Speed Limit Enforcement

EVIDENCE BRIEF

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

Evidence rating:	Strong
Unit cost:	NA
Effect size (number needed to treat):	NA
Current spend:	$88.2 million estimated for 2016/2017
Unmet demand:	High

DOES SPEED LIMIT ENFORCEMENT REDUCE OFFENDING?

Overview

Exceeding speed limits is common[i]. 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

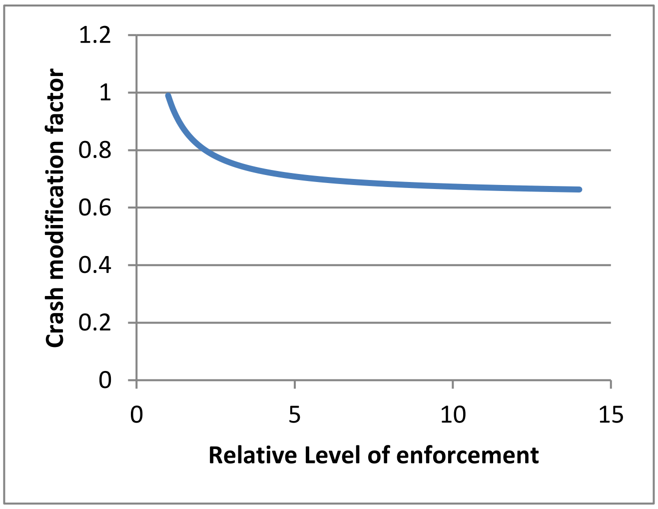
There are several international meta-analyses and systematic reviews on the effects of speed enforcement[ii]. The majority of international studies investigate the effect of speed enforcement on outcomes such as speed levels, number of crashes, and number of traffic fatalities.

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

[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[v] 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[vi]. 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[vii], 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[viii] 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[ix] 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[x] 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.

[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[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" [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[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)[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[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[xvi] which focus on the randomisation of speed camera placement, as well as older New Zealand research from 1992[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[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[xix]. After further intensification, the relative decrease in crash levels becomes smaller.

Other moderating factors

Meta analysis from 2009[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[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[xxii]: Several studies have looked at whether levels of advertising alter the effectiveness of speed limit enforcement. There are mixed findings[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.

WHAT OTHER BENEFITS DOES SPEED LIMIT ENFORCEMENT HAVE?

Public health and behavioural outcomes

As mentioned above, the majority of international studies into the effect of speed enforcement look at outcomes related to public health, such as car crashes and fatalities. The precise relationship between speed and crash injury severity has been examined in several studies[xxiv].

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[xxv].

CURRENT INVESTMENT IN NEW ZEALAND

$88.2 million was spent on speed limit enforcement over 2015/2016, according to the NZTA Road Policing Programme[xxvi].

EVIDENCE RATING AND RECOMMENDATIONS

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

Harmful	Robust evidence that intervention increases crime
Poor	Robust evidence that intervention tends to have no effect
Inconclusive	Conflicting evidence that intervention can reduce crime
Fair	Some evidence that intervention can reduce crime
Promising	Robust international *or* local evidence that intervention tends to reduce crime
Strong	Robust international *and* local evidence that intervention tends to reduce crime

According to the standard criteria for all Evidence Briefs[4], the appropriate evidence rating for Speed Enforcement is Strong.

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

[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

FIND OUT MORE

Go to the website

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

Email

whatworks@justice.govt.nz

Recommended reading

Erke, A., Goldenbeld, C., & Vaa, T. (2009). Good practice in the selected key areas: Speeding drink driving and seat belt wearing: Results from meta-analysis. *Police Enforcement Policy and Programmes on European Roads (PEPPER), Deliverable, 9.*

Elvik, R. (2012). Speed limits, enforcement, and health consequences. *Annual review of public health, 33,* 225-238.

Citations

[i] See, for example, ETSC Report (2010) and Ministry of Transport (2016).
[ii] Elliott & Broughton (2005), Erke et al (2009), Elvik (2011). Zaidel (2002), Zaal (1994).
[iii] Erke et al (2009).
[iv] Elvik (2011).
[v] Cameron et al (2016).
[vi] Wilson et al (2010).
[vii] Høye (2014).
[viii] Høye (2014), Høye (2015a), Høye (2015b), Hu & McCartt (2016), Li et al (2013), Li et al (2016).
[ix] Povey et al (2003).
[x] Van Lamoen (2014).
[xi] Tay (2000).
[xii] See, the discussion in section 3 of Erke et al (2009), or 2.4.1 of Zaal (1994).
[xiii] 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
[xiv] Hauer et al (1982)
[xv] Elliott & Broughton (2005), section 7.1.3.
[xvi] Newstead & Cameron (2013).
[xvii] See Table 1 and citations from Newstead et al.. (2001)
[xviii] Elvik (2011).
[xix] Elvik (2011), Elvik (2012), see also Cameron et al (2016).
[xx] Erke et al (2009) section 7.1
[xxi] Tay (2009)
[xxii] Bobevski et al (2007)
[xxiii] See, for example, Erke (2009) Section 3.5, and Cameron et al (2003).
[xxiv] Elvik (2003) and references therein.
[xxv] Brace et al (2009).
[xxvi] New Zealand Transport Agency (2016).

REFERENCES

Brace, C., Whelan, M., Clark, B., & Oxley, J. (2009). *The relationship between crime and road safety* (No. 284).

Blais, E., & Dupont, B. (2005). Assessing the Capability of Intensive Police Programmes to Prevent Severe Road Accidents: A Systematic Review. *British Journal of Criminology, 45*(6), 914-937.

Bobevski, Irene, et al. *Generalised linear modelling of crashes and injury severity in the context of the speed-related initiatives in Victoria during 2000-2002. No. 268. 2007.*

Cameron, M. H., & Delaney, A. K. (2008, September). Speed enforcement – Effects, mechanisms, intensity and economic benefits of each mode of operation. In *Proceedings Joint Australasian College of Road Safety and Queensland Parliamentary Travelsafe Committee conference: High Risk Road Users – Motivating behaviour change: what works and what doesn't work (pp. 18-19).*

Cameron, M., Newstead, S., Diamantopoulou, K., & Oxley, P. (2003) The interaction between speed camera enforcement and speed-related mass media publicity in Victoria. *Monash University Accident Research Centre Reports,* (201), 130.

Cameron, M., Newstead, S., & Diamantopoulou, K. (2016). A resource allocation model for traffic enforcement. *Journal of the Australasian College of Road Safety, 27*(2), 23.

Delaney, A., Diamantopoulou, K., & Cameron, M. (2003). *MUARC's Speed enforcement research: Principles learnt and implications for practice* (No. 200).

Diamantopoulou, K., & Cameron, M. (2002). *An evaluation of the effectiveness of overt and covert speed enforcement achieved through mobile radar operations* (No. 187). Monash University, Accident Research Centre.

Dowling, K. W., & Holloman, E. (2008). The effects of conspicuous traffic enforcement on speeding behaviours: a study of speed reduction response. *International Social Science Review, 83* (3/4), 181-188.

Elliott, M. A., & Broughton, J. (2005). *How methods and levels of policing affect road casualty rates.* Transport Research Laboratory, Report TRL637.

Elvik, R. (2001). *Cost-Benefit Analysis of Police Enforcement. Report ESCAPE Project.* Working Paper, VTT, Helsinki.

Elvik, R. (2011). Developing an accident modification function for speed enforcement. *Safety science, 49*(6), 920-925.

Elvik, R. (2012). Speed limits, enforcement, and health consequences. *Annual review of public health, 33,* 225-238.

Elvik, R. (2013). A re-parameterisation of the Power Model of the relationship between the speed of traffic and the number of accidents and accident victims. *Accident Analysis & Prevention, 50,* 854-860.

Erke, A., Goldenbeld, C., & Vaa, T. (2009). Good practice in the selected key areas: Speeding, drink driving and seat belt wearing: Results from meta-analysis. *Police Enforcement Policy and Programmes on European Roads (PEPPER), Deliverable 9.*

Eur. Transp. Saf. Counc. (ETSC). 2010. Road Safety Target in Sight: Making Up for Lost Time. *4th Road Saf. PIN Rep. Brussels: Eur. Transp. Safe. Counc.* http://www.etsc.eu/documents/ETSC%20PIN%20Report%202010.pdf

Hauer, E., Ahlin, F. J., & Bowser, J. S. (1982). Speed enforcement and speed choice. *Accident Analysis & Prevention, 14*(4), 267-278.

Høye, A. (2014). Speed cameras, section control, and kangaroo jumps- a meta analysis. *Accident Analysis & Prevention, 73, 200-208.*

Høye, A. (2015a). Safety effects of fixed speed cameras – An empirical evaluation. Accident Analysis & Prevention, 82, 263-269.

Høye, A. (2015b). Safety effects of section control – An empirical Bayes evaluation*. Accident Analysis & Prevention, 74,* 169-178.

Hu, W., & McCartt, A. T. (2016). Effects of automated speed enforcement in Montgomery County, Maryland, on

Li, H., Graham, D. J., & Majumdar, A. (2013). The impacts of speed cameras on road accidents: An application of propensity score matching methods*. Accident Analysis & Prevention, 60,* 148-157.

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

Li, R., El-Basyouny, K., & Kim, A. (2015). Before-and-after empirical Bayes evaluation of automated mobile speed enforcement on urban arterial roads. *Transportation Research Record: Journal of the Transportation Research Board,* (2516), 44-52.

Luoma, J., Rajamäki, R., & Malmivuo, M. (2012). Effects of reduced threshold of automated speed enforcement on speed and safety. *Transportation research par F: traffic psychology and behaviour*, 15(3), 243-248.

Ministry of Transport (2016). 2015 Speed survey results. Retrieved from: http://www.transport.govt.nz/assets/Uploads/Research/Documents/Speed-survey-results-2015.pdf

Newstead, S., & Cameron, M. (2013, August). Crash effects of the Queensland camera detected offence program. In *Australasian Road Safety Research Policing Education Conference, Brisbane, Queensland, Australia.*

Newstead, S. V. Cameron, M. H., & Leggett, L. M. W. (2001). The crash reduction effectiveness of a network-wide traffic police deployment system. *Accident Analysis & Prevention, 33*(3), 393-406.

New Zealand Government (2012). Embedding the Safe System approach to road safety. Retrieved from http://www.saferjourneys.govt.nz/assets/Safer-journeys-files/safe-system-for-designers-leaflet.pdf

New Zealand Transport Agency (2016). Road Policing Programme (RPP). Retrieved from https://www.nzta.govt.nz/resources/road-policing-programme/

Povey, L. J., Frith, W. J., & Keall, M. D. (2003). An investigation of the relationship between speed and enforcement, vehicle speeds and injury crashes in New Zealand. *Land Transport Safety Authority. New Zealand.*

Redelmeier, D. A., Tibshirani, R.J., & Evans, L. (2003). Traffic-law enforcement and risk of death from motor-vehicle crashes: case-crossover study. *The Lancet, 361*(9376), 2177-2182.

Shinar, D., & McKnight, A. J. (1985). The effects of enforcement and public information on compliance. In *Human behaviour and traffic safety* (pp. 385-419). Springer US.

Tay, R. (2000). Do speed cameras improve road safety?. In *Traffic and Transportation Studies (2000)* (pp. 44-51).

Tay, R. (2009). The effectiveness of automated and manned traffic enforcement. *International journal of sustainable transportation, 3*(3), 178-186.

Vaa, T. (1997). Increased police enforcement: effects on speed. *Accident Analysis & Prevention, 29*(3), 373-385.

van Lamoen, N. (2014). Evaluation of the "Safer Summer" Road Safety Campaign. New Zealand Police Report.

van Lamoen, N. (2014, November). The impacts of a reduced speed enforcement tolerance threshold on road safety outcomes.

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

Wilson, C., Willis, C., Hendrikz, J. K., Le Brocque, R., & Bellamy, N. (2010). Speed cameras for the prevention of road traffic injuries and deaths. *The Cochrane Library.*

Zaal, D. (1994). Traffic law enforcement: A review of the literature. Monash University, Accident Research Centre, Australia. Report No. 53.

Zaidel, D. M. (2002). The impact of enforcement on accidents. *The 'Escape' Project (Enhanced Safety Coming from Appropriate Police Enforcement)*. Retrieved from http://virtual.vtt.fi/virtual/proj6/escape/escape_d3.pdf

SUMMARY OF EFFECT SIZES FROM META-ANALYSES

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

* 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