Accident Analysis and Prevention 108 (2017) 1–8

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

# Meta-analysis of the effect of road work zones on crash occurrence

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ARTICLE INFO

*Keywords:*
Work zones
Crashes
Meta-analysis
Meta-regression

ABSTRACT

There is strong evidence that work zones pose increased risk of crashes and injuries. The two most common risk factors associated with increased crash frequencies are work zone duration and length. However, relevant research on the topic is relatively limited. For that reason, this paper presents formal meta-analyses of studies that have estimated the relationship between the number of crashes and work zone duration and length, in order to provide overall estimates of those effects on crash frequencies. All studies presented in this paper are crash prediction models with similar specifications. According to the meta-analyses and after correcting for publication bias when it was considered appropriate, the summary estimates of regression coefficients were found to be 0.1703 for duration and 0.862 for length. These effects were significant for length but not for duration. However, the overall estimate of duration was significant before correcting for publication bias. Separate meta-analyses on the studies examining both duration and length was also carried out in order to have rough estimates of the combined effects. The estimate of duration was found to be 0.953, while for length was 0.847. Similar to previous meta-analyses the effect of duration after correcting for publication bias is not significant, while the effect of length was significant at a 95% level. Meta-regression findings indicate that the main factors influencing the overall estimates of the beta coefficients are study year and region for duration and study year and model specification for length.

## 1. Introduction

The safe and efficient movement of drivers through work zones is a major concern to transportation engineers, road industry and researchers. There is strong evidence that work zones a hazardous roadway environment to drivers that increases the risk of road crashes and injuries. The reduction of number and capacity of road lanes, the changes in road delineation and signage, the presence of workers, construction machinery, roadside construction barriers and other objects and obstacles, may create more complex environment with increased conflicts that in turn lead to high risk conditions.

Early research on this topic indicates that crash rates increase in work zones (Juergens, 1972; Liste et al., 1976; Graham et al., 1977; Rouphail et al., 1988). More recent research used statistical models in order to examine the relationship between work zone characteristics and crash frequency (Pal and Sinha, 1996; Khattak and Council, 2002; Venugopal and Tarko, 2000; Chen and Tarko, 2012, 2014) and severity (Khattak and Council, 2002; Venugopal and Tarko, 2000; Li and Bai, 2008; Khattak and Targa, 2004) and largely confirmed the earlier results. The most common significant work zone factors found to increase the number of crashes in work zone areas are duration of works and length of the work zone (Pal and Sinha, 1996; Khattak and Council, 2002; Venugopal and Tarko, 2000; Chen and Tarko, 2012). Other contributory factors were found to be traffic conditions and driver behavior at work zones (Chen and Tarko, 2012; Daniel et al., 2000; Wang et al., 1996), as well as work zone configurations such as signage, alternate one-way traffic etc. (Qi et al., 2013).

More specifically, a study by Khattak and Council (2002) quantified the effect of work zone presence, duration and length on non-injury and injury accidents on the basis of California crash data for 1992 and 1993. The authors found that both length and duration increase occurrence of both non-injury and injury crashes. Another similar study (Ozturk et al., 2013) used 2004–2010 crash data in work zones of New Jersey and argued that increased length and increased duration are associated with increased number of crashes. Chen and Tarko (2012) examined 3 year of work zone crash and indicated that increased lengths increase number of crashes. Similar findings were reported in Chen and Tarko (2014). Venugopal and Tarko (2000) investigated the effect of work zone characteristics on the crash frequencies for different injury severity levels and found similar relationships across different injury

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http://dx.doi.org/10.1016/j.aap.2017.07.024
Received 15 December 2016; Received in revised form 21 April 2017; Accepted 26 July 2017

**Table 1**
Studies selected for meta-analysis.

| Authors/ Year | Model | Effects | | | State | Sample crashes | Sample sites | Moderator variables | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number | Duration | Length | | | | traffic | work type | work intensity | roadway characteristics | traffic management | enforcement | temporal variables | road type | speed/ speed limit | ramp | intersection |
| Chen and Tarko (2012) | Random effects Negative Binomial | 1 | | ● | Indiana | 2712 | – | | | ● | ● | ● | ● | ● | | | | |
| Chen and Tarko (2014) | Poisson random effects/ Poisson random parameters | 2 | | ● | Indiana | 547 | 72 | | ● | ● | ● | ● | | | | | | |
| Khattak and Council (2002) | Fixed effects Negative Binomial | 3 | ● | ● | California | 2038 | 36 | | | | | | | | ● | | | |
| Ozturk et al. (2013) | Fixed effects Negative Binomial | 1 | ● | ● | New Jersey | 5382 | – | ● | | | | ● | | | ● | ● | ● | ● |
| Ozturk et al. (2014) | Fixed effects Negative Binomial | 5 | | ● | New Jersey | 8749 | 60 | ● | | | | | | | ● | ● | ● | ● |
| Pal and Sinha (1996) | Fixed effects Negative Binomial | 2 | ● | | Indiana | – | 34 | ● | | | | | | | | | | |
| Venugopal and Tarko (2000) | Fixed effects Negative Binomial | 3 | ● | ● | Indiana | 5025 | – | | ● | ● | | | | | | | | |
| Yang et al. (2013) | Bayesian Random Effects Negative Binomial | 2 | | ● | New Jersey | – | – | | | | | | | | | | | |