



National Solutions Worldwide Impact

Pedestrian and Bicycle Safety Performance Functions for the Highway Safety Manual (NCHRP 17-84)

Research Team

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Research Objective and Scope

- **Objective**

- Develop pedestrian and bicycle SPFs using risk-based or predictive methods for transportation practitioners at all levels to better inform planning, design, and operations decisions

- **Scope**

- Plan to develop pedestrian and bicycle SPFs for:
 - Roadway segments and intersections
 - Rural and urban areas

Primary Work Plans

- Work Plan A – Develop Pedestrian and Bicycle SPFs using Available Exposure Data
- Work Plan B – Develop and Test an Alternative Risk-Based Approach to Pedestrian and Bicycle Crash Prediction based on RAP
- Work Plan C – Develop Risk-Based Models for Pedestrians and Bicycles Based on Crash Data in the Absence of Pedestrian and Bicycle Volume Data

Work Plan A – Develop Pedestrian and Bicycle SPFs using Available Exposure Data

- Focus on developing pedestrian and bicycle SPFs for roadway segments and intersections in urban areas, for which exposure, crash, and inventory data are available

Minneapolis (MN)

- Collected inventory, traffic volume, pedestrian and bicycle volume, and crash data
 - Since 2006, bicyclist and pedestrian traffic counts available for approximately 575 locations throughout city
 - Developed methodology to extrapolate short-term counts to long-term counts
 - Gathered data from existing data sources and manually using aerial mapping tools
 - Database includes up to 13 yrs of data (2006 – 2018)

Philadelphia (PA)

- Electronic data sources gathered and processed
- Manual data collection underway
- Database to include 5 yrs of data (2014 – 2018)

Work Plan A – Develop Pedestrian and Bicycle SPFs using Available Exposure Data (Summary)

- High priority site types:

Roadway Segments

- 2U
- 3T
- 4U
- 4D
- One-way
 - 1 In
 - 2 In
 - 3 In

Intersections:

- 3ST
- 4ST
- 3SG
- 4SG
 - Two-way vs two-way
 - One-way vs two-way

Work Plan A – Develop Pedestrian and Bicycle SPFs using Available Exposure Data (Summary)

- Preliminary analyses of segments (using negative binomial regression) show inconsistent results:
 - In most models, ped and bike exposure (ped/day or bike/day) are not significant
 - In some models, AADT is not significant
 - Types of variables found to be significant predictor of crashes (but not across site types):
 - Speed limit
 - Lane width
 - Parking lane width
 - Total road width
 - Total roadway width
 - Presence of parking
 - Presence of sidewalks
 - Bus stop density
 - Driveway density

Work Plan B – Develop and Test an Alternative Risk-Based Approach to Pedestrian and Bicycle Crash Prediction based on RAP

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Current Status

- Have completed drafts for three separate chapters:

DEFINITELY TO BE RECOMMENDED FOR HSM2:

- HSM Chapter 10 – Two-Lane, Two-Way Roads (2U roadways)
- HSM Chapter 11 – Rural Multilane Highways
 - Both multilane undivided (MU) and multilane divided (MD) roadways are addressed

POSSIBLY TO BE RECOMMENDED FOR HSM2 (or could be replaced or supplemented by Work Plan A results)

- HSM Chapter 12 – Urban and Suburban Arterials
 - 2U, MU, and MD

Work Plan C – Develop Risk-Based Models for Pedestrians and Bicycles Based on Crash Data in the Absence of Pedestrian and Bicycle Volume Data

- Planned to develop models for segments and intersections in both rural and urban areas using data from two states
 - Initially collected detailed data for rural locations in California
 - Review of crash data showed so few ped and bike crashes at rural intersections so focused on collecting detailed data for segments

Work Plan C – Develop Risk-Based Models for Pedestrians and Bicycles Based on Crash Data in the Absence of Pedestrian and Bicycle Volume Data

Category	Data Element
Roadway Geometric and Operational Characteristics	Lane width (ft)
	Shoulder width (ft)
	Presence of bicycle lanes
	Presence of on-street parking
	Horizontal curve
	Presence of shared use paths
	Presence of sidewalks
	Presence of bus stops
	Presence of midblock crossing
	Presence of lighting
	Delineation
	Presence of shoulder rumble strips
	Average annual daily traffic
	Land Use
Block size	
Presence of school zone	
Presence of alcohol establishments	
Urban / rural	
Demographics	Age
	Population density
	Household size
	Mean household income
	Single-family residential
	Vehicle numbers in housing units

Work Plan C – Develop Risk-Based Models for Pedestrians and Bicycles Based on Crash Data in the Absence of Pedestrian and Bicycle Volume Data

- Eventually switched from collecting detailed for select few rural segments to focusing analysis on entire rural network with available electronic data sets
 - In addition to California, obtained electronic data from Ohio
- Using binary logistic regression, models were developed to estimate the risk of pedestrian or bicycle crashes occurring on various roadway segment types
 - Models aim at determining the probability that a crash occurred, involving a pedestrian or a bicyclist, on any given roadway segment.

Work Plan C – Develop Risk-Based Models for Pedestrians and Bicycles Based on Crash Data in the Absence of Pedestrian and Bicycle Volume Data

- Results show that for:
 - Rural two-lane and multilane
 - Risk of a pedestrian or bicycle crash occurring **increases** with
 - Vehicular traffic volume
 - Population within census tract
 - Roadways with higher speed limits
 - Risk of pedestrian or bicycle crash occurring **decreases** on
 - Roadways with lanes greater than or equal to 12 feet

Work Plan C – Develop Risk-Based Models for Pedestrians and Bicycles Based on Crash Data in the Absence of Pedestrian and Bicycle Volume Data

- Results show that for:
 - Urban two-lane undivided
 - Risk of a pedestrian or bicycle crash occurring **increases** with
 - Vehicular traffic volume
 - Number of intersections along the segment
 - Number of bus stops (for pedestrian crashes)
 - Total roadway width (for pedestrian crashes)
 - School density (for bicycle crashes)

Work Plan C – Develop Risk-Based Models for Pedestrians and Bicycles Based on Crash Data in the Absence of Pedestrian and Bicycle Volume Data

- Results show that for:
 - Urban four-lane divided and undivided
 - Risk of a pedestrian crash occurring **increases** with
 - Vehicular traffic volume
 - Number of intersections along the segment
 - Number of bus stops
 - Pedestrian crash risk is **lower** on divided roadways compared to undivided roadways

Work Plan C – Develop Risk-Based Models for Pedestrians and Bicycles Based on Crash Data in the Absence of Pedestrian and Bicycle Volume Data

- Results show that for:
 - Urban four-lane divided and undivided
 - Risk of a bicycle crash occurring **increases** with
 - Vehicular traffic volume
 - Number of intersections along the segment
 - Bicycle crash risk is **lower** on roadways with a higher speed limit (35 mph or greater) compared to roadways with lower speed limits.
 - This could be due to fewer bicyclists riding on roadways with higher speed?

Work Plan C – Develop Risk-Based Models for Pedestrians and Bicycles Based on Crash Data in the Absence of Pedestrian and Bicycle Volume Data

- Results show that for:
 - Urban one-way roads
 - Risk of a pedestrian crash occurring **increases** with
 - Vehicular traffic volume
 - Number of intersections along the segment
 - Number of bus stops
 - Total roadway width
 - Risk of a bicycle crash occurring **increases** with
 - Vehicular traffic volume
 - Roadways with higher speed limits (30 mph or greater)
 - School density

Next Steps

- Conduct analyses for Work Plan A segments and intersections
- Meet with panel to review results
 - October 2021
- Write draft HSM chapters
 - End of November 2021
 - April 2022 (completion date)