Factors that Increase and Decrease Motorcyclist Crash Risk

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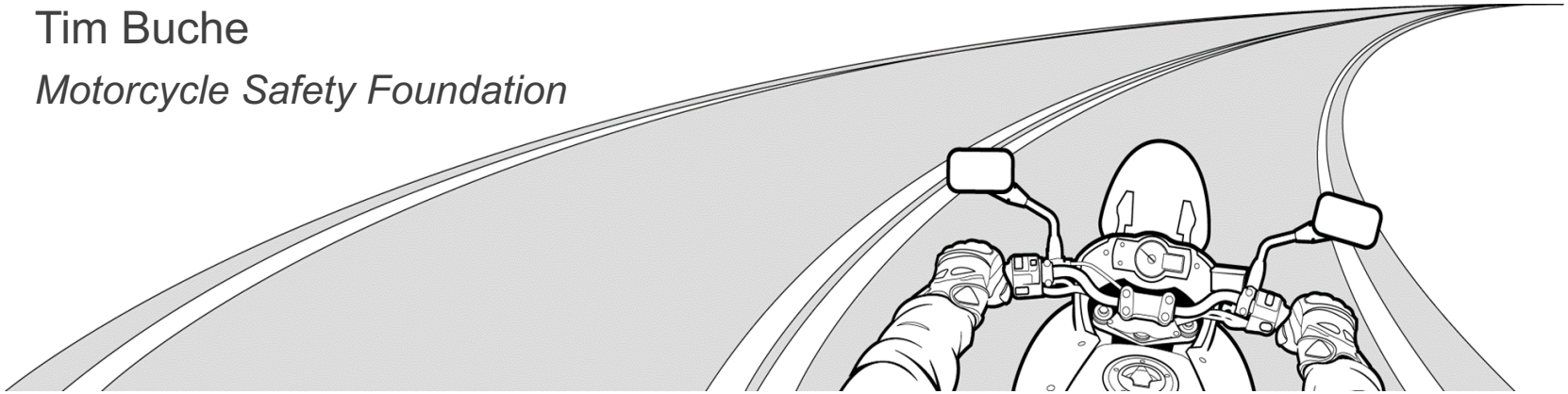

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Naturalistic Study

Organizational Mission

- **Virginia Tech Transportation Institute**
  - Conducts research to save lives, save time, save money, and protect the environment
  - Develops the techniques and technologies to solve transportation challenges from vehicular, driver, infrastructure, and environmental perspectives
  - Specifically for motorcycle safety, uses the collection of real-world driving/riding data and analysis/data mining to improve safety, with a focus on the user

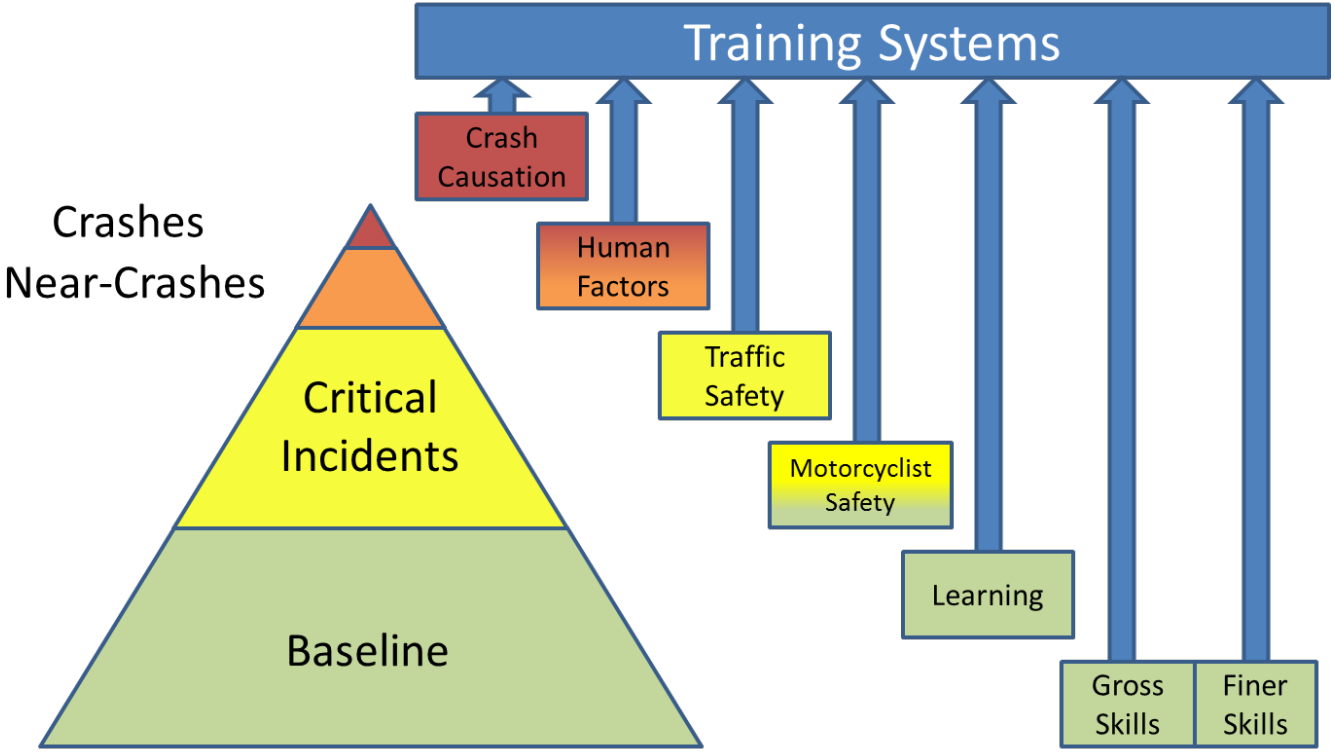
Organizational Mission

- **Motorcycle Safety Foundation**
  - **Mission:** To make motorcycling safer and more enjoyable by ensuring access to lifelong quality education and training for current and prospective riders, and by advocating a safer riding environment.
  - **Vision:** The MSF is an internationally recognized not-for-profit foundation, supported by motorcycle manufacturers, that provides leadership to the motorcycle safety community through its expertise, tools, and partnerships.

Understanding Crash Risk

- Traditional methods to understand crash risk rely on post-event analyses
- Other methods include simulators and controlled experimentation
- Observance of crash events via naturalistic study reveals conditions that would otherwise remain unknown
- In addition, near-crash events (surrogates for crashes) are observed as never before

Training Systems Development



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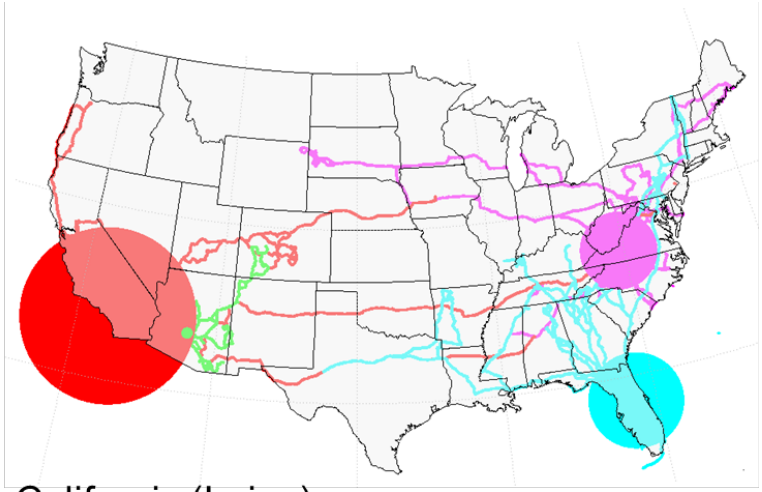
The Study

The MSF 100 Motorcyclists Naturalistic Study

- Sponsored by MSF, who assisted with day-to-day operations
- Instrumentation of 100 riders' personal motorcycles (riding as they normally do)
- Recorded video and kinematic data (collected 366,667 miles)
- First large-scale naturalistic motorcycle study to provide this type of unique and complex data

MSF 100 Motorcyclists Naturalistic Study



- California (Irvine)
  - Year-round riding
  - Mixed traffic densities
  - Geographic overlap with past studies
- Arizona (Phoenix)
  - Year-round riding
  - Mixed traffic densities
  - High concentration of sport bikes
- Virginia (Blacksburg)
  - Fall and Winter
  - Two-lane with hills and curves
  - Geographic overlap with automotive studies
- Florida (Orlando)
  - Conditional helmet law
  - Mandatory training
  - Flat and straight roads

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MSF 100 Motorcyclists Naturalistic Study

- GPS
- Machine vision lane tracker
- Accelerometers (3 axes)
- Gyro (3 axes)
- Forward radar

- Turn Signals
- Brake lever inputs
- Continuous collection
- 8-12 mo capacity
- Cellular communication from bikes back to VTTI

- Five color cameras
  - forward
  - rear
  - left hand
  - right hand
  - rider torso

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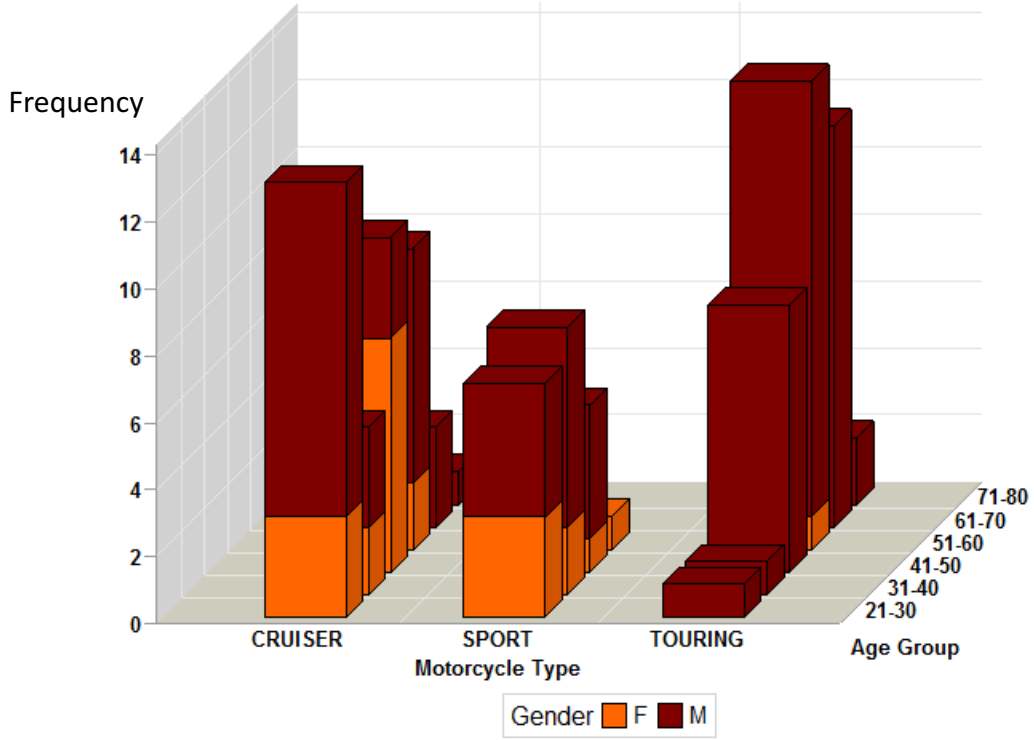
MSF 100 Motorcyclists Naturalistic Study



Female	22
Male	78

Cruiser	41
Sport	21
Touring	38

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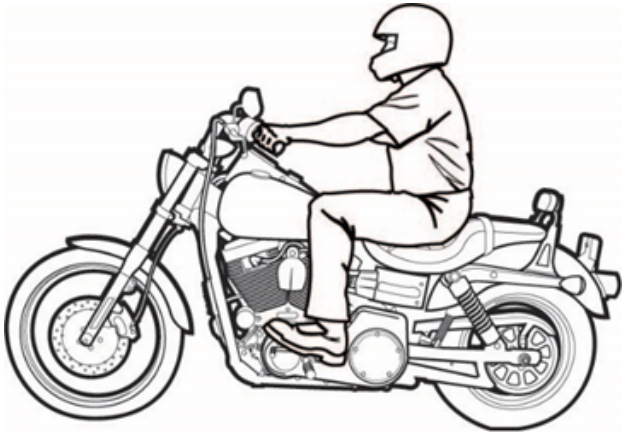
Collected Data

- Study participation
  - Range: 2 months to 2 years
  - Total of 30,844 trips
  - Total of 366,667 miles
  - Total installed time of 100.6 years
- Collected events
  - 30 crashes
  - 122 near-crashes
  - Events per rider ranged from 0 to 13
  - 55 riders experienced at least one event



Descriptive Statistics for CNCs

CNC	Mean	Median	Std. Dev.	Minimum	Maximum
Count per Participant	1.54	1	2.18	0	13
Rate per 1000 Miles per Participant	0.87	0.18	2.85	0	27.03

- Sample participants averaged 1.5 CNC events per rider
- When expressed as a rate, the average participant noticed a CNC rate of 0.87 per 1,000 miles traveled
- 34% of the riders in the study accounted for 86% of the crashes and near-crashes

Crash Descriptions

- "Crash," as defined by this study, includes:
  - Any contact that the subject vehicle has with an object, either moving or fixed, at any speed.
  - Non-premeditated departures of the roadway where at least one tire leaves the paved or intended travel surface of the road.
  - Any contact between the ground and the bike (other than tires/stands) or ground and rider (other than foot).
- 57% of the 30 crashes were low-speed "capsizes"
- Other crashes were of various types, as indicated in the next slide

Crash Descriptions

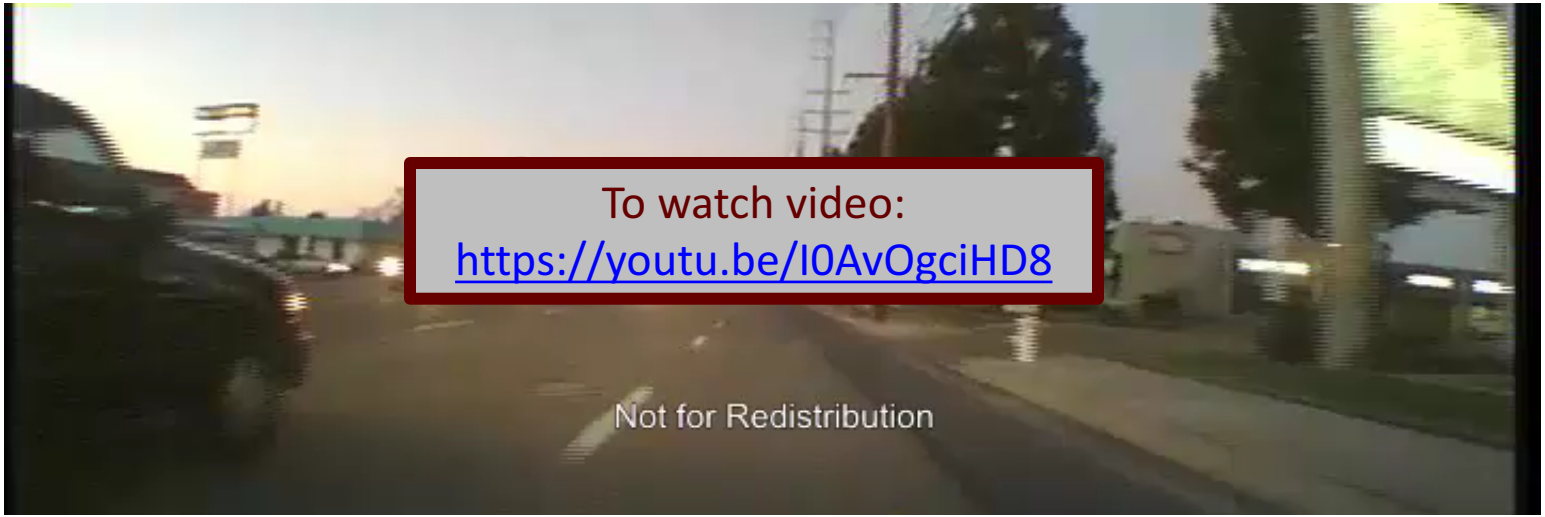
Incident Type	Number of Cases	Percentage of Crashes
Ground impact - low speed	17	56.67%
Road departure (left or right)	3	10.00%
Other vehicle turn across path	3	10.00%
Rear-end, striking	2	6.67%
Ground impact - while underway	1	3.33%
Poor curve negotiation	1	3.33%
Rear-end, struck	1	3.33%
Other vehicle straight crossing path	1	3.33%
Subject vehicle turn into path (same direction)	1	3.33%

Crash Descriptions

- Example of Ground Impact – Low Speed (“capsize”)

Crash Descriptions

- Example of Other Vehicle Turn Across Path



Single-Vehicle Crash and Near-Crash Descriptions

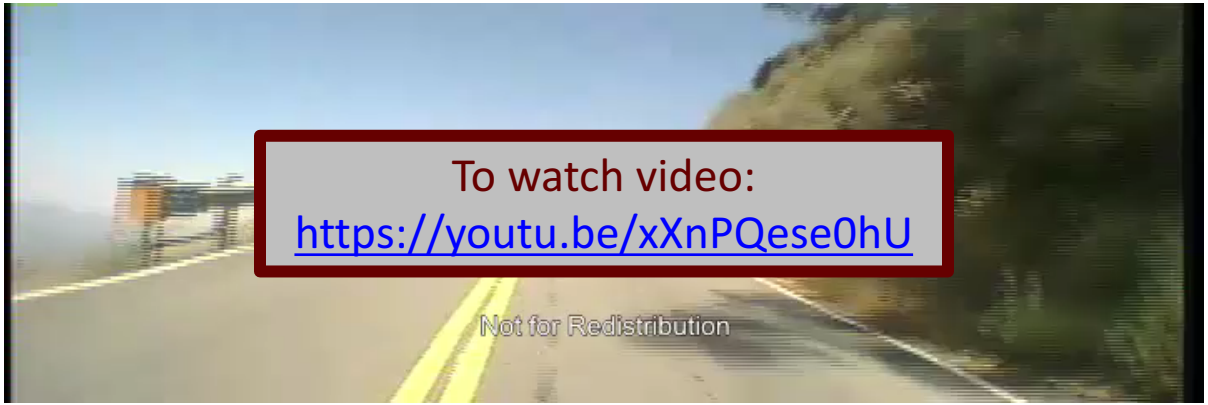
- The next slide provides an indication of the types of crashes and near-crashes (where a rapid, evasive maneuver is required) that involved only the participant bike (no other vehicles, objects, or pedestrians were influential in the event)
- There were 53 cases of these single-vehicle events (involving 29 different riders)
- 55% of these 53 single-vehicle (motorcycle) events involved the participant negotiating a curve leading into the crash or near-crash
- The remainder of these events involved various scenarios, as indicated in the following table

Single-Vehicle Crashes (SVCs) & Near-Crashes

Precipitating Event	Pre-incident Maneuver	Number of Events	Percentage of SVCs
Subject over left lane line	Negotiating a curve	18	34.0%
Subject over left edge of road	Turning right	1	1.9%
Subject over right edge of road	Negotiating a curve	4	7.5%
	Going straight, but with unintentional "drifting" within lane or across lanes	1	1.9%
Subject over right lane line	Negotiating a curve	2	3.8%
This vehicle lost control - excessive speed	Going straight, constant speed or decelerating	4	7.5%
	Negotiating a curve	3	5.7%
This vehicle lost control - insufficient speed	Entering/leaving a parking position, moving forward	3	5.7%
	Going straight, constant speed or decelerating	3	5.7%
	Turning right	2	3.8%
	Turning left	1	1.9%
	Backing up (other than for parking purposes)	1	1.9%
	Making U-turn	1	1.9%
	Negotiating a curve	1	1.9%
	Starting in traffic lane	1	1.9%
	Stopped in traffic lane	1	1.9%
This vehicle lost control - other cause	Backing up (other than for parking purposes)	1	1.9%
	Negotiating a curve	1	1.9%
This vehicle lost control - poor road conditions	Going straight, constant speed or decelerating	2	3.8%
	Turning right	2	3.8%

Single-Vehicle Crash and Near-Crash Descriptions

- Example of subject over left lane line while negotiating a curve



Crash and Near-Crash Descriptions Involving Other Vehicles or Objects

- The remainder of the crashes and near-crashes involved at least one other vehicle or object (e.g., pedestrian, animal, cyclist)
- There were 99 of these events (involving 44 different riders)
- 35% of these 99 events were cases of the subject bike rear-ending a lead vehicle
- The rest of the events included 13 categories of Incident Type, and are included in the following table

Crash and Near-Crash Descriptions Involving Other Vehicles or Objects

Primary Incident Type	Number of Events	Percentage of Multi-Vehicle Conflicts
Rear-end, striking	35	35.4%
Sideswipe, same direction (left or right)	21	21.2%
Other vehicle turn across path	8	8.1%
Opposite direction (head-on or sideswipe)	7	7.1%
Animal-related	6	6.1%
Other vehicle turn into path (opposite direction)	6	6.1%
Other vehicle turn into path (same direction)	5	5.0%
Pedestrian-related	3	3.0%
Backing into traffic	2	2.0%
Rear-end, struck	2	2.0%
Subject vehicle turn into path (same direction)	1	1.0%
Other	1	1.0%
Pedal cyclist-related	1	1.0%
Other vehicle straight, crossing subject path	1	1.0%

Method of Evaluating Crash/Near-Crash (CNC) Risk

- Video verification of crash and near-crash events
- Video analysis using a 95-variable data dictionary, VTTI developed/tested
  - 7,028 baseline events ("eventless" riding), randomly selected per rider, number based on rider mileage
  - 152 crash and near-crash events
- Odds of being involved in a crash or near-crash (CNC) given exposure to a factor are calculated
  - Based on odds of CNC occurrence when exposed to factor compared to odds when not exposed to factor
  - Factors can be related to the rider, environment, or roadway (these are the dictionary variables)

Results: Factors that Increase CNC Risk

Variable	Level	Odds Ratio	Reference
	Exposure to this	*increases risk by this many times*	*compared to:*
Intersection Influence	Yes, Uncontrolled	40.7	None
Intersection Influence	Yes, Parking lot, driveway entrance/exit	8.5	None
Intersection Influence	Yes, Traffic signal	2.9	None
Rider Behavior	Aggressive riding (only)	17.9	None
Rider Behavior	Lack of knowledge or skill/Inattention (only)	9.3	None
Rider Behavior	Combination of behaviors	30.4	None
Pre-incident Maneuver	Maneuvering to avoid object	11.8	Going straight, constant speed
Surface Type	Gravel/Dirt road	9.4	Paved, smooth
Roadway Grade	Grade down	4.3	Level
Roadway Grade	Grade up	1.9	Level
Traffic Density	Unstable	3.6	Stable
Roadway Alignment	Curve right	2.1	Straight

Results: Factors that Decrease CNC Risk

Variable	Level	Odds Ratio	Reference
	Exposure to this	*is associated with a risk that is this many times*	*the risk for:*
Locality	Urban	0.1	Open country/ Open residential
Locality	Highway	0.2	Open country/ Open residential
Locality	Miscellaneous/Other	0.2	Open country/ Open residential
Locality	Moderate residential/ Business/Industrial	0.4	Open country/ Open residential
Pillion Riders	1	0.3	0

Contribution to Motorcycle Safety Research

- Discovered 12 factors that increase the risk of CNCs
- Discovered 5 factors that decrease the risk of CNCs
- Provided detailed guidance based on risk factors that can be incorporated into training programs
- Produced a large, rich database of naturalistic riding information that will be used for years to uncover crash and near-crash mechanisms and support safety-related motorcycle research
- Developed and tested a data reduction dictionary specifically for naturalistic motorcycle analysis that can be applied consistently across future studies

Contributions to Motorcycle Safety Research

- Observed some good things, too
- Useful in supporting the emphasis of proper technique and execution

Contact Info

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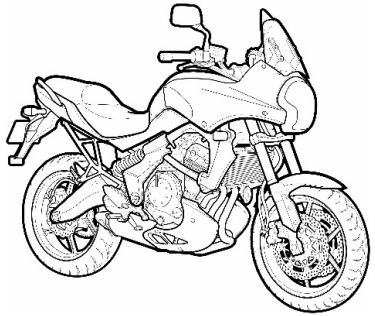

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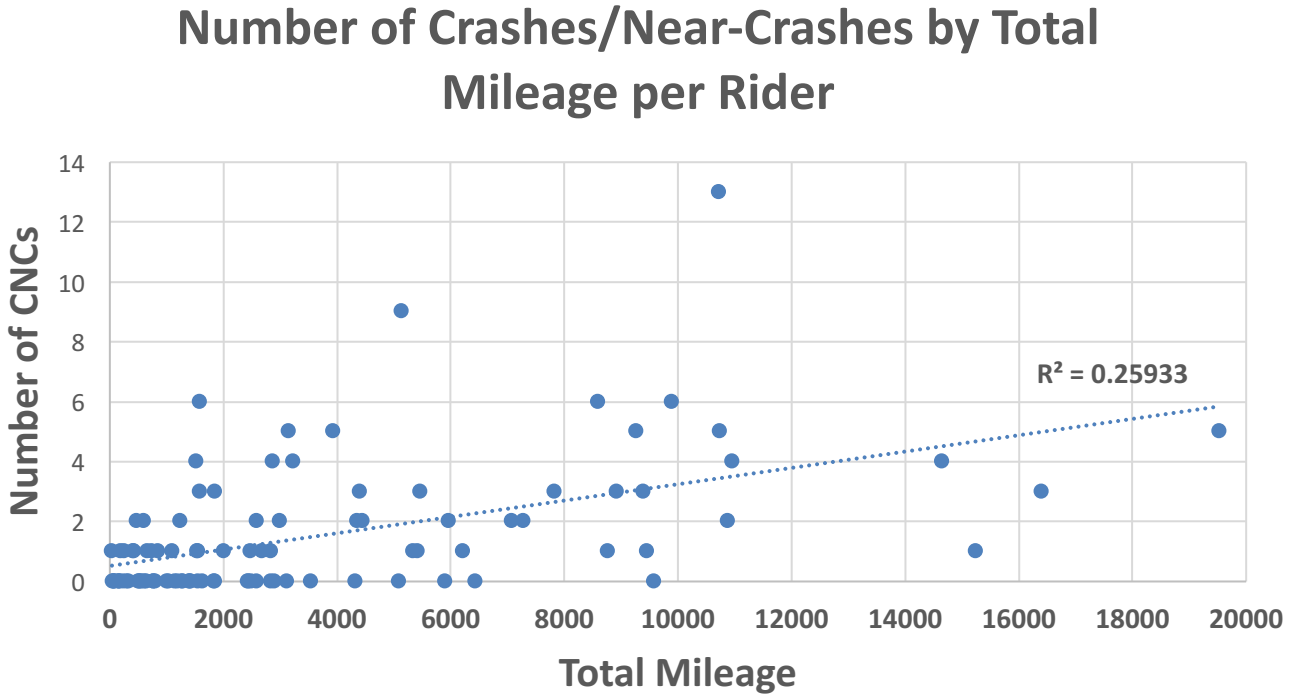
Descriptive Statistics for CNCs



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