stated "these results need further investigation and remain to be matched with the results of objective measurements of traffic and motorcycles' speeds."[12]

Overall, while these analyses provide evidence of lane-splitting/sharing/filtering, the study designs did not allow researchers to evaluate the impact of lane-splitting/sharing/filtering on traffic collisions.

US Context: California, Utah, & Montana

In 2016 legislation, California vehicle code defined lane-splitting as driving a motorcycle between rows of stopped or moving vehicles in the same lane, including on both divided and undivided streets, roads, or highways.[8] The technique became legal in the state in 2017.[8] Prior to 2017, no law prohibited lane-splitting (personal communications, January 2022). Key informants noted that because California law did not explicitly prohibit lane-splitting, the established driving culture was more equipped to expect and anticipate motorcyclists using this technique (personal communications, January 2022). Key informants noted that, due to current statute, Washington

State drivers likely do not expect or anticipate motorcyclists to operate in ways that would be allowed by SB 5622 (personal communications, January 2022).

Utah's lane-filtering law went into effect in 2019.[9] The law allows motorcyclists to lane-filter if all of the following criteria are met: a rider must be traveling in a roadway with 2 or more lanes in the same direction; the speed limit on the roadway must be 45 mph or less; the vehicle being overtaking must be stopped; the motorcyclist must be traveling at a speed of 15 mph or less; and the movement must be able to be made safely.[9,21] While the law is set to expire in 2022,[9] a state legislator is working on a bill that would extend the expiration date to 2027 to allow more time for data to be collected.[22] A Utah Highway Patrol Sergeant is quoted saying, "the data we have right now - is insufficient to help us fully understand whether the law is working."[22] Furthermore, State officials shared "current data on lane filtering is limited, largely because officers can't clearly indicate whether lane filtering is a factor in current crash reports – an issue [the Utah Department of Public Safety] plans to rectify next year."[22]

Montana's lane-filtering law went into effect in October 2021.[10] The law permits motorcyclists to lane-filter when the rider is on a road with wide enough lanes to pass safely, when the overtaking motorcyclist is operating at a speed of 20 mph or less while overtaking a stopped or slow-moving vehicle, and when conditions are reasonable and prudent.[10] Montana's law has been active for 4 months, and lane-filtering has not yet been legal within a peak riding season (i.e., warmer seasons, particularly for leisure riders[23]) or for an entire 12-month period to allow for evaluation of impacts.

As the majority of available studies do not assess association or have mixed findings and are only slightly generalizable to Washington State, and the policies recently implemented in other states have not been evaluated to determine how they affected collisions, the relationship between lane-splitting/sharing/filtering and traffic collisions is not well researched. Since this relationship is not well researched, the pathway to health impacts could not be completed.

Other Considerations

This Health Impact Review focused on the most direct pathway between provisions in the bill and health outcomes and equity. However, the relationship between lane-splitting/sharing/filtering and traffic collisions is not well researched, and the pathway to health impacts could not be completed. Other considerations related to the policy proposal are discussed below.

Impacts on enforcement

Under current law, motorcyclists who lane-split/share/filter may be issued a citation. There is limited data about current enforcement and how frequently or under what circumstances people receive a citation for lane-splitting/sharing/filtering (personal communication, WSP, January 2022). In Washington, any infraction relating specifically to motorcycles has a penalty of $48.[24]

SB 5622 creates two possible infractions related to lane-splitting/sharing/filtering: 1) for a motorcyclist who did not legally lane-split/share/filter and 2) for any motor vehicle driver who intentionally impeded or attempted to prevent a motorcyclist from operating their vehicle as permitted under Section 2(3). Key informants shared multiple potential challenges related to enforcing provisions in SB 5622.

First, under current statute a law enforcement officer may be able to easily recognize when a motorcyclist is lane-splitting/sharing/filtering because they are not allowed to pass a vehicle in the same lane or travel between lanes of traffic (personal communications, WSP, January 2022). However, Section 2(3) of the proposal creates an enforcement challenge, because the officer would need to be able to recognize that a motorcyclist is traveling at a speed more than 10 mph faster than the flow of traffic (personal communication, WSP, January 2022). A key informant with experience riding motorcycles shared that generally if a lane-sharing motorcyclist is passing a motor vehicle in less than 1 second then they are traveling at a rate faster than a 10 mph speed differential (personal communication, ABATE of Washington, January 2022). However, no studies reviewed discussed a systematic way for officers to accurately and consistently measure a motorcyclist's speed compared to the flow of traffic.

Additionally, lane-splitting/sharing/filtering inherently allow motorcyclists to move through traffic congestion in ways that other motor vehicles cannot. This presents a challenge for enforcement officers who drive cars (personal communications, January 2022). For example, if a motorcyclist does not abide by the speed parameters outlined in Section 2(3) while lane-splitting/sharing, an officer may not be able to navigate and catch up to the motorcyclist due to traffic congestion (personal communications, January 2022).

Lastly, in cases that both a motorcyclist and a motor vehicle driver violated the law, "practically, [law enforcement officers] would have to choose which person to stop and talk to" (personal communication, WSP, January 2022).

While legal financial obligations (LFOs) (i.e., potentially resulting from traffic citations) and involvement in the criminal legal system can impact health and equity, data is not available to determine how often citations are currently issued or could be issued for improper lane-splitting/sharing/filtering or how infractions for motorcyclists and/or other motor vehicle drivers outlined in SB 5622 may impact different communities. Therefore, this pathway was not included in the logic model.

Impacts on training and education

Key informants noted that SB 5622 does not address training or education for motorcyclists or other road users (personal communications, January 2022). As allowing motorcycles to lane-split/share/filter has the potential to increase interactions between motorcyclists and all other road users (personal communications, January 2022), all key informants stated the need for expanded awareness and specific training on lane-splitting/sharing/filtering for motorcyclists and all other road users. There is generally consensus among key informants and in the literature that education and training around lane splitting/sharing/filtering is needed not only for motorcyclists, but for other road users, particularly for motor vehicle drivers (personal communications, January 2022).[11,13,23,25,26]

Key informants noted that if lane-splitting/sharing/filtering were legalized, there would likely be a learning curve as motorcyclists and other road users adjust to the new practice (personal communications, January 2022). Research has shown that a multitude of factors work together to create visual schema which influence seeing, perceiving, and appraising visual stimuli and probabilities related to collisions between motorcyclists and other road users.[26] Lack of perception of and limited attention to motorcyclists by motor vehicle drivers is a key concern among motorcyclists.[23] Moreover, key informants also stated that aggressive driving is at an all-time high and could pose a safety concern if motorcyclists lane-split/share/filter unless proper outreach and communication campaigns prepare road users for such techniques (personal communications, WTSC, 2022).

Currently in Washington State, motorcyclists must have a driver's license with an endorsement. Since 2020, motorcyclists have been required to pass a basic knowledge and skills exam to obtain a permit and an advanced knowledge and skills exam to obtain an endorsement (personal communication, DOL, January 2022). Currently, there is not data to reflect whether an endorsement can be reflective of safety and it is unknown how many unendorsed riders are operating motorcycles in the state (personal communications, DOL, January 2022). If lane-splitting/sharing/filtering become allowable, key informants from DOL discussed the potential of adding these skills for endorsements in the future (personal communication, DOL, January 2022).

Educational campaigns have been conducted alongside expanded allowability of lane-splitting/sharing/filtering. For example, ACT launched a media-awareness campaign in conjunction with their 2015-2017 lane filtering trial to examine community awareness and knowledge of lane filtering.[11] Surveys found that knowledge of lane-filtering increased over the trial period; the proportion of respondents endorsing the correct definition of lane-splitting significantly increased from 52.5% of respondents pre-trial to 71.5% post-trial; and the awareness of lane filtering increased from 20% of respondents pretrial to 49% post-trial.[11] Opinions were divided as to whether lane filtering improved road safety.[11]

In Utah, the Utah Department of Public Safety (DPS) and Utah Department of Transportation (UDOT) developed a safety campaign to educate both motorcyclists and drivers of other vehicles about lane-filtering.[27] Motorcyclists were encouraged to enroll in motorcycle skills courses. The campaign is currently on-going.[27]

Key informants agreed that training and education for all road users would be essential to develop awareness and predictability of lane-splitting/sharing/filtering (personal communications, January 2022). Since SB 5622 does not include provisions related to training and education, this pathway was not included in the logic model.

Impacts on health and safety for motorcyclists

Per vehicle miles traveled (VMT) in the U.S. in 2019, motorcyclists were about 29 times more likely than passenger vehicle occupants to die in a motor vehicle crash and were 4 times more likely to be injured.[28] NHTSA reported "the majority of multi-vehicle motorcycle crashes generally are caused when other drivers simply didn't see the motorcyclist."[29] Nationally, NHTSA reported that "[t]he most harmful event in 2019 for 2,811 (55%) of the 5,114 motorcycles involved in fatal crashes was collisions with motor vehicles in transport."[28] Among two-vehicle collisions, "76[%] of the motorcycles involved in fatal crashes were struck in the front. Only 7[%] were struck in the rear."[28] Specifically, in 2019 in the U.S. "there were 2,495 fatal two-vehicle crashes each involving a motorcycle and another type of vehicle. In 41[%] (1,034) of these crashes, the other vehicles were turning left while the motorcycles were going straight, passing, or overtaking other vehicles."[28] In 558 crashes (22%) both vehicles were traveling straight.[28]

In Washington State, motorcycles comprise 3% of registered vehicles, but accounted for 14% of motor vehicle crash fatalities and 19% of serious injuries occurring from 2015 through 2017.[6] Approximately 1 in 5 motorcycle crashes result in a fatality or serious injury with an average of 75 motorcyclists dying from fatal collisions each year.[6] From 2012 through 2014, there were 225 motorcyclist fatalities and 1,165 motorcyclists who experienced a serious traffic injury.[6‡] From 2015 through 2017, there were 236 motorcycle fatalities and 1,209 motorcyclists who experienced a serious traffic injury, a 4.9% and 3.8% respective increase from 2012 through 2014.[6] Of motorcyclist fatalities between 2015 and 2017, 42% did not involve another vehicle.[6] Speeding and impairment were the top two factors observed in fatal motorcyclist crashes.[6]

WTSC analyzed Coded Fatal Crash (CFC) and Fatality Analysis Reporting System (FARS) data related to motorcycle crashes. Between 2016 and 2020, there were 27 motorcyclist fatalities (11% of total motorcyclist fatalities involved in multi-vehicle collisions) that involved the motorcyclist rear-ending another vehicle and 11 motorcyclist fatalities (4.3% of total motorcyclist fatalities involved in multi-vehicle collisions) that involved a motorcyclist being rear-ended (unpublished data, WTSC, January 2022). Among the 11 deaths that involved the motorcyclist being rear-ended, the majority occurred when the motorcyclist was stopped at an intersection (unpublished data, WTSC, January 2022). WTSC reviewed these 11 cases to determine if lane-splitting could have been used as an evasive action and concluded that there was 1 case in which lane-filtering may have assisted (personal communications, WTSC, January 2022). WTSC concluded that lane-splitting/sharing/filtering would likely not have prevented the crash outcomes in any of the other cases (personal communications, WTSC, January 2022).

While motorcyclists are disproportionately more likely to experience serious injury or fatality resulting from collisions and SB 5622 has the potential to increase interactions between motorcyclists and other road users, it is not well researched how lane-splitting/sharing/filtering may impact collisions (see discussion in Summaries of Findings) or traffic injuries or fatalities. Therefore, this pathway was not included in the logic model.

Impacts on health and safety for bicyclists and pedestrians

Washington State data show that bicyclists and pedestrians experienced the highest fatality rate of all road users.[6] From 2015 through 2017, bicyclist and pedestrian deaths in Washington State increased by 41% from 2012 through 2014, compared to a 20% increase nationally.[6] The majority of bicyclist and pedestrian fatalities (93.5% and 75.3%, respectively) occurred in areas where the motorist was driving faster than 25 mph.[6] Pedestrians and bicyclists have a 95% survival rate if struck by a motor vehicle traveling 20 mph or less.[30] In collisions between motor

‡ In Target Zero reporting, the definition of motorcyclists was expanded to include riders of motor scooters, mopeds, and motorized bicycles to align with NHTSA's definition of motorcycles, and is applied more broadly than "motorcycle" as defined in RCW 46.04.330.

vehicles and bicyclists or pedestrians where the bicyclists or pedestrian is struck at 30 mph, the survival rate is 45% and the risk of injury is 95%.[30]

Based on an analysis by WTSC, between 2016 and 2020, there were 3 bicyclist/pedestrian fatality cases involving motorcycle drivers (unpublished data, WTSC, January 2022). In 2 of the 3 instances, the bicyclist or pedestrian failed to yield the right of way to the motorcyclist (personal communications, WTSC, January 2022). In the third case, a pedestrian laying in the road and was struck by 3 different vehicles, one of which was a motorcyclist (personal communications, WTSC, January 2022).

An 8-week study on lane-filtering in New South Wales found that pedestrians experienced safety risks when motorcycles lane-filtered, primarily at intersections where motorcyclists intruded on pedestrian crossing space.[14] Law enforcement officers observed that lane-filtering into a curbside lane occurred, with motorcycle riders overtaking space next to parked vehicles.[14] Survey responses conducted with road users during the trial period, inclusive of motorcyclists, identified pedestrians to be at greater risk as a result of lane-filtering.[14] The researchers discussed the critical nature of speed management, as pedestrians are more susceptible to injury and death as impact speeds increase.[14]

In the absence of specification, this analysis assumes motorcyclists would be able to lane-split/share/filter across all road types including freeways and local arterial roads throughout both rural and urban geographies (personal communications, January 2022). While current law specifies that motor vehicle operators need to move into another lane or leave at least 3 feet while passing,[3] the legal allowance for lane-splitting/sharing could increase interactions between motorcyclists and road users such as bicyclists and pedestrians (personal communications, January 2022). This may be especially true in urban areas that typically have more bicyclist and pedestrian traffic (personal communication, January 2022).

Data from Washington State has also shown that, "[c]ommunities with poverty rates higher than the state average also have the highest numbers of households that lack access to a personal vehicle and are therefore more likely to rely on walking, bicycling, and transit for their transportation needs… Lack of sidewalks, crosswalks, lighting, and bicycling paths can increase crash exposure for road users who are walking and bicycling as a primary mode of transportation. These roads often have higher vehicle speeds, wider roads, and higher traffic volumes when compared with more affluent neighborhoods with lower crash rates."[6]

While key informants suggested that contact with other road users, including bicyclists and pedestrians, may increase as a result of lane splitting/sharing/filtering, there is limited data and information exploring these potential impacts. Therefore, this pathway was not included in the logic model.

Annotated References

1. **RCW 46.04.330 - Motorcycle., Revised Code of Washington(2002).**
RCW 46.04.330 provides the definition of "motorcycle" for Title 46 RCW Motor Vehicles.

2. **RCW 46.61.526 - Negligent driving—Second degree—Vulnerable user victim—Penalties—Definitions., Revised Code of Washington(2020).**
RCW 46.61.526(11)(c) defines vulnerable users of the public way.

3. **RCW 46.61.110 - Overtaking on the left—Fine., Revised Code of Washington(2019).**
RCW 46.61.110 establishes rules for the overtaking and passing of vehicles traveling in the same direction.

4. **Importation and Certification FAQs Group 2: Motorcycles and Scooters. 2022; Available at: https://www.nhtsa.gov/importing-vehicle/importation-and-certification-faqs-0#:~:text=How%20does%20NHTSA%20define%20a,%E2%80%9D%20(49%20CFR%20571.3). Accessed January 27, 2022.**
The webpage on the US Department of Transportation's National Highway Traffic Safety Administration (NHTSA) site provides NHTSA's definition for "motorcycle."

5. **Vision Zero Network. Available at: https://visionzeronetwork.org/. Accessed January 27, 2022.**
This website provides information on the Vision Zero Network and related efforts. The goal of the Vision Zero Network is to eliminate all traffic fatalities and severe injuries, while increasing safe, healthy, and equitable mobility. The Vision Zero Network is a nonprofit project.

6. **Commission Washington Traffic Safety. Washington State Strategic Highway Safety Plan 2019: Zero Deaths and Zero Serious Injuries by 2030.Olympia, WA2019.**
The 2019 Target Zero plan is Washington’s Strategic Highway Safety Plan (SHSP) required by federal law. Target Zero plans towards Washington State’s vision for zero deaths and serious injuries on Washington roadways by 2030. The plan sets statewide priorities for all safety partners provides resources, guides funding, and monitors priority-area outcomes. Data from 2015-2017 show a 23% increase in traffic fatalities and a 7% increase in serious injuries compared to 2012-2014 data. Traffic safety data within the report comes from Washington’s Traffic Record Systems that includes details about crashed, vehicles, drivers, citations, legal outcomes, and injuries. The report identifies strategies and policy recommendations to accomplish the zero fatalities and serious injuries goal.

7. **Licensing Washington State Department of. Motorcycle Operating Manual: Two- and Three-Wheel. In: Program MS, ed. Olympia, WA.**
Washington Department of Licensing published a motorcycle operator's manual with information that provides motorcycle riding techniques and information for both inexperienced and experienced riders. Information is sourced from National Public Services Research Institute (NPSRI), the National Highway Traffic Safety Administration (NHTSA), the Motorcycle Safety Foundation (MSF), Evergreen Safety Council (ESC), and the American Association of Vehicle Administrators (AAMVA).

8. **21658.1., California Vehicle Code(2016).**
21658.1 of California Vehicle Code defines "lane splitting" under Article 1. Driving on Right Side.

9. **House Bill 149 Traffic Code Amendments, Laws of Utah(2019).**
HB 149 Traffic Code Amendments passed the Utah State Legislature during the 2019 General Session. It amends sections of the State Traffic Code to allow lane filtering. Unless extended, the bill is set to sunset in 2022.

10. **61-8-392 Lane Filtering For Motorcycles, Montana Code Annotated 2021(2021).**
61-8-392 specifies legal lane filtering practices under Montana State code for motor vehicles.

11. **Beanland V. . Evaluation of the ACT Motorcycle Lane Filtering Trial: Report for the ACT Government.Centre for Human Factors and Sociotechnical SystemsOctober 2018.**
The Australian Capital Territory (ACT) Government conducted a two-year trial and evaluation of safety outcomes and community attitudes focused on lane filtering, where a powered two-wheeler (PTW) vehicle passes between two lanes of traffic that are stopped or moving very slowly. The study began in February 2015 and ended in January 2017. The definition of PTW is inclusive of motorcycles and other PTWs (e.g., mopeds and scooters). Data on road crashes were extracted through the ACT Road Crash Database, and researchers noted that the data are non-exhaustive, as not all crashes are reported. There were 15,685 crashes in the period, involving 30,686 vehicles or pedestrians. At least 1 PTW was involved in 3.6% of crashes, with 574 crashes involving PTWs over the trial period and an average of 23.9 crashes per month. Crash rates in pre-trial and trial periods were similar. About one-third of crashes in both pre-trial and trial periods involved a single PTW and no other vehicle. The most common PTW crash types were “vehicles from one direction” (36.5-40.1%), “off path on straight” (20.9-23.8%), and “Intersections” (12.5-13.8%). Rear-end crashes were the most common type of crash for both PTW and non-PTW vehicles pre-trial and during the trial (26.5-26.9% and 44.2-44.7%, respectively). Binary logistic regression considered vehicle crash type (involving a PTW or not) and the reporting period (pre-trial and trial group). The study found that “PTWs had significantly lower odds of being involved in a rear end crash than other vehicle types. Reporting period did not show a statistically significant association, indicating that there was no clear increase or decrease in rear end crashes overall during the trial period.” Additionally, when considering the consequences of crashes, injury crashes accounted for 20.4% of PTW rear-end crashes during the lane-filtering trial period and 19.2% during the pre-trial period. Results indicated no change in the rate or severity of rear-end crashes involving PTWs. Side swipe crashes increased from a pre-trial PTW crash composition of 2.6% to 5.7% during the lane filtering trial. Using a binary logistic regression, the researchers examined whether the probability of a side swipe crash was associated with vehicle crash type or reporting period. During the pre-trial period, the average PTW side swipe rate was 0.58 per month; during the trial-period the side swipe rate increased to 1.38 per month, indicating “this increase in number of PTW side swipe crashes was statistically significant, $U = 182.5$, $Z = -2.320$, $p = .020$.” The researchers found no change in the rate of lane change crashes determined through multiple analyses. Lane change crashes accounted for less than 5% of all crashes for both PTWs and non-PTWs. Casualty rate analysis included the number of individuals who were injured or killed in crashes. Over the lane filtering trial, approximately

9.8% of crashes involved an injury and 0.16% involved a fatality (15,685 cases resulting in 1,531 total injuries and 25 total fatalities); pre-trial 10.1% of crashes resulted in injuries and 0.11% resulted in fatalities (15,680 cases resulting in 1,591 total injuries and 17 total fatalities). There were no clear fluctuations on injuries or fatalities between the two periods. Researchers classified people who experienced a casualty into 1 of 5 road user categories: car, motorcycle, bicycle, pedestrian, or bus. The number of total injured motorcyclists in both pre-trial and trial periods was nearly the same (n=236 pre-trial, n=235 during the trial). Considering both motorcyclists and their pillion (i.e., behind the rider) passengers, there was an average of 9.8 injuries per month in both the pre-trial and trial periods. There was not a statistically significant change in the number of average monthly fatalities during pre- and trial periods ($U = 252.0$, $Z = -1.019$, $p = .308$). The researchers considered whether the severity of PTW casualties changed during the trial and considered three variables: injury requiring medical treatment, injury requiring hospitalization, and fatality. Because there were few fatalities in the dataset, they were considered with injuries requiring hospitalization. Crash severity was considered for rear-end crashes, side-swipe crashes, and lane change crashes. Researchers' analyses concluded that casualty severity was not significantly different during the lane filtering trial for rear-end crashes, that there was no change in side-swipe crash causality rates, and that there was non-significant change in casualty patters for lane change crashes. Researchers examined motorcycle licensure and registration as a proxy for motorcycling exposure, as there was not attainable data on exposure. Over the trial period, the total increase of licensed riders was 0.6% compared with a 3.6% increase of all licenses in the same time frame. Motorcycle registration fluctuated consistently throughout the year, suggesting that riding increases during the summer months, with a significant decrease each winter. Over the trial period, the number of registered motorcycles increased 3.3%, similar to the registration increase of all vehicles at 3.6%. A media awareness campaign ran in conjunction with the lane-filtering trial, inclusive of telephone surveys conducted both pre- and post-trial (n=800 in total) and examined community attitudes towards lane filtering with a random sample of residents. Examination found that knowledge of lane-filtering increased over the trial period; the proportion of respondents endorsing the correct definition of lane-splitting significantly increased (52.5% pre-trial to 71.5% post-trial); awareness of lane-filtering increased (20% pre-trial, 49% post-trial); most respondents learned about the trial from television; and support increased for lane-filtering, though opinions were divided as to whether it improved road safety.

12. **Aupetit S. , Espie S., Bouaziz S. Naturalistic study of riders' behaviour in lane-splitting situations. *Cognition, Technology & Work.* 2015;17(2):301-313.**
Aupetit et al. conducted a naturalistic study of motorcyclists' behaviors during their commutes in the Paris region of France to improve understanding of motorcyclists' behavior in real-world lane-splitting situations. Authors noted that collision research has found that lane-splitting is involved in few personal injury or fatal collisions (between 1% and 5%, depending on the geographic areas considered) in France or internationally. However, French insurance indicates that lane-splitting is involved in 60% of the powered two-wheeler (PTW) collisions. Authors hypothesized that situations that are significant for riders in lane-splitting situations are missing from collision registers, which do not include incidents that do not require police action or near-accidents, which the rider manages to avoid just before collision. Eleven experienced motorcyclists were recruited to ride for a month (normal journeys: home-to-work and/or leisure) with an instrumented vehicle with camera. Recruited riders held a motorcycle license for several

years, had not been disqualified from driving in the last two years, and owned a machine with similar characteristics to those used in the study; together they had a mean age of 41 years and mean riding experience of 20 years. Authors noted that the motorcyclists “studied appear to be ‘experts’ at interpreting the driving situation and selecting useful information” and can identify risky situations in advance. Vehicles were fitted with 4 cameras: 3 covering a 160-degree visual field to the front, and 1 on the rider’s face (or helmet). A total of 85 hours of footage involving lane-splitting was recorded. Researchers conducted self-confrontation interviews with participants in which they showed video sequences of lane-splitting in the 3 days prior to the interview. “The riders made comments with assistance from the researcher and described their actions and intentions.” A total of 33 interviews were completed (3 per rider) for a total 13.5 hours. Two researchers analyzed the self-confrontation data. The analysis showed that all studied riders used their motorcycles for commuting, and “riding between traffic lanes represents an average of 72% of the riding time and about 77% of the travel led distance during each commute trip.” Researchers identified three classes of differential speed with car drivers according to traffic speed: when traffic is completely stopped, when cares are at low speeds, and when traffic operates at more than 50 km/h. When traffic was completely stopped, the studied riders averaged a lane-splitting speed of 38 km/h. In interviews, almost all the motorcyclists noted that when they increase the differential speed beyond 50 km/h they do not feel safe. When traffic speed was between 10 and 40 km/h, interview data showed a decrease in the differential speed motorcycle/cars (average 19 km/h). “The riders consider that traffic context as the most dangerous situation when lane splitting because lane changing by car drivers is frequent, fast, and in many cases done without use of turn signals”. At traffic speeds greater than 50 km/h, 7 participants continued to ride between traffic lanes with a differential speed of about 28 km/h, and 4 riders stop lane splitting. Riders were constantly looking for information about the environment including traffic configuration (e.g., width of the corridor between two streams of cars, speed of the vehicles, vehicle gaps between traffic lanes); signs of potentially risky motorist behaviors (e.g., angle of car’s wheels which can indicate intention to change lanes, driver movements inside the passenger compartment like use of GPS or mobile phones or head movements indicating they are mid-conversation, license plates from outside the region); other PTW users riding between lanes (e.g., adapt activity like adjusting speed or allowing them to pass to avoid being bothered by them either); specific zones on the road (e.g., avoid entries and exits where cars are merging, radar speed detectors where cars brake suddenly); and identifying situations that impair other motorist’s ability to see PTW riders (e.g., when the only lane-splitting rider, poor weather conditions, like rain, in corridors not usually used by PTWs). Authors stated that, at the time the report was being written, the French Authorities were using findings to inform motorcycle training and considerations to authorize (or not) lane-splitting in France.

13. **Clarke D, Ward P, Bartle C, et al. In Depth Study of Motorcycle Accidents: Road Safety Research Report No. 54 Department for Transport: London2004.**
Research based in the United Kingdom (UK) examined a sample of 1,790 collision incidents, including 1,003 in detail from police records between 1997 and 2002, inclusive of motorcyclists of all ages, relying on the human interpretation of road accident case reports. Case studies were built through recorded objective information (i.e., time of day, speed limit, class of road), a “prose account” for each case given by the rider, a sketch graphic of the incident and a standard checklist of possible explanatory rider/other driver factors (i.e., road environment, vehicle and

rider characteristics, specific rider actions). Attitudes of motorcyclists were examined through a qualitative questionnaire focused on the rider's experience, training, safety issues, and personal details. The study results showed that 73.7% of collisions occurred in urban or suburban areas. They found that rural collisions are more than 1.5 times more likely to be serious and more than 3 times more likely to be fatal than non-rural serious injury and fatal collisions. Researchers found two peak age ranges for collision involvement: ages 16-20 years and 31-35 years. The majority of collisions involved males, with 12 times as many male motorcyclists involved in collisions as females. Researchers considered the time of day and day of the week that collisions occurred, finding that right of way and overtake/filtering collisions tended to occur during peak morning and late afternoon traffic flow and bend (i.e., at a curve) collisions tended to peak in the afternoon and early evening. Thirty-eight percent of the collisions studied occurred in the right of way, with the majority being at T-junctions. Fifteen percent of collisions studied involved loss of control at a bend or curve on the road. In the collisions where fault was fully or partially attributed to the motorcyclist (n=919), 16.5% involved the motorcyclist overtaking the other vehicles. Of the entire collision sample 5% identifiably involved filtering (passing slow moving or stationary traffic) showing an increased proportion of combined fault, where the other vehicle driver did not see or did not expect the motorcyclist involved. Regarding types of motorcycles involved in collisions, super-sport motorcycles were over-represented in bend accidents, with less propensity than other types of motorcycles to be involved in rear-end shunts and right of way collisions. Sports-tourer motorcycles are over-represented in overtaking/filtering accidents. When the researchers examined possible explanatory factors or countermeasures for both motorcyclists and other vehicle drivers, they concluded that motorcyclists must mind their speed, not only in relation to speed limits, but also in consideration of normal road hazards (i.e., bends) and avoid overtaking slower vehicles in the vicinity of junctions, even if traffic is stationary. Meanwhile, researcher determined drivers of other vehicles must be mindful of motorcycles at all junction types, with careful rear observations before making any maneuvers. Researchers stated that motorcycle safety should address the behaviors of both motorcyclists and all other road users. Particularly in right of way collisions, there is a problem with other vehicles seeing motorcyclists. Here, researchers discussed other drivers' expectations and perceptual schema for motorcycles in the traffic scheme. The same concept would apply for pedestrian expectations, and inattentional blindness would be more frequently seen in experienced vehicle operators versus inexperienced vehicle operators. Age may also be a factor in right of way accidents; visual error compared with other at fault errors increased with the age of a vehicle operator. Researchers also noted literature suggesting age is the most important factor in risk-taking, and their study supported this showing "a steady reduction in the numbers of [collisions] as the age of the riders involved increases from 35 years of age upward." At the time of the report, motorcyclists made up less than 1% of vehicle traffic and 14% of the total deaths and serious injuries on Britain's roads.

14. **NSW Transport for. NSW Government: Motorcycle lane filtering trial Summary of Trial Results.New South Wales: Centre for Road Safety, Policy and Regulation;2014.**
Transport for New South Wales (TfNSW) conducted an 8-week lane-Motorcycle Lane Filtering trial from March 1 through April 30, 2013, in the northern sector of Sydney, Australia's central business district (CBD). "The purpose of the trial was to gain an understanding of the impacts of motorcycle lane filtering on traffic congestion, road user behavior, attitudes and road safety, across all road user groups." Lane-filtering was permitted during the trial; lane-splitting was not.

Lane-filtering meant a motorcycle moving between lanes of stationary vehicles that are proceeding in the same lane. The researchers used a before and after research method collecting data by examining traffic volume and vehicle classification; incidence of motorcycle lane-filtering; traffic flow, congestion, travel time; nature of lane-filtering maneuvers, motorcycle stopping position at intersections; incidence and nature of motorcycle conflicts; and road user attitudes. Congestion data were collected through Sydney Coordinated Adaptive Traffic System (SCATS) data, remote video camera, and The Infra-Red Traffic Logger (TIRTL) vehicle counters. Behavioral data collection was examined through video-based observation with fixed digital video cameras; intercept surveys of motorcyclists, other motorists, pedestrians, and cyclists; an online attitudinal survey; and police monitoring observations. The study reported that "[lane-filtering] was a relatively low risk riding activity for motorcyclists under the conditions of the trial;" there were no reported collisions during the trial period and no reported rear-end collisions for motorcyclists who did not participate in lane-filtering maneuvers during the trial period. Survey data reported that 63% of motorcycle riders reported filtering; video footage found a lower frequency with 20-30% of riders observed to filter. Lane-splitting was observed in video analysis; it was not part of the trial but was noted as consistent across the three periods of study, occurring 15% of the time. Motorcyclists surveyed reported feeling safer when able to filter, "believing that lane-filtering improved their safety by having greater control over their exposure to traffic, particularly vehicles following behind." Pedestrians were found to experience safety risks when motorcycles filtered. At intersections, motorcyclists were found to intrude on pedestrian crossing space. Police observed that filtering into a curbside lane occurred, with motorcycle riders overtaking space next to parked vehicles. All survey respondents, including motorcyclists, identified pedestrians to be at greater risk as a result of filtering. The researchers discussed the critical nature of speed management, as pedestrians are more susceptible to injury and death as impact speeds increase. At an impact speed of 30 km/h the average pedestrian has a 90% chance of surviving the crash. However, this reduces to around 70% at 40 km/h, whilst at impact speeds above 60 km/h, pedestrian survivability is less than 1%. Specific to travel time and congestion, researchers found travel time for motorcyclists may be improved with the ability to lane-filter. Overall, traffic congestion was not found to be impacted as motorcyclists in the trial only represented 4% of the traffic.

15. **Sperley M, Pietz A. J. . Motorcycle Lane-Sharing Literature Review.Salem, OR: Oregon Department of Transportation Research Section;2010.**

The Oregon Department of Transportation (ODOT) conducted a literature review focused on motorcycle lane-sharing in 2010. ODOT contextualized that lane-sharing is generally prohibited in the U.S. The research stated that lane-sharing is the practice that allows motorcyclists to pass between lanes of stopped or slower moving traffic. "Lane-filtering" may be used to describe moving between stationary traffic and "lane-splitting" may be used to describe moving between traffic in motion. ODOT's literature review discussed the 1981 "Hurt Report," a benchmark study that provided a comprehensive examination of variables affecting motorcycle safety. Since the Hurt report was published, ODOT summarized that motorcycle design has changed (e.g., bigger engines, more power, different brake systems); motorcycle riders demographics shifted; helmet laws have changed; licensing requirements are often more stringent and rigorous; and the motor vehicle population has changed. ODOT also cited a 2009 European study, Motorcycle Accident In-Depth Study (MAIDS), inclusive of sample areas in France, Germany, Italy, the Netherlands, and Spain, that examined "collision dynamics including pre-crash motions prior to the crash," inclusive of lane-sharing behaviors. The study found "of the 921 crashes investigated, 4 (0.4%) were engaged in filtering as the pre-crash motion. Comparatively, 26 (2.8%) [collisions] occurred while the motorcycle (referred to as the powered two-wheeler [PTW]) was stopped in traffic with a speed of zero, and 452 (49.1%) occurred with the PTW moving in a straight line with constant speed." ODOT concluded that the MAIDS findings "suggest that despite the legality of lane-sharing in the study areas of MAIDS, crashes with lane-sharing related behaviors make up a relatively small percentage of total crashes. The majority of motorcyclists in the study were traveling straight with 90% of the vehicles they crash with being in front of them." ODOT cited a UK analysis of crashes that used 1997-2008 data that found that "overtaking/filtering was a factor in 19% of multi-vehicle motorcycle accidents, and when three or more vehicles were involved that percent increased to 33%." ODOT cited additional UK studies including Clarke et. al. (2004) that found filtering was a factor in 5% of studied motorcycle [collisions]; the greatest frequency of overtaking/filtering [collisions] occurred on weekdays and peak travel times; approximately half of motorcycles involved in overtaking/filtering had engine capabilities above 600cc; and that motorcycles categorizes as "sports tourer" were significantly over-represented. ODOT discussed the commonly mentioned benefits of lane-sharing: reduced congestion, reduced motorcyclist travel times, modal shift, and emission reduction, stating that these benefits have rarely been quantified or well measured. ODOT also stated that law enforcement may benefit from lane-splitting because they would be better able to maneuver in traffic to respond to emergencies. Through discussion of safety considerations, ODOT discussed the lack of safety impact data in a U.S. context.

16. **Clabaux N., Fournier J. Y., Michel J. E., et al. Does filtering by powered two-wheelers present a risk for pedestrians in city centers? *Journal of Transport & Health* 2019;13:224-233.**

Clabaux et al. examined the risk of powered two-wheelers (PTW) riders hitting and injuring a pedestrian per kilometer traveled when filtering compared to the risk present when not filtering. Investigations included all PTW categories (i.e., motorcycles and mopeds) and all filtering practices (e.g., splitting in the space between lanes of cars going the same direction, filtering forward through the center of the roadway, or through bus lanes). The researchers' meta-analysis showed "overall relative risk of 5.30 (95% CI [2.97; 9.43]). The heterogeneity test suggest[ed] that the trend observed can be considered as being common to all sections (Q = 15.1; p = 0.30). During rush hours, the relative risk is 5.94 (95% CI [2.72; 12.96]) and during non-rush hours, the relative risk is 4.21 (95% CI [2.09; 8.50])." The small sample size weakened the ability to calculate relative risk per type of filtering or space of filtering due to the small numbers of collisions in each category. Researchers concluded that filtering would adversely affect pedestrian safety in urban areas. The study was conducted over 6 years between 2007 and 2012 on 14 sections of urban arterial roads in the city center of Marseille, France, totaling a distance of 18 km (approximately 11.2 miles). Roads in the study were primarily major arterial roads with shared characteristics of traffic going in the same direction, with most roads having traffic lights and dedicated bus lanes. The study period included weekdays and Saturdays, from 6 a.m. to 10 p.m. and excluded public holidays and Sundays. The roads were selected because the researchers could obtain precise traffic data for them. Police reports were used to determine the number of PTW and pedestrian collisions and to determine whether filtering was used at the time of the collision. The risk exposure calculation included data on the hourly traffic count and on-the-ground observations to determine the share of PTW in the total traffic and their filtering practices (a total of 56 hours of observation). Researchers estimated that on average, PTWs accounted for 17.9% of the traffic in the observation area, and 20.7% of the annual kilometers ridden in the study and were while filtering. The proportion of distance ridden while filtering was higher during rush hour (25.4%) than during non-peak times. Researchers tested exposure data, concluding that the estimate of the share of kilometers traveled by PTWs while filtering may be overestimated slightly, therefore, the relative risks risk of collision while filtering compared to the risk of collision while not filtering were probably underestimated. Between 2007 and 2012, there were 67 collisions that involved both a PTW and a pedestrian in the study time frame and locations. The maneuver of the PTW was able to be classified in 54 of the 67 cases reviewed. Of these, filtering was involved in 61%, or 33 cases. Forty-three percent, or 14 of the 33 collisions between a PTW and a pedestrian occurred within 50 meters (approximately 0.03 miles) before a traffic light. Researchers discussed that excess risk may not be a result of filtering and due to other factors, such as age and experience of the PTW driver. The high relative risk could also be due to the number of pedestrian movements during peak travel times, which corresponds to more frequent filtering maneuvers, however, the results of the study show higher risk on peak and off-peak hours. The researchers also discussed the structural aspects of collisions and the predicament of PTWs and pedestrians being invisible to one another in some cases due to stopped vehicle obstruction. Travel in between lane passages can also reduce the ability of a PTW to maneuver away to avoid a pedestrian. Pedestrians, like PTWs, navigate congested traffic differently than if traffic were flowing. For example, among the 33 cases involving filtering PTW, 14 (42%) involved pedestrians running across the street and 21 (64%) concerned pedestrians crossing outside pedestrian crosswalks. The introduction to this research cited other studies that concluded pedestrian safety was at risk when PTWs were allowed to filter, notably when pedestrians cross lanes of congested traffic; cognitive conspicuity between PTWs and pedestrians; and the awareness on the part of the pedestrian in expecting PTW maneuvers.

17. **Clabaux N., Fournier J. Y., Michel J. E. Powered two-wheeler riders' risk of crashes associated with filtering on urban roads. *Traffic Injury Prevention* 2016;18(2):182-187.** Researchers examined the risk of powered two-wheelers (PTWs) filtering on urban roads in the city of Marseille, a metropolitan area in France. Marseille, after Paris, has the second highest number of crashes involving PTWs, approximately 1,300 a year, as recorded by police. The study examined 14 sections of main arterial streets over a 3-year time frame between 2007-2009. All lanes traveled in the same direction, intersections had traffic lights, and most streets in the study had a bus lane. Roads were examined on weekdays (excluding weekends) between the hours of 6 a.m. to 10 p.m. because roads were more likely to be congested. The first phase of research estimated the risk for PTW riders of being involved in an injury crash for each kilometer traveled and the risk for PTW drivers when they do not filter, and the 95% confidence interval for both. The second phase estimated the relative risk for both populations, distinguished between types of PTW maneuvers (e.g., filtering forward along the axis of the carriage way, filtering forward in a bus lane, and filtering forward in the space between traffic lanes going the same direction). The third phase involved a meta-analysis of data for all 14 sections of road. Police reports were used to determine if filtering was involved in a crash and the type of filtering used. Researchers examined the number of PTWs x kilometers exposed through hourly traffic data from electromagnetic loops installed on the roadways and by direct observation. Researchers determined that PTWs accounted for 17.9% of traffic in the 14 roadways studied, with light motorcyclists as the most numerous (44.5% of PTW traffic), followed by heavy

motorcyclists (37.5%), and moped users (18%). During the study period, 20.7% of PTW x kilometers were traveled while filtering. The axis of the carriageway was the most common space to filter (42.7%), followed by bus lanes (30.8%), the space between traffic (12.8%), and other spaces (13.7%). During the time period studied, 345 PTW operators were involved in crashes. Presence of filtering or not filtering was able to be determined in 309 of the crashes: 160 involved filtering and 149 did not involve filtering. In the 160 cases of crashes that involved filtering, "83 had not been previously detected by a car driver in the lane of vehicles being overtaken, when engaging a maneuver for changing lanes, turning right/left (toward another street or access), or making a U-turn." The study also found that vehicle queues obstructed visibility between the PTW and the pedestrian or other vehicle with 59 of 77 PTW riders not detected or detected late due to lack of visibility because of vehicle queues. Forty-five percent of moped riders had crashes while filtering, proportionally fewer crashes while filtering than light motorcycle riders (57%) and heavy motorcycle riders (54%). The researchers' meta-analysis of the results of each relative road section showed "a common relative risk with heterogeneity of 3.67 (95% CI, 2.93, 4.60) and a common relative risk corrected for heterogeneity of 3.94, with a 95% confidence interval of (2.63, 5.89)." Mopeds had a greater associated risk of crashing while filtering than light or heavy motorcycle riders. Among the spaces studied for filtering, no space appeared to be safer than others. Traffic observations found that riders filtered for an average of 21% of the total distance they traveled. The researchers concluded that "PTW riders filtering on urban roads have a risk of being involved in injury crashes that is nearly 4 times greater (3.94 times) than for riders driving in general traffic lanes." The researchers discussed risk factors for filtering and crashes that they did not examine age, experience, driving style, or the power ratio of the vehicle. Researchers also did not measure conditions under which filtering was performed (i.e., traffic conditions, speed of the PTW, lane geometry). Researchers conclude stating that their research suggests that legalizing filtering behaviors would probably have a negative effect on safety.

18. **Rice T. , Troszak L. , Erhardt T. . Motorcycle Lane-splitting and Safety in California.Berkeley, California: Safe Transportation Research & Education Center University of California Berkeley; 29 May 2015.**

In this white paper, Rice et al. conducted a descriptive analysis of a primary data set from the California Enhanced Motorcycle Collision Data Project, a collaboration between the University of California, Berkeley, and the California Highway Patrol (CHP). The study included two objectives: 1) to compare personal, motorcycle, and collision characteristics of lane-splitting collisions with those of other collision types and 2) to compare the occurrence of head, torso, and extremity injury among lane-splitting riders by the manner in which they were lane-splitting. From June 2012 through August 2013, CHP officers and officers at more than 80 local law enforcement agencies in California used a 1-page supplemental data form to collect additional information during collision investigations. CHP officers used an encrypted website to complete the forms (August 1, 2012 to July 31, 2013), and local agencies completed supplemental forms (June 1, 2012 through May 31, 2013) which were mailed to CHP and forwarded to UC Berkeley for entry. A small number of supplemental forms submitted in August 2013 were also included in the analysis. Reports provided the following information: rider and motorcycle characteristics, collision descriptors, alcohol use, extent of injury, and information on lane-splitting or helmet characteristics included in the report narrative. Police collision report data were linked to the supplemental form data using collision date, time, and officer badge number. Inconclusive matches were matched by hand. This work resulted in a database of 7,836 motorcycle involved collisions in California and information about the operators (n=7,836) and passengers (n=426) involved. CHP submitted 81% of the supplemental forms and local agencies submitted 19%. For the analysis, authors restricted the sample to collisions that occurred on roadways in CHP jurisdiction to reduce heterogeneity of roadway types and local law enforcement reporting practices. A total of 5,969 collision-involved motorcyclists had both a supplemental form and a police collision report and occurred in CHP jurisdiction. Of riders involved in collisions, 47% were aged 15-34 years; 24% were aged 25-54; 13% were aged 55-64 years, and 4% were aged 65 or older. The majority (93%) of the riders were male (5% female, 1.3% undetermined gender). Of the motorcyclists, 171 were fatally injured (2.9%), 1,025 were severely injured (17%), 2,388 received some other visible injury (40%), and 2,329 had either no injury or a complaint of pain (39%). Nearly 20% of the riders were not properly licensed at the time of collision. At the time of collision, 17% of motorcyclists were lane-splitting. Authors found that lane-splitting motorcyclists were more likely to have been riding on weekdays than other motorcyclists. They were also more likely to have been riding during commute hours (6:00-8:59 a.m. or 3:00-5:59 p.m.) than non-lane-splitting motorcyclists (62% and 38%, respectively). Lane-splitting motorcyclists were also younger than non-lane-splitting riders (58% were aged 34 or younger and 6% were aged 55 or older, compared with 45% and 19%, respectively, for other motorcyclists). The observed injuries among the motorcyclists were significantly different between lane-splitting motorcyclists and non-lane-splitting motorcyclists: head injury (9% vs. 17%), torso injury (19% vs. 29%), or fatal injury (1.2% vs. 3.0%). However, the occurrence of neck injuries and injuries to the extremities did not differ meaningfully between the two groups. While motorcyclists were very infrequently rear-ended by other motorists (4.3%), lane-splitting riders were significantly less likely to be rear-ended than other non-lane splitting riders (2.6% vs. 4.6%). However, lane-splitting riders were more likely to rear-end another vehicle than other riders (38% vs. 16%). Authors also found that “most riders exceeded the speed of surrounding traffic by a small or moderate amount. For example, 69% of riders were exceeding the traffic speed by 15 MPH or less.” They noted that 14% of lane-splitting riders had a speed differential of 25 MPH or great, with 3% traveling 40 MPH or faster than surrounding traffic. “Lane-splitting in such a manner is likely to increase the risk of being involved in a traffic collision.” Overall, “[b]oth traffic speed and motorcycle speed differential were significantly associated with the occurrence of head, torso, and extremity injury.” Authors noted a major limitation of the study was the lack of exposure data. Specifically, the “data set cannot be used to compare the collision risks for lane-splitting or non-lane-splitting riders.” Authors could not “estimate how the risk of being involved in a collision changes when motorcyclists [choose] to lane-split.” Additionally, other researchers have noted several factors observed in the study are covariates of one another. For example, as lane-splitting is a technique often used to move through congested traffic it makes sense that motorcyclists involved in collisions while lane-splitting were more likely to ride on weekdays and more likely to be riding during commute hours and in congested traffic conditions than non-lane-splitting motorcyclists. Additionally, the finding that lane-splitters were more likely to be wearing full-faced standard motorcycle helmets (81% versus 67%) and “markedly less likely” to suffer a head injury (9%) than non-lane-splitting riders (17%) fails to acknowledge the affect that wearing an appropriate helmet has on reducing head injuries.

19. **Team National Highway Traffic Safety Administration Technical Assistance. Motorcycle Safety Program Technical Assessment for the State of Washington. In: Butler**

TJ, Davis G, Krajewski AS, Montoya CA, O'Leary M, eds: Washington Traffic Safety Commission & Washington State Department of Licensing; 2017.
This document was compiled by a multi-disciplinary Technical Assessment Team of national experts assembled by the National Highway Traffic Safety Administration. They conducted a review of Washington State's motorcycle safety efforts, identified strengths and areas for improvement, and provided recommendations to enhance the program.

20. **SMARTER. Motorcyclist Lane-splitting/filtering: An Overview of the Literature 2010 - 2020. 2021.**
SMARTER as a motorcyclist safety advocacy association published a review of literature that included a summary of "Inter-line Traffic Experiences (CIF) of Motorized Two-wheelers: Assessment Report." This study was conducted in France and published in French. SMARTER provided a translated abstract to the study.

21. **Lane Filtering. 2022; Available at: https://dld.utah.gov/lane-filtering/. Accessed January 27, 2022.**
This Utah Department of Public Safety web page describes how motorcyclists can abide by the state's "lane filtering" rules. "'Lane filtering' means, when operating a motorcycle other than an autocycle, the act of overtaking and passing another vehicle that is stopped in the same direction of travel in the same lane." Motorcycles can only lane filter when the following conditions are met: 1) the speed limit on the road is 45 MPH or less (the practice is never allowed on freeways); 2) the road has two or more adjacent traffic lanes in the same direction of travel; 3) other vehicles are stopped; 4) the motorcycle speed cannot be more than 15 MPH; and 5) the movement may be made safely.

22. **KUTV. Citing incomplete data, lawmaker pushes to extend Utah's motorcycle lane filtering law. 2021; Available at: https://kutv.com/news/local/citing-incomplete-data-lawmaker-pushes-to-extend-utahs-motorcycle-lane-filtering-law. Accessed January 27, 2022.**
This online news article from Salt Lake City, Utah's KUTV notes that a state lawmaker was working on a bill to extend Utah's motorcycle lane filtering law for another five years. The rationale behind extending the expiration of the law to 2027 is to allow more time for data to be collected. The law which took effect in 2019 is set to expire in 2022. A Utah Highway Patrol Sergeant is quoted saying, "the data we have right now - is insufficient to help us fully understand whether the law is working." Furthermore, State officials shared "current data on lane filtering is limited, largely because officers can't clearly indicate whether lane filtering is a factor in current crash reports – an issue [the Utah Department of Public Safety] plans to rectify next year." The Communications manager in the Utah Highway Safety Office stated, "We simply do not have enough data yet to determine an increase in motorcycle traffic safety [...] However, we are able to show that there is not any significant data related to lane filtering that shows that this driving behavior is dangerous."

23. **(FEMA) Federation of European Motorcyclists' Associations. A European Agenda for Motorcycle Safety: The Motorcyclists' Point of View.Brussels, Belgium2009.**
The Federation of European Motorcyclists' Associations (FEMA) published a report in 2009 representing the perspective of motorcyclists. FEMA reports a key concern to be the lack of

perception and limited attention of motorcyclists by car drivers. The report contextualized the 3 types of motorcyclists: commuters, leisure riders, or a combination of the two. The report outlined the advantages of motorcycles (i.e., affordable means of transport, environmentally friendly, efficient travel medium, social value) and provided contextual considerations (i.e., motorcycling can never be made risk-free and the majority of motorcyclists are cautious). Regarding safety and collision reports, FEMA stated the variance in reporting of different enforcement geographies both in terms of qualitative and quantitative data results in the inability to complete analyses and comparisons across enforcement jurisdictions. FEMA discussed the concept of "Shared Responsibility" between transportation planners, law enforcement, the medical community, vehicle designers, government, researchers, insurers, and other road users as partners to ensure motorcyclist safety. FEMA discussed human, vehicle, environmental, and social factors to improve motorcyclist safety. Among the human factors is the need for education and training focused on information processing for both car drivers and motorcyclists, along with collision avoidance skills. The report discussed rider experience as a key factor in being able to avoid collisions, and initial training should be inclusive of both information processing and collision-avoidance skills. There is a stated need for qualified trainers and effective training centers. The FEMA report included a brief discussion on lane-filtering (moving between traffic when other surrounding traffic is stationary) in congested traffic conditions and lane-splitting (moving through traffic when other traffic is in motion). Vehicle factors discussed to improve safety included equipment, conspicuity, vehicle modifications, maintenance, and Intelligent Transport Systems. The report discussed environmental factors including road infrastructure, road conditions (e.g., wet roads), road maintenance, road hazards and black spot management, other vehicle design (e.g., A-pillars) and traffic management (inclusive of the ability to filter through slow or stationary traffic). Social factors FEMA reports on related to safety included driver awareness, motorcycle industry advertising and motorcycle magazines, attitudes of the transportation community, rider peer advice, and insurance and fiscal incentives.

24. **Courts Washington State Administrative Office of the. IRLJ 6.2 - Monetary Penalty Schedule for Infractions. Olympia, WA2022.**

Rule 6.2 of the Washington State Court Infraction Rules for Courts of Limited Jurisdiction (i.e., district and municipal courts) provides the monetary penalty schedule for infractions.

25. **Huth V., Füssl E., Risser R. Motorcycle riders' perceptions, attitudes and strategies: Findings from a focus group study. *Transportation Research Part F: Traffic Psychology and Behaviour.* 2014;25:74-85.**

This study assessed motorcyclists' attitudes and beliefs regarding their own safety and examined their behavioral strategies through focus group interviews conducted within the European Project 2-BE-SAFE. The researchers conducted semi-structured focus groups comprised of 42 people in Austria and Spain to explore the "why" behind behaviors and attitudes for specific areas of interest that included riders' views on riding situations and determinants of risky riding behavior and their perceptions and behavioral strategies facing hazards or interacting with other road users. Participants were selected on the "basis of purposiveness for a given topic." Focus group participants were primarily male, with approximately equal representation of recreational and commuter riders. A thematic approach was used to analyze data and followed 6 systematic steps. The study found 5 themes with several sub-themes. The first theme concentrated on individual riding behavior and that behavior was adaptable to the rider, the vehicle, and the road situation

(i.e., the type of motorcycle, speed, engine capacity, road setting, traffic density). They found the purpose behind the ride (i.e., comfort, timesaving, necessity, just for fun) influenced judgement of the riding behavior. The second theme focused on interaction with other road users and was discussed as an issue of considerable magnitude, mainly characterized by unexpected actions of other road users (e.g., cars cutting into a motorcyclist's trajectory, car drivers breaking traffic rules, driver distraction by a mobile phone). Participants felt a general lack of knowledge between road user groups and traffic culture. The third theme related to riding in a group of other motorcyclists and discussed benefits and safety hazards of such a practice in developing social riding norms. Fundamental to group riding is establishing rules and having a leader, with an optimal group size of 15 riders. Less experienced riders tempted to orientate to more skilled riders was noted as a risk. The fourth theme related to environmental risk, including road infrastructure (i.e., road surface, curves and bends, presence of guardrails) and riding environment (i.e., traffic density, light, visibility, predictability). The fifth theme concerned improvement suggestions for riding safety and included 4 subthemes: education and training, law and enforcement infrastructure, and equipment and technologies. There was an expressed need for specific education for car drivers and motorcycle safety training. The authors discussed that "[t]he outcomes of the focus group discussions with the riders encourage adopting a holistic view of riding situations, including the human, the vehicle and the environment." The researchers concluded that "recommendations for education and training can be anticipated on the basis of the findings presented in this paper." Recommendations included rider education focused on development of anticipation abilities on relevant aspects when judging situations, training focused on hazard awareness, and specific practice in judging a road situation. Moreover, other motor vehicle drivers need to be trained on the physical characteristics of motorcycles, the vulnerability of motorcyclists, and practice cognizance of their behaviors and vehicle maneuvers to develop a mutual understanding between road users. The authors stated that these focus groups were crucial for further qualitative study of a larger population and to formulate and design valid and large-scale studies.

26. **Crundall D. , Clarke D. , Ward P. , et al. Car Drivers' Skills and Attitudes to Motorcycle Safety: A review; Road Safety Research Report No. 85 London: Department of Transport;2008.**

Crundall et al. conducted a review of literature to "assess the evidence concerning those factors that are important when designing an intervention which targets car drivers with the aim of improving car–motorcycle interactions." The authors focused on the mental schema for a car driver's reaction to a motorcyclist and accompanying visual process: (1) Did the car driver look at the motorcycle (e.g., whether the driver oriented their eyes in the direction of the motorcycle); (2) Did the car driver perceive the motorcycle; and, (3) Did the car driver correctly appraise the motorcycle? Experience offers a person, in this case a car driver, information on where to look in a given situation, what to expect, and what to do given the observed information. Researchers discussed the eye movement pattering of fixations and saccades and the importance of those eye movements in looking at an object. Eyes process the visual scene through fixation, for approximately 200-300ms. Saccades are sudden and very fast eye jumps to different locations. It is possible that eyes may not see aspects of the environment through these movements. Considering a car drivers' perceptions, researchers discussed how a car driver must identify and categorize a motorcyclist. Eye fixations may not actually represent cognitive process and it could be possible for a car driver to look at a motorcyclist and not register it. To accurately appraise a

motorcyclist, first the car driver would have had to looked at and registered the motorcyclist and then, determined an appropriate maneuver. The researchers addressed car drivers' attitudes, car drivers' knowledge, and car drivers' skills and strategies as part of the schemata guide at play for car-motorcycle interactions. They discussed relevant studies and literature pertaining to individual bottom-up factors (i.e., of movement, color and luminance, spatial frequencies, saccade landing positions, obstructions, and change blindness), top-down factors that influence whether a car driver looks at a motorcycle (i.e., driving experience, peripheral vision, attitudinal influences, errors and lapses, and environmental knowledge), top-down factors that influence whether a car perceives a motorcycle (i.e., expectations of what is task relevant, priming the processing of information, competition between eye fixation and eye movement, attention on autopilot), and top-down factors that influence whether car drivers correctly appraise a motorcyclist (i.e., the size-arrival effect, distraction during decision making, age of the driver). The researchers concluded that "variables at all levels of the framework could influence the probability of a car colliding with a motorcycle." At the time of the article, the researchers also stated that there has been no research to provide evidence in measuring the three behaviors of car drivers looking, perceiving, and appraising in relationship to motorcyclists and which factors contribute the most to collisions.

27. **New Effort Launched to Improve Safety for Motorcyclists. 2021; Available at: https://www.udot.utah.gov/connect/2021/04/21/new-effort-launched-to-improve-safety-for-motorcyclists/. Accessed.**
The webpage reflects a news release from the Utah Department of Transportation (UDOT) describing Utah's "Ride to Live" campaign as part of UDOT's effort to improve motorcycle safety.

28. **Administration National Highway Traffic Safety. Traffic Safety Facts 2019 Data Motorcycles. Washington, DC: U.S. Department of Transportation; 2021.**
This 2019 fact sheet from the U.S. Department of Transportation's (DOT) National Highway and Traffic Safety Administration's (NHTSA) National Center for Statistics and Analytics provides an overview of motorcycle traffic safety facts. It defines motorcycles as "two- and three-wheeled motorcycles, off-road motorcycles, mopeds, scooters, mini bikes, and pocket bikes." Terms used include "motorcycle rider", the person operating the motorcycle; "passenger" a person seated on, but not operating, the motorcycle; and "motorcyclist" used to refer to either a rider or passenger. The fact sheet presents information from Fatality Analysis Reporting System (FARS), which includes data on every fatal motor vehicle traffic crash within the 50 States, the District of Columbia, and Puerto Rico. "To be included in FARS, a traffic crash must involve a motor vehicle traveling on a public trafficway that results in the death of a vehicle occupant or a nonoccupant within 30 days of the crash." It also includes data on non-fatal motor vehicle traffic crashes from the National Automotive Sampling System (NASS) General Estimates System (GES) and Crash Report Sampling System (CRSS). The fact sheet addresses crash characteristics (i.e., land use, motorcyclist location, weather, light condition, and functional system), crash involvement, motorcyclists (i.e., age, engine size, speeding, licensing and previous driving records, and alcohol use), state, and important safety reminders.

29. **U.S. Department of Transportation. Motorcycle Safety. 2021; Available at: https://www.nhtsa.gov/road-safety/motorcycles. Accessed 19 January, 2022.**

This NHTSA webpage provides an overview of motorcycle safety.

30. **Pedestrian laws & safety. 2022; Available at: https://wsdot.wa.gov/travel/bicycling-walking/walking-rolling-washington/pedestrian-laws-safety. Accessed January 27, 2022.**
This webpage provides and overview of Washington State's pedestrian laws.

31. **What Are Powered Two-Wheelers (PTWs)? 2022; Available at: http://www.immamotorcycles.org/?q=about/ptw. Accessed January 30, 2022.**
International Motorcycle Manufacturers Association (IMMA) is a "federation of regional and national associations representing the manufacturing industry of Powered Two Wheelers." The website defined a Powered Two-Wheeler (PTW).