Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes

Introduction

This issue brief documents estimates of the crash reduction that might be expected if a specific countermeasure or group of countermeasures is implemented with respect to pedestrian crashes. The crash reduction estimates are presented as Crash Reduction Factors (CRFs). As some studies reviewed included bicycle crashes in their analysis, some of the crash reduction estimates include bicyclists.

Traffic engineers and other transportation professionals can use the information contained in this issue brief when asking the following types of question: Which countermeasures might be considered at the signalized intersection of Maple and Elm streets, an intersection experiencing a high number of pedestrian crashes? What change in the number of pedestrian crashes can be expected with the implementation of the various countermeasures?

Crash Reduction Factors

A CRF is the percentage crash reduction that might be expected after implementing a given countermeasure. In some cases, the CRF is negative, i.e. the implementation of a countermeasure is expected to lead to a percentage increase in crashes.

One CRF estimate is provided for each countermeasure. Where multiple CRF estimates were available from the literature, selection criteria were used to choose which CRFs to include in the issue brief:

- Firstly, CRFs from studies that took into account regression to the mean and changes in traffic volume were preferred over studies that did not.
- Secondly, CRFs from studies that provided additional information about the conditions under which the countermeasure was applied (e.g. road type, area type) were preferred over studies that did not.

Where these criteria could not be met, a CRF may still be provided. In these cases, it is recognized that the reliability of the estimate of the CRF is low, but the estimate is the best available at this time. The CRFs in this issue brief may be periodically updated as new information becomes available.

The *Desktop Reference for Countermeasures* includes most of the CRFs included in this issue brief, and adds many other CRFs available in the literature. A few CRFs found in the literature were not included in the *Desktop Reference*. These CRFs were considered to have too large a range or too large a standard error to be meaningful, or the original research did not provide sufficient detail for the CRF to be useful.

A CRF should be regarded as a generic estimate of the effectiveness of a countermeasure. The estimate is a useful guide, but it remains necessary to apply engineering judgment and to consider site-specific environmental, traffic volume, traffic mix, geometric, and operational conditions which will affect the safety impact of a countermeasure. Actual effectiveness will vary from site to site. The user must ensure that a countermeasure applies to the particular conditions being considered. The reader is also encouraged to obtain and review the original source documents

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for more detailed information, and to search databases such as the National Transportation Library (ntlsearch.bts.gov) for information that becomes available after the publication of this issue brief.

Presentation of the Crash Reduction Factors

In the Tables presented in this issue brief, the crash reduction estimates are provided in the following format:

CRF(standard error)^{REF}

The CRF is the value selected from the literature.

The standard error is given where available. The standard error is the standard deviation of the error in the estimate of the CRF. The true value of the CRF is unknown. The standard error provides a measure of the precision of the estimate of the true value of the CRF. A relatively small standard error indicates that a CRF is relatively precisely known. A relatively large standard error indicates that a CRF is not precisely known.

The REF is the reference number for the source information.

As an example, the CRF for the countermeasure *convert unsignalized intersection to roundabout* is:

27(12)^{2}

The following points should be noted:

- The CRF of 27 means that a 27% reduction in pedestrian crashes is expected after converting the unsignalized intersection to a roundabout.
- This CRF is bolded which means that a) a rigorous study methodology was used to estimate the CRF, and b) the standard error is relatively small. A CRF which is not bolded indicates that a less rigorous methodology (e.g. a simple before-after study) was used to estimate the CRF and/or the standard error is large compared with the CRF.
- The standard error for this CRF is 12.
- The reference number is 2 (De Brabander, B. and Vereeck, L., as listed in the References at the end of this issue brief).

Using the Tables

The CRFs for pedestrian crashes are presented in three tables which summarize the available information. The Tables are:

Table 1: Signalization Countermeasures

Table 2: Geometric Countermeasures

Table 3: Signs/Markings/Operational Countermeasures

The following points should be noted:

- Where available, separate CRFs are provided for different crash severities. The crash severities are: all, fatal/injury, fatal, or injury. The categories depend on the approach taken by the original study. For example, some studies referred to fatal/injury (fatal and injury crashes combined). Some distinguished fatal from injury. "All" is used for CRFs from studies which did not specify the severity. "All" is also used for CRFs that refer to the total number of crashes, including pedestrians.
- The CRF listed under the pedestrian column refers to the reduction in crashes involving pedestrians crossing the street, unless otherwise specified.
- Blank cells mean that no information is reported in the source document.
- For additional information, please visit the FHWA Office of Safety website (safety.fhwa.dot.gov).

Legend

CRF(standard error)[REF]

CRF is a crash reduction factor, which is an estimate of the percentage reduction that might be expected after implementing a given countermeasure. A number in bold indicates a rigorous study methodology and a small standard error in the value of the CRF.
Standard error, where available, is the standard deviation of the error in the estimate of the CRF.
REF is the reference number for the source information.

Table 1: Signalization Countermeasures

Countermeasure(s)	Crash Severity	Left-Turn Crashes	Pedestrian
Add exclusive pedestrian phasing	All		34[4]
Improve signal timing [to intervals specified by the ITE *Determining Vehicle Change Intervals: A Proposed Recommended Practice (1985)*]	Fatal/Injury		37[8]
Replace existing WALK / DON'T WALK signals with pedestrian countdown signal heads	All		25[5]
Modify signal phasing (implement a leading pedestrian interval)	All		5[4]
Remove unwarranted signals (one-way street)	All		17[7]
Convert permissive or permissive/protected to protected only left-turn phasing	All	99[10]	
Convert permissive to permissive/protected left-turn phasing	All	16[10]	

Table 2: Geometric Countermeasures

Countermeasure(s)	Crash Severity	All Crashes	Pedestrian
Convert unsignalized intersection to roundabout	Fatal/Injury		**27**(12)[2]
Install pedestrian overpass/underpass	Fatal/Injury		90[3]
	All		86[3]
Install pedestrian overpass/underpass (unsignalized intersection)	All		13[4]
Install raised median	All		25[3]
Install raised median (marked crosswalk) at unsignalized intersection	All		46[9]
Install raised median (unmarked crosswalk) at unsignalized intersection	All		39[9]
Install raised pedestrian crossing	All	30(67)[1]	
	Fatal/Injury	36(54)[1]	
Install refuge islands	All		56[4]
Install sidewalk (to avoid walking along roadway)	All		88[6] *
Provide paved shoulder (of at least 4 feet)	All		71[3] *
Narrow roadway cross section from four lanes to three lanes (two through lanes with center turn lane)	All	29[10]	

*** This only applies to "walking along the roadway" type crashes**

Table 3: Signs/Markings/Operational Countermeasures

Countermeasure(s)	Crash Severity	All Crashes	Pedestrian
Add intersection lighting	Injury	27[10] *	
	All	21[10] *	
Add segment lighting	Injury	23[10] *	
	All	20[10] *	
Improve pavement friction (skid treatment with overlay)	Fatal/Injury		3[3]
Increase enforcement **	All		23[11]
Prohibit right-turn-on-red	All	3[10]	
Prohibit left-turns	All		10[3]
Restrict parking near intersections (to off-street)	All		30[3]

*** This applies to nighttime crashes only**

**** This applies to crash reduction on corridors where sustained enforcement is used related to motorist yielding in marked crosswalks combined with a public education campaign**

References

1. Bahar, G., Parkhill, M., Hauer, E., Council, F., Persaud, B., Zegeer, C., Elvik, R., Smiley, A., and Scott, B. "Prepare Parts I and II of a Highway Safety Manual: Knowledge Base for Part II". Unpublished material from NCHRP Project 17-27, (May 2007).
2. De Brabander, B. and Vereeck, L., "Safety Effects of Roundabouts in Flanders: Signal type, speed limits and vulnerable road users." AAP-1407, Elsevier Science, (2006).
3. Gan, A., Shen, J., and Rodriguez, A., "Update of Florida Crash Reduction Factors and Countermeasures to improve the Development of District Safety Improvement Projects." Florida Department of Transportation, (2005).
4. Institute of Transportation Engineers, "Toolbox of Countermeasures and Their Potential Effectiveness to Make Intersections Safer." Briefing Sheet 8, ITE, FHWA, (2004).
5. Markowitz, F., Sciortino, S., Fleck, J. L., and Yee, B. M., "Pedestrian Countdown Signals: Experience with an Extensive Pilot Installation." *Institute of Transportation Engineers Journal*, Vol. January 2006, ITE, (1-1-2006) pp. 43–48. Updated by Memorandum, Olea, R., "Collision changes 2002–2004 and countdown signals," (February 7th, 2006).
6. McMahon, P., Zegeer, C., Duncan, C., Knoblauch, R., Stewart, R., and Khattak, A., "An Analysis of Factors Contributing to 'Walking Along Roadway' Crashes: Research Study and Guidelines for Sidewalks and Walkways." FHWA-RD-01-101, (March 2002)
7. Persaud, B., Hauer, E., Retting, R. A., Vallurupalli, R., and Mucsi, K., "Crash Reductions Related to Traffic Signal Removal in Philadelphia." *Accident Analysis and Prevention*, Vol. 29, No. 6, Oxford, N.Y., Pergamon Press, (1997) pp. 803–810.
8. Retting, R. A., Chapline, J. F., and Williams, A. F., "Changes in Crash Risk Following Re-timing of Traffic Signal Change Intervals." *Accident Analysis and Prevention*, Vol. 34, No. 2, Oxford, N.Y., Pergamon Press, (2002) pp. 215-220.
9. Zegeer, C., Stewart, R., Huang, H., and Lagerwey, P., "Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines." FHWA-RD-01-075, (March 2002)
10. Harkey, D. et al., "Crash Reduction Factors for Traffic Engineering and ITS Improvements." NCHRP Report No. 617, (2008).
11. Van Houten, R. and Malenfant, J. E., "Effects of a Driver Enforcement Program on Yielding to Pedestrians." *Journal of Applied Behavioral Analysis*, No. 37, (2004) pp. 351–363.