FHWA Motorcycle Crash Causation Study

Carol H. Tan, Ph.D
Office of Safety Research & Development
Federal Highway Administration

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Presentation Overview

• Background
• Data Collection
• Results
• Current FHWA Activities
Background:
Why Study MotorcyclesCrashes?

![Graph showing motorcycle fatalities and all traffic fatalities from 1996 to 2014. The graph illustrates a significant increase in motorcycle fatalities compared to all traffic fatalities over the years.]
Background:
Why Study Motorcycles Crashes?

Percentage of All Fatalities: Motorcyclists

- 1997: 4%
- 1999: 5%
- 2001: 6%
- 2003: 7%
- 2005: 8%
- 2007: 9%
- 2009: 10%
- 2011: 11%
- 2013: 12%
- 2015: 14%
Background:
Congressional Response

- Congress mandated the Motorcycle Crash Causation Study (MCCS)
  - OECD Data Collection Protocol
  - Oklahoma State University

- NHTSA Pilot Study
  - FHWA and NHTSA worked to develop data collection program
  - Final Report: June 2010
Background: MCCS Partners

• Partners
  – USDOT
    • FHWA
    • NHTSA
  – Six State DOTs
    • New Mexico
    • New York
    • Ohio
    • Oklahoma
    • Texas
    • Wisconsin
  – American Motorcyclist Association (AMA)

• Sample Size
  – 351 Crash Investigations
  – 702 Control Rider Interviews
MCCS Data Collection

• Orange County, California
  – Urban
  – Rural
  – Commuters
  – Leisure Riders

• 3 Crash Investigators
  – 2 re-hired from the NHTSA Pilot
  – Experienced Crash Investigators
  – On call 24/7
OECD Methodology

- Organisation for Economic Co-operative Development (OECD)
  - On-Scene Investigation
  - Vehicle Inspection
  - Rider Interviews
  - Injury Data
  - Control Rider Interviews
    - 2 Controls/Crash
  - 1,600+ Data Elements
Crash Investigation Process

Respond On-Scene

– Scene / Evidence Documentation
– Interview participants / Witnesses
– Take initial measurements
Scene Diagram

Motorcycle Crash Causes and Outcomes Study

Vehicle 1: 2011 Suzuki GSXR 750 (750cc's)
Other Vehicle: 2006 Honda Element
Scene Diagram

• Detailed Measurements
  • Lane width
  • Curb height
  • Point of Final Rest

• Record any crash-related evidence
  • Tire marks
  • Remaining debris
  • Damage to roadside objects
Motorcycle Investigation
Other Information Resources

- **Police Accident Report**
  - Description of crash event
  - BAC measurements

- **Rider Interviews**
  - Crash account
  - Riding history
  - Licensing status
  - Rider training
  - Emotional state
Medical Records

- **Obtain Medical Records from Hospital**
  - Code all injuries using Abbreviated Injury Scale (AIS)
  - Identify location and description of all injuries
- **Obtain coroner’s report**
  - Injury details
  - Toxicology results
Helmet Reconstruction

- **Documentation**
  - Helmet certification
  - Manufacture date
  - Chin strap

- **Helmet recovery**
  - Offer $100 gift card for replacement helmet
  - Used for reconstruction (~10%)
Helmet Reconstruction

Recreate Crash Forces on Exemplar Helmet

Identify Impact Zones and Direction of Force
Control Interviews

• Serve as Control Population
• Detailed data collection
  – Rider history
  – Motorcycle detail
  – Protective equipment
  – Trip purpose
• $40 Gas Card
Results
Caution

• While it is possible to perform the statistical analysis and calculate statistically significant differences, additional analysis/research is required before cause and effect can be demonstrated.

• The contribution of this study is to help identify which cause and effect studies may be needed.
Data Analysis

• While Data Collection was the Goal of the Study, (Limited) Data Analysis Was Performed

• Simple Comparisons of Proportions Were Conducted and Statistical Significance Identified* (90 and 95 percentile, Over/Under Representation of Variable in Sample)
  – Single vs. Multiple Vehicle Crashes
  – Fatal vs. Non-Fatal Crashes
  – Crash vs. Controls
  – (Limited) Study Data vs. Larger Data Sets/Previous Studies

* While it is possible to calculate the presence of absence of statistical significance with small samples, it is generally recommended that sample sizes of 25 or greater should be present before the statistical analysis should be used. Tables with small sample sizes are presented within this report as these may provide researchers with insight on how, or if, parameters that were not observed frequently may or may not be linked with motorcycle crash causation.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Question Identifier</th>
<th>Total Coded in Sample/Data Subset 1</th>
<th>Total Coded in Sample/Data Subset 2</th>
<th>Statistical Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Meaning A</td>
<td>( n_{1} )</td>
<td>( n_{2} )</td>
<td>Finding of Presence/Absence of Statistical Significance</td>
</tr>
<tr>
<td></td>
<td>Code (00)</td>
<td>( p_{1} )</td>
<td>( p_{2} )</td>
<td>( z )</td>
</tr>
<tr>
<td>01</td>
<td>Meaning B</td>
<td>( n_{1} )</td>
<td>( n_{2} )</td>
<td>Finding of Presence/Absence of Statistical Significance</td>
</tr>
<tr>
<td></td>
<td>Code (01)</td>
<td>( p_{1} )</td>
<td>( p_{2} )</td>
<td>( z )</td>
</tr>
<tr>
<td>02</td>
<td>Meaning C</td>
<td>( n_{1} )</td>
<td>( n_{2} )</td>
<td>Finding of Presence/Absence of Statistical Significance</td>
</tr>
<tr>
<td></td>
<td>Code (02)</td>
<td>( p_{1} )</td>
<td>( p_{2} )</td>
<td>( z )</td>
</tr>
</tbody>
</table>

\[
z = \frac{(p_{1} - p_{2})}{\sqrt{\frac{p \cdot (1-p) \cdot (1/n_{1} + 1/n_{2})}{2}}}\
\]

where

- \( p_{1} \) is the proportion in sample 1 with the code/characteristic of interest,
- \( p_{2} \) is the proportion in sample 2 with the code/characteristic of interest,
- \( p \) is the proportion in the combined sample (all individuals with the code/characteristic of interest in both data subsets),
- \( n_{1} \) is the number in data subset 1, and
- \( n_{2} \) is the number in data subset 2. (see [link](http://www.dummies.com/how-to/content/how-to-compare-two-population-proportions.html))
RESULTS

- **Motorcycle Crash Causation Study: Final Report**
- **Volume 1 – Data Collection Forms and Variable Naming** (note: this volume was originally **Volume 1: Study Overview, Findings, Variables, and Data Forms**)
- **Volume 2 – Coding Manual** (note: this volume was originally **Volume 14 – Coding Manual**; subsequent volumes have been renumbered)
- **Volume 3 – Crash Form Data**
- **Volume 4 – Environmental Form Data**
- **Volume 5 – Contributing Factors Data**
- **Volume 6 – Motorcycle Rider Data – Control Rider Data**
- **Volume 7 – Motorcycle Passenger Data – Control Passenger Data**
- **Volume 8 – Motorcycle Mechanical Data – Control Motorcycle Data**
- **Volume 9 – Motorcycle Dynamics Data**
- **Volume 10 – Injury Form Data**
- **Volume 11 – Other Driver Data**
- **Volume 12 – Other Vehicle Data**
- **Volume 13 – Helmet Data**
- **Volume 14 – Comparisons to Other Studies**
Data Analysis (cont.)

Example: Comparison/Analysis
- Single vs. Multiple Vehicle Crashes

Crash Form

1. Day of Week Crash Occurred
   (1) Monday
   (2) Tuesday
   (3) Wednesday
   (4) Thursday
   (5) Friday
   (6) Saturday
   (7) Sunday

6. How Many Other Vehicles Were Involved in the Crash?
   (00) none
   (01) one
   (02) two
   (03) three
   (04) four or more

7. How Many Pedestrians Were Involved in the Crash?
   (00) none
   (01) one
   (02) two
   (03) three
   (04) four or more
   (05) not applicable
   (06) other

8. Number of Passengers on the Motorcycle
   (00) none
   (01) one
   (02) two
   (03) three
   (04) four
   (05) five
   (06) six
   (07) seven
   (08) eight
   (09) unknown

9. Are There Any Fatal Injuries Involved?
   (00) no
   (01) yes

Single Vehicle Crashes were Overrepresented in the Sample Data (relative to Multiple Vehicle Crashes) on Sundays.

### Single vs. Multiple Vehicle Crashes (MC Data)

<table>
<thead>
<tr>
<th>Code</th>
<th>Meaning of Code</th>
<th>Single Vehicle Count</th>
<th>Percent of Single</th>
<th>Multiple Vehicle Count</th>
<th>Percent of Multiple</th>
<th>R2</th>
<th>Z</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Monday</td>
<td>8</td>
<td>9.8%</td>
<td>82</td>
<td>11.3%</td>
<td>0.446</td>
<td></td>
<td>Not Significant</td>
</tr>
<tr>
<td>02</td>
<td>Tuesday</td>
<td>7</td>
<td>8.5%</td>
<td>82</td>
<td>11.9%</td>
<td>0.647</td>
<td></td>
<td>Not Significant</td>
</tr>
<tr>
<td>03</td>
<td>Wednesday</td>
<td>12</td>
<td>14.6%</td>
<td>56</td>
<td>14.1%</td>
<td>-0.115</td>
<td></td>
<td>Not Significant</td>
</tr>
<tr>
<td>04</td>
<td>Thursday</td>
<td>9</td>
<td>11.0%</td>
<td>34</td>
<td>12.6%</td>
<td>0.402</td>
<td></td>
<td>Not Significant</td>
</tr>
<tr>
<td>05</td>
<td>Friday</td>
<td>10</td>
<td>12.2%</td>
<td>53</td>
<td>19.7%</td>
<td>1.551</td>
<td></td>
<td>Not Significant</td>
</tr>
<tr>
<td>06</td>
<td>Saturday</td>
<td>17</td>
<td>20.7%</td>
<td>47</td>
<td>17.5%</td>
<td>-0.988</td>
<td></td>
<td>Not Significant</td>
</tr>
<tr>
<td>07</td>
<td>Sunday</td>
<td>19</td>
<td>23.2%</td>
<td>54</td>
<td>12.5%</td>
<td>-2.882</td>
<td></td>
<td>Over Represented (20%)</td>
</tr>
</tbody>
</table>

**Day of Week Crash Occurred (Single vs. Multiple Vehicle Crashes)**

- **Monday**: 8
- **Wednesday**: 7
- **Friday**: 12
- **Sunday**: 19

(U.S. Department of Transportation Federal Highway Administration)
Preliminary Results

AGE OF RIDER IN CRASH AND CONTROL

- 0.0%
- 5.0%
- 10.0%
- 15.0%
- 20.0%
- 25.0%

- 20 AND UNDER
- 21 - 25 YEARS
- 26 - 30 YEARS
- 31 - 35 YEARS
- 36 - 40 YEARS
- 41 - 45 YEARS
- 46 - 50 YEARS
- 51 - 55 YEARS
- 56 - 60 YEARS
- 61 - 65 YEARS
- 66 - 70 YEARS
- 71 - 75 YEARS
- 75 YEARS AND ABOVE

[Graph showing age distribution in crash and control]
Preliminary Results (Crash)

• **95%** of crashed riders were male

• **98.9%** of crashed riders were wearing helmets
  – **74%** were wearing full-face helmets

• **19%** of crashed riders did not have a MC license
  – **5%** had no license at all
## Preliminary Results

<table>
<thead>
<tr>
<th>Type of Motorcycle Training</th>
<th>Crashes</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>None *</td>
<td>24%</td>
<td>15%</td>
</tr>
<tr>
<td>State Recognized, Entry-Level Motorcycle Course</td>
<td>50%</td>
<td>45%</td>
</tr>
<tr>
<td>Experienced Rider Course</td>
<td>8%</td>
<td>10%</td>
</tr>
<tr>
<td>High Performance/ Competitive Track Course</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Self Taught*</td>
<td>6%</td>
<td>18%</td>
</tr>
<tr>
<td>Taught By Family and/or Friends</td>
<td>6%</td>
<td>7%</td>
</tr>
</tbody>
</table>
## Preliminary Results

<table>
<thead>
<tr>
<th>Age When Rider Began To Ride</th>
<th>Crashes</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never Rode Before, Or Rarely Ever Ride*</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Under The Age Of 17*</td>
<td>27%</td>
<td>40%</td>
</tr>
<tr>
<td>Age Between 17 - 25 Years*</td>
<td>51%</td>
<td>42%</td>
</tr>
<tr>
<td>Age Between 26-35 Years</td>
<td>13%</td>
<td>9%</td>
</tr>
<tr>
<td>Age Between 36-45 Years</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Age Between 46-55 Years</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Age More Than 55 Years</td>
<td>1%</td>
<td>1%</td>
</tr>
</tbody>
</table>
Preliminary Results (Crash)

• **11% of crashes resulted in a fatality to the rider**
  – **22%** of single vehicle crashes resulted in a fatality
  – **62%** of the fatalities involved a collision with a fixed object

• **77% coded as multiple vehicle**
  – **48%** of multi-vehicle crashes were the result of a turn by the MC or OV
  – **41%** of single vehicle crashes involved a rider leaving the roadway

• **10% crashes occurred between 10pm-6am**
  – **13%** of fatalities
  – **12%** of single vehicle crashes
Preliminary Data (Environment)

- 66.7% of crashes occurred at an intersection
  - 50% of fatal crashes occurred at intersections compared to 28% of non-fatal
  - 17% of crashes occurred at driveways
- 34% of crashes occurred on curves
  - 48% of fatal crashes occurred on curves as compared to 32% of non-fatal crashes
- 74% of crashes occurred on principal or minor arterials
Preliminary Data (Causation)

- A failure by the rider: the **primary contributing factor** in **44.3% of crashes** and a failure by the other vehicle driver was attributed to **51% of crashes**
  - **Unsafe acts by the rider** were deemed to be related to **50% of crashes**
  - **Traffic Scanning errors** by the other vehicle driver contributed to **70% of crashes**
  - **Inadequate control skills of the rider** contributed to **26% of crashes**
Preliminary Data (Injuries)

MAXIMUM INJURY SEVERITY FOR EACH CASE (SINGLE VS. MULTIPLE VEHICLE CRASHES)

- **MINOR INJURY**
  - Single Vehicle Crashes: 35.0%
  - Multiple Vehicle Crashes: 40.0%

- **MODERATE INJURY**
  - Single Vehicle Crashes: 30.0%
  - Multiple Vehicle Crashes: 40.0%

- **SERIOUS INJURY**
  - Single Vehicle Crashes: 25.0%
  - Multiple Vehicle Crashes: 20.0%

- **SEVERE INJURY**
  - Single Vehicle Crashes: 15.0%
  - Multiple Vehicle Crashes: 10.0%

- **CRITICAL INJURY**
  - Single Vehicle Crashes: 5.0%
  - Multiple Vehicle Crashes: 5.0%

- **MAXIMUM (UNTREATABLE)**
  - Single Vehicle Crashes: 0.0%
  - Multiple Vehicle Crashes: 0.0%
NO ALCOHOL USE, ONLY DRUG/MEDICATION USE

ONLY COMBINED ALCOHOL AND DRUG/MEDICATION USE

ALCOHOL OR DRUG CONSUMPTION OF RIDERS
**TYPE OF INTERSECTIONS**

- **Not an Intersection**: 60.0% (MCCS) 70.0% (NASS/GES)
- **Four-Way Intersection**: 40.0% (MCCS) 30.0% (NASS/GES)
- **T-Intersection**: 10.0% (MCCS) 0.0% (NASS/GES)
- **Y-Intersection**: 0.0% (MCCS) 0.0% (NASS/GES)
- **Traffic Circle / Roundabout**: 0.0% (MCCS) 0.0% (NASS/GES)
- **Five-Point, or More**: 0.0% (MCCS) 0.0% (NASS/GES)

**NOTE**: NOT AN INTERSECTION, FOUR-WAY INTERSECTION, T-INTERSECTION, Y-INTERSECTION, TRAFFIC CIRCLE / ROUNDABOUT, FIVE-POINT, OR MORE

**TYPE OF INTERSECTIONS**

- **Not an Intersection**: 80.0% (MCCS) 70.0% (FARS)
- **Four-Way Intersection**: 60.0% (MCCS) 50.0% (FARS)
- **T-Intersection**: 20.0% (MCCS) 10.0% (FARS)
- **Y-Intersection**: 10.0% (MCCS) 0.0% (FARS)
- **Traffic Circle / Roundabout**: 0.0% (MCCS) 0.0% (FARS)
- **Five-Point, or More**: 0.0% (MCCS) 0.0% (FARS)

**NOTE**: MCCS - FARS
Data Access

Data access administered by the FHWA Highway Safety Information System (HSIS) Program: www.hsisinfo.org
Current FHWA Activities
Current FHWA Safety Activities

• Identifying Infrastructure-Based Motorcycle Crash Countermeasures – Yusuf Mohamedshah (Yusuf.Mohamedshah@dot.gov)

• Motorcycle Advisory Council (MAC) – Guan Xu (Guan.Xu@dot.gov)

• Addressing Motorcycle Crashes at Intersections – Jeff Shaw (Jeffrey.Shaw@dot.gov)
Phase I Project Objectives:

- Analysis of Motorcycle Crash Causation Study (MCCS) database.
- Identify three to five infrastructure-based countermeasures to reduce motorcycle crashes on our nation’s highway.
Phase 1 Project Deliverables

- Summary report: literature review, data analysis methodology and results
- Potential infrastructure based countermeasures
- Research questions can be addressed using MCCS data
- Workshop findings and list of research questions paired with potential countermeasures
- Phase II plans
  - Plan to develop and field test three to five countermeasures
  - Evaluation plan to study effectiveness of these countermeasures on motorcycle crashes
More Information

• Contact Information
  Yusuf.Mohamedshah@dot.gov
  Carol.Tan@dot.gov

• MCCS Website
Questions?

Thank You