Speed limit enforcement includes patrolling, speed cameras, and other methods. There is evidence that speed limit enforcement reduces speed levels, road crashes and injuries.

**OVERVIEW**

- The goal of speed limit enforcement is to reduce the level of crashes and injuries. It includes mobile patrols with radar, stationary patrols with radar, mobile and fixed speed cameras and other forms of automated speed enforcement.

- Research into speed limit enforcement investigates the effect on driving speeds, road crashes, injuries/fatalities and infringements. As such, this research is not specifically measuring ‘crime’ outcomes.

- There is international and New Zealand evidence that speed limit enforcement reduces driving speeds, road crashes, numbers of fatalities and severity of injuries.

- There is some international evidence that the effects of speed enforcement are greater when a new form of speed enforcement is introduced and for more serious crashes.

- There is international evidence that randomised speed enforcement is effective.

**INVESTMENT CLASS SUMMARY**

<table>
<thead>
<tr>
<th>Evidence rating:</th>
<th>Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit cost:</td>
<td>NA</td>
</tr>
<tr>
<td>Effect size (number needed to treat):</td>
<td>NA</td>
</tr>
<tr>
<td>Current spend:</td>
<td>$88.2 million estimated for 2016/2017</td>
</tr>
<tr>
<td>Unmet demand:</td>
<td>High</td>
</tr>
</tbody>
</table>
DOES SPEED LIMIT ENFORCEMENT REDUCE OFFENDING?

Overview

Exceeding speed limits is common\(^1\). The goal of speed enforcement is to improve safety by ensuring compliance with speed limits.

Most types of speed enforcement programmes can be classified as either:

- Stationary speed enforcement.
- Mobile speed enforcement (e.g. mobile patrols).
- Automatic speed enforcement (e.g. speed cameras).

The purpose of this evidence brief is to assess the causal relationship between speed enforcement of all types and speeding. Levels of speed enforcement can be measured using patrolling hours, radar hours, percentage vehicles stopped/checked, camera hours, officers per kilometre, and related measures.

International meta-analyses and systematic reviews

There are several international meta-analyses and systematic reviews on the effects of speed enforcement\(^6\). The majority of international studies investigate the effect of speed enforcement on outcomes such as speed levels, number of crashes, and number of traffic fatalities.

It is difficult to perform randomised trials on the effects of speed enforcement. Therefore, the majority of studies considered in this brief are either quasi-experimental (using a comparison group), or else before-and-after, controlling for time effects.

A meta-analysis from 2009\(^iii\) used 45 studies dating from between 1960-2008. These studies looked at situations where either a new type of enforcement was introduced, or existing enforcement was increased. Types of enforcement included stationary speed enforcement, patrolling, and automatic speed enforcement. The majority of studies in this meta-analysis were quasi-experimental.

Meta-analysis found a statistically significant reduction of 18% in crashes (of all levels of severity) due to speed enforcement\(^1\).

A meta-analysis from 2011 developed a ‘crash modification function’\(^iv\). The idea is to find the precise relationship between changing levels of enforcement and changes in the number of crashes. The level of enforcement is given relative to a baseline level of 1, so that relative level of enforcement of 5 means that there is five times as much enforcement. Similarly, change in number of crashes is given relative to a baseline of 1.

In this analysis, a classic dose-response pattern emerges: as the relative level of enforcement increases, there is a sharp reduction in crashes.

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\(^1\) This meta-analysis supersedes that of Elvik and Vaa, (2004), including more studies. Elvik and Vaa (2004) also forms the basis of Zaidel (2002).
which then flattens out\(^2\). For example, doubling the level of enforcement gives a 20\% reduction in crashes.

A similar approach was also implemented in a more recent meta-analysis\(^6\) from 2016. Meta-analysis was used to find crash modification functions for covert mobile speed cameras in Victoria and overt mobile speed cameras in both Queensland and Ireland.

Similar results were found: the levels of crashes decreases as the use of speed cameras increases\(^3\).

In 2012 a meta-analysis was performed which focused entirely on speed cameras\(^4\). A reduction in the proportion of speeding vehicles was found, mostly occurring in the 10\% to 35\% range. For injury crashes, decreases ranged between 8\% and 50\%, and for crashes resulting in death or serious injury most studies reported reductions between 30\% and 40\%.

More recently\(^9\), a meta-analysis focusing entirely on speed cameras and point-to-point speed cameras (which are not currently used in New Zealand) found that, on average, the introduction of speed cameras reduces total crash numbers by about 20\%, when compared to a control area where no speed cameras are introduced. This effect declines with increasing distance from the camera location, and for distances of more than 500 metres there is no longer a statistically significant effect.

There have also been several individual studies\(^18\) published after the previously mentioned meta-analyses, mostly dealing with speed cameras; all of these studies show that the rate of crashes decreases when speed enforcement is increased.

**New Zealand evidence**

In 2003, a study\(^\text{xiv}\) investigated the relationship between enforcement, speed, and crashes using data from 1996-2002. Enforcement levels were measured by counting speed infringements of all types.

Average open road speeds were estimated to reduce by 0.8\% for every 10,000 extra infringements served, with higher reductions found for those travelling at higher speeds. To put this in context, the same data showed that a reduction by 1kph in the average speed was associated with a 13\% reduction of all injury-causing crashes.

A more recent study by New Zealand Police\(^\text{xv}\) was released in 2014. This study investigated the impact of the “Safer Summer” campaign, which took place between 1 December 2013 and 31 January 2014. The campaign involved the introduction of a reduced speed enforcement threshold and increased traffic enforcement intensity over the two-month summer period, as a well as extensive coverage in printed, online, and social media. The study used previous seasons as a control.

The intervention was associated with a statistically significant 36\% reduction in the proportion of vehicles exceeding the speed limit by 1-10kph. That is, in the season before the intervention 211,198 out of 2,514,265 vehicles were exceeding the speed limit, and during the intervention 154,029 out of 2,852,402 were speeding.

Furthermore, a statistically significant 45\% decrease in the proportion of vehicles speeding in excess of 10kph was found. Speeding rates reverted to pre-intervention levels after the reduced enforcement threshold and the associated publicity campaign ended.

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\(^2\) The resulting function is nonlinear: \(y = 0.64 + \frac{0.35}{x}\), where \(x\) is the relative level of enforcement, and \(y\) is the crash modification factor.

\(^3\) The rate of crashes is proportional to \(x^{-0.0461}\) in the case of mobile speed cameras in Victoria, where \(x\) is the level of enforcement. The rate of crashes is proportional to \(x^{-0.1054}\) in the Queensland/Ireland case.
Other results included a decrease of 22% in fatal crashes, a decrease of 8% in serious injury crashes, and a decrease of 16% in minor injury crashes during their intervention. However, none of these reductions were statistically significant, or close to being statistically significant.

Finally, a before-and-after study (with control) was performed on the introduction of speed cameras to Christchurch\textsuperscript{xi} in the nineties. This study reported a (statistically significant) 32.3% reduction in serious injury crashes, and a reduction of 9.17% in total crashes.

**WHEN IS SPEED LIMIT ENFORCEMENT MOST EFFECTIVE?**

**Halo effects**

Speed enforcement methods are often susceptible to “time halo effects” and “distance halo effects”\textsuperscript{xii}.

- “Distance halo” refers to an area around the point of enforcement; inside the area the effects of the enforcement are still noticeable, outside they disappear.

- “Time halo” refers to the maximum length of time after (or before) the enforcement in which the effect is still noticeable.

The extent of halo effects in space and time varies considerably\textsuperscript{xiii}. For example, reported time halo effects in the research literature range from 1 hour to 8 weeks after enforcement activity has ceased. Some authors believe that longer halo effects are associated with longer periods of police presence, but more research is needed to establish the precise relationship in a New Zealand context.

Likewise, distance halo effects reported in the literature vary considerably (from 2.5 to 8 kilometres). Hauer et al (1982)\textsuperscript{xiv} give a rule of thumb that the effects of visible and stationary policing on driving speeds are halved for every 900 metres downstream of the enforcement site.

**Randomisation**

Some studies look at the deployment of speed enforcement at random times and places. A systematic review\textsuperscript{ xv} of randomisation from 2005 claims that even low intensity random speed enforcement can bring about reductions in mean speeds between 3 and 5 kph, as well as an impact on crash rates. The distance halo effects associated with random policing are large.

The effectiveness of randomisation is also borne out by more recent international studies\textsuperscript{xvi} which focus on the randomisation of speed camera placement, as well as older New Zealand research from 1992\textsuperscript{xvii}.

Theoretically, randomisation is likely to enhance the deterrent effect of speed limit enforcement, giving the impression of a large-scale enforcement effort. As such, randomisation is believed to increase the motorist’s perceived risk of apprehension, even though the objective risk of apprehension is unlikely to change substantially.

**Optimal rates of crash reduction**

The crash modification function, mentioned above\textsuperscript{xviii} gives detail on the relationship between increased levels of enforcement and crash rate reduction. The greatest relative decrease in crash rates comes from doubling or tripling enforcement intensity\textsuperscript{xix}. After further intensification, the relative decrease in crash levels becomes smaller.

**Other moderating factors**

Meta analysis from 2009\textsuperscript{xx} revealed that larger reductions in the number of crashes were found:
• When a new form of enforcement is introduced.

• For more serious crashes.

Individual studies have found that other moderating factors that have an effect on the effectiveness of speed limit enforcement include:

• Manual vs. automated enforcement\textsuperscript{xxi}: a study in Queensland found that manual enforcement had a significant effect on the total number of crashes, and the number of serious crashes, while automated enforcement only had an effect on the total number of crashes. This suggests that manual enforcement provides specific deterrence targeted at high-risk drivers, while automated enforcement provides a general deterrence effect on a broad spectrum of the driving population.

• Levels of advertising\textsuperscript{xxii}: Several studies have looked at whether levels of advertising alter the effectiveness of speed limit enforcement. There are mixed findings\textsuperscript{xxiii} on this. Note that this is not a question of whether advertising campaigns are effective, but whether their effect interacts with the effect of speed enforcement.

Crime and road safety

There is evidence for a general association between various forms of criminal behaviour (specifically violence, theft & burglary and recidivist drink driving) and traffic offences and crashes. This research is summarised in a systematic review from 2009\textsuperscript{xxiv}.

CURRENT INVESTMENT IN NEW ZEALAND

$88.2 million was spent on speed limit enforcement over 2015/2016, according to the NZTA Road Policing Programme\textsuperscript{xxv}.

EVIDENCE RATING AND RECOMMENDATIONS

Each Evidence Brief provides an evidence rating between Harmful and Strong.

<table>
<thead>
<tr>
<th>Evidence Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmful</td>
<td>Robust evidence that intervention increases crime</td>
</tr>
<tr>
<td>Poor</td>
<td>Robust evidence that intervention tends to have no effect</td>
</tr>
<tr>
<td>Inconclusive</td>
<td>Conflicting evidence that intervention can reduce crime</td>
</tr>
<tr>
<td>Fair</td>
<td>Some evidence that intervention can reduce crime</td>
</tr>
<tr>
<td>Promising</td>
<td>Robust international or local evidence that intervention tends to reduce crime</td>
</tr>
<tr>
<td>Strong</td>
<td>Robust international and local evidence that intervention tends to reduce crime</td>
</tr>
</tbody>
</table>

According to the standard criteria for all Evidence Briefs\textsuperscript{4}, the appropriate evidence rating for Speed Enforcement is Strong.

As per the standard definitions of evidence strength outlined in our methodology, the

\textsuperscript{4} Available at www.justice.govt.nz/justice-sector/what-works-to-reduce-crime/
interpretation of this evidence rating is that there is:

- Robust international and local evidence that speed limit enforcement tends to reduce speeding and road crashes.
- Speed limit enforcement is likely to generate a return if implemented well.
- Could benefit from additional evaluation to confirm intervention is delivering a positive return and to support fine-tuning of its design.

First edition completed: June 2017
Primary author: Callum Sleigh

Citations

i See, for example, ETSC Report (2010) and Ministry of Transport (2016).
vii Høye (2014).
x Van Lamoen (2014).
xii Tay (2000).
xiii See, the discussion in section 3 of Erke et al (2009), or 2.4.1 of Zaal (1994).
xiv See, Elliott & Broughton (2005) section 7.1.2 and Appendix B, as well as the introduction to Vaa 1997 for a range of results on halo effects.
xvi Elliott & Broughton (2005), section 7.1.3.
xvii Newstead & Cameron (2013).
xviii See Table 1 and citations from Newstead et al. (2001).
xxi Erke et al (2009) section 7.1
xxii Tay (2009).
xxiv See, for example, Erke (2009) Section 3.5, and Cameron et al (2003).
xxv Elvik (2003) and references therein.
xxvi New Zealand Transport Agency (2016).

Recommended reading


FIND OUT MORE

Go to the website
www.justice.govt.nz/justice-sector/what-works-to-reduce-crime/

Email
whatworks@justice.govt.nz
REFERENCES


Li, H., & Graham, D. J. (2016). Heterogeneous treatment effects of speed cameras on road safety. Accident Analysis & Prevention, 97, 153-161.


In Australasian Road Safety Research Policing Education Conference, 2014, Melbourne, Victoria, Australia.


## SUMMARY OF EFFECT SIZES FROM META-ANALYSES

<table>
<thead>
<tr>
<th>Meta-analysis</th>
<th>Treatment type/population</th>
<th>Outcome measure</th>
<th>Reported average effect size</th>
<th>Number of estimates meta-analysis based on</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erke et al (2009)</td>
<td>New or increased enforcement</td>
<td>Injury causing accidents</td>
<td>OR=0.835* (lower accident rate for treatment group)</td>
<td>129</td>
</tr>
<tr>
<td>Elvik (2011)</td>
<td>Levels of enforcement</td>
<td>Crashes</td>
<td>NA (See discussion of function in main text)</td>
<td>63</td>
</tr>
<tr>
<td>Cameron et al (2016)</td>
<td>Overt mobile speed cameras in Queensland (&amp; Ireland)</td>
<td>Crashes</td>
<td>NA (See discussion of function in main text)</td>
<td>Approx. 6 (not stated explicitly)</td>
</tr>
<tr>
<td>Cameron et al (2016)</td>
<td>Covert mobile speed cameras in Victoria</td>
<td>Crashes</td>
<td>NA (See discussion of function in main text)</td>
<td>Approx. 6 (not stated explicitly)</td>
</tr>
<tr>
<td>Høye (2014)</td>
<td>Introduction of speed cameras</td>
<td>Crashes</td>
<td>OR=0.85*</td>
<td>63</td>
</tr>
</tbody>
</table>

* Statistically significant at a 95% threshold
OR=Odds ratio
d=Cohen’s d or variant (standardised mean difference)
Φ=phi coefficient (variant of correlation coefficient)
NA=Not applicable (no positive impact from treatment or non-offending measure)
NNT=Number needed to treat
NS: Not significant
NR: Significance not reported
RR: Risk Ratio