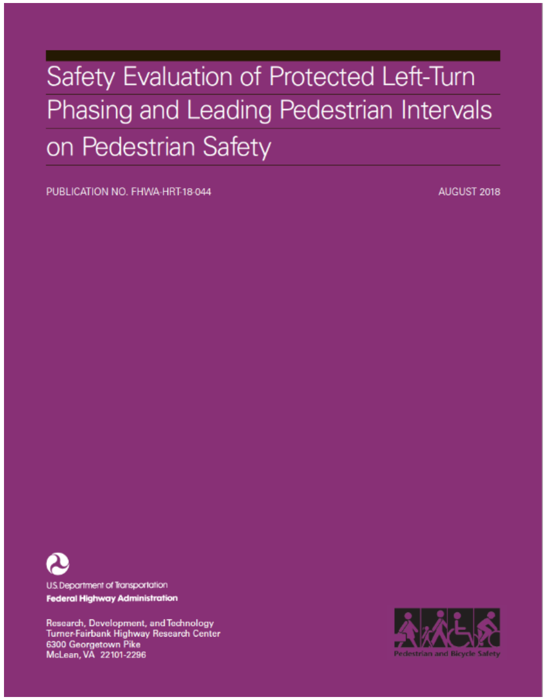
# Evaluation of Protected Left-Turn Phasing and Leading Pedestrian Intervals Effects on Pedestrian Safety



Safety Evaluation of Protected Left-Turn Phasing and Leading Pedestrian Intervals on Pedestrian Safety

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Pedestrian and Bicycle Safety

# Study Background

- VHB, UNC and Persaud and Lyon Inc.
- FHWA sponsored through DCMF pooled fund
- Goals are to develop CMFs
- Two treatments covered for signalized intersections
  - Adding protected-permissive or protected left-turn phasing
  - Adding leading pedestrian interval (LPI)

# Previous Findings for Left-Turn Phasing

- [1]Hauer suggested a CMF of 0.3 for left-turn opposing crashes for adding protected phasing and no effect for other crash types
- [1]Hauer suggested a CMF of 1.0 (no effect) for changing from permissive to permissive-protected
- [2]Lyon et al. estimated a CMF of 0.88 and 0.75 for flashing advance green and LTGA for left-turn opposing crashes

[1]Hauer, E. (2004). Left-Turn Protection, Safety, Delay and Guidelines: A Literature Review, ResearchGate, Berlin, Germany. Available online: https://www.researchgate.net/publication/280310470_Left_ _turn_protection._Safety._Literature_review_up_t0_2003, last accessed November 2017.
[2]Lyon, C., Haq, A., Persaud, B., and Kodama, S. (2005). "Safety Performance Functions for Signalized Intersections in Large Urban Areas: Development and Application to Evaluation of Left-Turn Priority Treatment." Transportation Research Record: Journal of the Transportation Research Board, 1908, pp. 165–171, Transportation Research Board, Washington, DC.

# Previous Findings for Left-Turn Phasing

- [3]Srinivasan et al. found decreases in left-turn opposing (CMF 0.86) and increases in rear-ends (CMF 1.08) for a mix of permissive to protected-permissive or protected phashing
- [4]NY estimated a CMF of 0.52 for veh-ped crashes for a mix of permissive to protected-permissive or protected phasing

[3]Srinivasan, R., Gross, F., Lyon, C., Persaud, B., Eccles, K., Hamidi, A., Baek, J., et al. (2011). Evaluation of Safety Strategies at Signalized Intersections, National Cooperative Highway Research Program Report 705, Appendices to Final Report, Transportation Research Board, Washington, DC.
[4]Chen, L., Chen, C., Ewing, R., McKnight, C.E., Srinivasan, R., and Roe, M. (2013). "Safety Countermeasures and Crash Reduction in New York City: Experience and Lessons Learned." Accident Analysis and Prevention, 50, pp. 312–322, Elsevier, Amsterdam, Netherlands.

# Previous Findings for LPI

- [1]King found the crash rate of LPI sites to be 28% lower for veh-ped crashes
- [2]Fayish and Gross estimated a CMF of 0.61 for veh-ped crashes based on 10 sites

[1]King, M.R. (2000). "Calming New York City Intersections," Transportation Research E-Circular: Urban Street Symposium, Number E-C019, Transportation Research Board, Washington, DC. Available online: http://onlinepubs.trb.org/onlinepubs/circulars/ec019/Ec019_i3.pdf, last accessed June 28, 2018.

[2]Fayish, A.C. and Gross, F. (2010). "Safety Effectiveness of Leading Pedestrian Intervals Evaluated by a Before–After Study With Comparison Groups." Transportation Research Record: Journal of the Transportation Research Board, 2198, pp. 15–22, Transportation Research Board, Washington, DC.

# Study Methodology

- empirical Bayes Before-after
- Uses Safety Performance Functions
- Analysis controls for three important confounding factors:
  - Regression-to-the-mean
  - Changes in traffic volumes
  - Time trends in crash counts unrelated to the treatment

# Data

- Intersection geometry, traffic volumes, crash data, ped volumes
- Data for treated and reference sites
- Looked at veh-ped primarily but also veh-veh and veh-veh inj

| Evaluation | City | Treatment Sites | Reference Sites |
|---|---|---|---|
| Left-Turn Phasing | Chicago | 27 | 149 |
| | New York City | 7 | 146 |
| | Toronto | 114 | 776 |
| LPI | Chicago | 56 | 183 |
| | New York City | 42 | 157 |
| | Charlotte | 7 | 111 |

# Results for Left-Turn Phasing

| City | Treatment Sites | CMF for Vehicle–Vehicle Crashes (SE) | CMF for Vehicle–Vehicle Injury Crashes (SE) | CMF for Pedestrian–Vehicle Crashes (SE) |
|---|---|---|---|---|
| Chicago | 68 protected-permissive, 2 protected | 1.031 (0.040) | 0.890 (0.079) | 1.136 (0.146) |
| New York City | 1 protected-permissive, 8 protected | **0.672*** (0.110) | 0.788 (0.153) | 0.718 (0.196) |
| Toronto | 134 protected-permissive, 2 protected | 1.025 (0.011) | **0.951*** (0.020) | 1.106 (0.061) |
| All cities combined | 203 protected-permissive, 12 protected | 1.023 (0.016) | **0.942*** (0.028) | 1.091 (0.066) |

# Results for Left-Turn Phasing

- Disaggregate analysis undertaken
- No relationships between CMF and site characteristics found for veh-veh or veh-veh injury crashes
- For veh-ped some indications that CMF is lower at higher pedestrian volumes
- $CMF = \exp(1.4179)(PEDVOL)^{-0.1645}$

Where,

PEDVOL = sum of 24 hr pedestrian counts for all legs

- CMFunction indicates a CMF less than 1.0 for PEDVOL >5,500

# Results for LPI

| City | Treatment Sites | CMF for Total Crashes (SE) | CMF for Total Injury Crashes (SE) | CMF for Vehicle–Pedestrian Crashes (SE) |
|---|---|---|---|---|
| Chicago | 56 | **0.90*** (0.027) | **0.83*** (0.046) | **0.81*** (0.070) |
| New York City | 42 | **0.84*** (0.031) | **0.86*** (0.037) | 0.91 (0.062) |
| Charlotte | 7 | 0.90 (0.09) | 1.09 (0.18) | 0.54 (0.38) |
| All cities combined | 105 | **0.87*** (0.02) | **0.86*** (0.03) | **0.87*** (0.05) |

DCMF

# Implications

- Dependable estimates of safety benefits are required to prioritize safety treatments
- Safety benefits can vary based on site characteristics
- A scientific approach to selecting locations is critical for success