# Reduction of speed limit

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*Please note*: The studies included in this synopsis were selected from those identified by a systematic literature search of specific databases (see supporting document). The main criterion for inclusion of studies in this synopsis and the DSS was that each study provides a *quantitative effect estimate*, preferably on the number or severity of crashes or otherwise on road user behaviour that is known to be related to the occurrence or severity of a crash. Therefore, key studies providing qualitative information might not be included in this synopsis.

# 1 Summary

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## 1.1 COLOUR CODE: GREEN

Speed and road safety are inversely correlated. In that context, speed limit reduction has a significant positive impact on road safety. Studies observed a decrease of fatal crashes, of serious injuries, and also of other kind of injuries. The effects seem larger for a high level of initial speed than for a low level. No evidence of negative effects of speed limit reduction has been found. However, some studies lack statistical analyses and should be considered with care.

## 1.2 KEYWORDS

Road safety, speed limit reduction, crash risk, means speed, injuries, fatal crash, meta-analysis, power model

## 1.3 ABSTRACT

In the context of road transport, various speed limitations have been used worldwide, depending on historical background, infrastructure, country system of units, etc. It has been demonstrated that the faster vehicles go, the worse accidents are: increased crash risk, increased severity, and increased fatality rate. In that context, a meta-analysis from 2013 was analysed as well as five other more recent studies in order to evaluate the impact of speed limit reduction on road safety. Speed limit reduction measures were found to have a positive impact on road safety. Speed limit reduction reduces average speed on the road which has positive effects on road safety. The meta-analysis predicted a strong exponential link between relative injuries/fatal crash risk and initial speed. That means that speed decreases on highways would have even larger positive effects than speed decreases from 50 km/h. No evidence was found of negative effects on crash rates, or (fatal) injuries. The synopsis also highlights that the effects of speed limit reduction can change as a function of the road section that is considered: there seem to be smaller effects on intersections than on the road sections. But the meta-analysis illustrated that, overall, speed limit reduction had positive effects on road safety everywhere in the studied countries. This synopsis concludes that speed limit reduction can be considered as an important measure to improve road safety, but also that more studies should include statistical analyses in order to confirm all these trends.

## 1.4 BACKGROUND

The speed of an object is the rate of change of its position over time. The international system of units (SI) defines the unit of speed in terms of meters per second ($m.s^{-1}$ or m/s). However, it has been easier in everyday life to quantify the speed in kilometres per hour (km/h). The speed limit reduction measure is thus a measure allowing decreasing this rate of position change over time.

The literature review showed that speed limit can be reduced by the implementation of a decreased speed rule compared as before (De Pauw et al, 2014; Long et al., 2006). It can either be done as a general rule or regionally. Most often the reduction is not drastic, because it has been demonstrated that small changes had proportionally bigger effects on speed than important ones (Taylor et al., 2000).

Speed, by definition, directly affects road transport. It defines the mobility of persons and goods travelling from one location to another (Arts & Van Chagen, 2006). In today's modern life, citizens want to have a high degree of mobility and the possibility to travel fast by air, rail or road has become a requirement of our societies.
But driving speeds also have a direct impact on the risk of the driver and other people being involved and severely injured in a crash as well as on noise and pollutant emissions (Elvik, 2013).

### What is a speed reduction measure?

The literature review showed that speed limit can be reduced by the implementation of a decreased speed rule compared as before (Elvik 2013, De Pauw et al, 2014; Long et al., 2006). It can either be done as a general rule or regionally. Most often the reduction is not drastic, because it has been demonstrated that small changes had proportionally bigger effects on speed than important ones (Taylor et al., 2000).
The speed limit reduction can be definitive or temporary (for instance, linked to the weather, or linked to seasonal speed limits).
The objectives for this speed reduction measures vary from one place to another: it can be for road safety concerns, for environmental issues, for noise, or simply political decisions. in this synopsis We will focus only on road safety related measures.

### How is speed measured?

Speed can be measured instantly or as an average over a known distance (Soole et al., 2013). In order to compute the speed of a vehicle from a remote location, different devices can be used. The vehicle speed can be collected using automatic speed cameras (Keall et al., 2001). These cameras can be hidden or visible. Speed guns, manipulated by policemen, are also often used (Pilkington & Kinra, 2005): they are small devices using radar technology which produces and collects waves: the change of the wavelength can give the speed of the observed object. Policemen can also use laser speed guns, so called Lidar (Solomon 2006). It produces infrared light that is reflected by the car: the time taken to get back to the laser changes over time and it is then possible to compute accurately the speed of the vehicle. These guns are small and portative, they can thus be used almost everywhere.
Average speed can also be calculated. In order to do so, ANPR (automated number plate recognition) cameras are used at least at two locations on the road (Qadri & Asif, 2009). Knowing the distance between these two locations, and the time taken by the vehicle to reach the second one, it is possible to compute its average speed through the whole section. The zones where these devices are implemented are known as section controls.

### How is the effect of speed reduction measures on road safety studied?

The most direct way to investigate the effects of a speed reduction measure is to compare the mean speed in a before-after study, as in Islam (2014). Most of the studies are also road safety related. In these studies, crashes are analysed before and after the implementation of the speed limit reduction measure. Crash rate, fatal crash rate, and injury rate are most often reported (Elvik, 2013).

### What can influence speed reduction measures?

In order to be respected, the speed reduction has to be understood by the road users, and has to fit with the infrastructure and the usual traffic. An important speed decrease in a non-accidental area won't be understood and thus won't be applied by a substantial proportion of the drivers (Martinez et al., 2013).

## 1.5 OVERVIEW OF THE RESULTS

For this synopsis, an important meta-analysis (Elvik, 2013) and four other studies were used. No results found a negative effect of using speed reduction measures. In the meta-analysis, benefits were quantified for fatal crashes and injury crashes: the results gave significant effects of speed limit reduction on road safety, with very high R squared above 0.98. The relationship is thus really strong. Speed limit reduction allowed drastically decreasing the relative number of (fatal) accidents. The relative decrease is more important at a high level of initial speed. Finally this meta-analysis took into account a total of 115 studies from almost 20 countries worldwide: the effects of speed limit reduction seem significant anywhere.
Islam et al. (2014) also observed a decrease of mean speed with an implementation of speed reduction (From 50 to 40 km/h): a significant decrease of 3.86 km/h was observed after 3 months, and even a significant decrease of 4.88 km/h was observed after 6 months.
But the benefits are not observed on all road types. For instance at intersections were observed non-significant odds ratio equal to 0.97 for serious injuries, while through roads were observed significant odds ratio equal to 0.64 according to DePauw et al. 2014. Finally, some papers only observed trends and lack of rigorous statistical models.

## 1.6 TRANSFERABILITY

Speed is one of the four main killers on the road. In that context, this literature review highlighted that speed reduction measures are massively studied and applied in many countries all over the world. Main results suggested that speed reduction measures were increasing road safety. Crash rates, injuries and fatal crashes generally tend to decrease with a decreasing speed. However, more studies are still needed in order to remove ambiguity of some results.

### Notes on analysis methods

This synopsis was prepared as a review type analysis. A systematic review of the recent studies was carried out, and a recent and very exhaustive review from 2013 was found (Elvik 2013). The results of this meta-analysis were not ambiguous. Some more recent papers (Islam 2014, De Pauw et al. 2014, IRTAD report 2017) were then added and their results were in total accordance with Elvik (2013). So it was decided not to conduct our own meta-analysis because of it probable low added value to this document.

# 2 Scientific details

## 2.1 ANALYSIS OF STUDY DESIGNS AND METHODS

### Description of the studies

In order to elaborate this synopsis, one meta-analysis and four other recent papers have been coded. These studies are presented in **Table 1**.

### Description of the main research methods

The main research method to study the speed reduction measure is a before after study. It is indeed mainly used in evaluation studies of an implemented measure. This method has advantages in terms of experimental design: the same road is studied, including the same infrastructure, the same traffic and the same general characteristics. Most of the time, the only thing that has changed is the speed limit. So you drastically limit the number of normalisation you have to make in order to study specifically the speed reduction measure. The only limitation is to get the "before" data in order to compare it to the "after" data in terms of crash rate, injuries, mean speed, etc.
Observational studies can be trickier to prepare in term of experimental design. Most of the time researchers want to compare roads with reduced speed limits to roads where the speed limit remained the same. In order to do so, comparable roads have to be found for the control group. The control roads have to have the same kind of infrastructure, the same kind of traffic flow etc. But this research method remains a good solution if you do not have data of the situation before the implementation of a decreased speed limit.
The outcomes of the studies can be divided in two groups. The first one is physical measure related outcomes such as mean speed, variation of the speed, decrease of the speed. The second one is crash related outcomes such as crash events, crash severities, fatal crash, injuries etc.
**Table 1**. presents the selected studies. De Pauw et al. (2014) and Islam (2014) used the before-after study method. De Pauw et al. (2014) focused on crash related outcomes while Islam focused on a comparison of the mean speed before and after the implementation of the new speed regulation. Long et al (2006) performed an observational study where they compared different roads with or without a decreased speed limit. The considered outcome was then crash causalities.
Elvik (2013) investigates 115 studies that are a mix of all the research methods.

**Table 1:** Studies on speed reduction driving analysed for this study.

| Author | Year | Measure | Study type | Outcome variable |
|---|---|---|---|---|
| DePauw et al. | 2014 | Speed reduction | Before-after study | Injury crashes<br>Severe crashes |
| Elvik | 2013 | Speed reduction / Speed management | Review and meta-analysis | Fatal accidents<br>Injury accidents |
| IRTAD group | 2017 | Speed change | Systematic review | Change of fatalities<br>Change of severe injuries<br>Change of crashes |
| Islam | 2014 | Speed reduction | Before-after study | Mean speed |
| Long et al. | 2006 | Speed reduction | Observational study | Crash casualties |

## 2.2 STUDY RESULTS

The results highlighted by the various analysed studies are presented in **Table 3**.

### Crash related outputs

Most of the studies had an outcome related to **crashes**. The Elvik (2013) meta-analysis, that included 115 scientific studies, fitted an exponential function to link fatal crash and injuries with initial speed. The $R^2$ resulting from this regression was equal to 0.99 and 0.98 for injuries and fatal accidents, respectively. There is thus a very strong link between speed limit reduction and road safety. This also highlighted that the positive effects of speed reduction would be more pronounced at high level of initial speed (motorways) than at low speed (urban ways). This is true both for fatal accident but also for injury crashes. The IRTAD report also observed the same trend. Severe injuries seem to get more benefits than other injuries in De Pauw et al. (2013). Finally the effects seemed to vary between road types considered: for in De Pauw et al. (2013) no effect was observed at intersections, but significant benefits at through roads (**Table 3**).

### Mean speed outputs

One study analysed in this synopsis studied the mean speed after the implementation of speed reduction measures. Mean speed can be considered as an indirect measure of the effects on road safety. In that context, Islam (2014) studied the mean speed change after the implementation of a

reduced speed limit from 50 km/h to 40km/h in urban areas of Edmonton in Canada. It has been done 3 months after the implementation of the new speed limit, and then 3 months later. The study highlighted a significant speed decrease of the traffic flow equal to 3.86 km/h after 3 months, and even a 4.88 km/h decrease after 6 months. The speed reduction measure had significant effect, and thus can improve road safety (**Table 3**).

### Modifying conditions

It should also be noticed by the reader that the homogeneity of the traffic flow is also an important parameter on road safety. Many studies have indeed demonstrated that homogeneity of the flow was increasing road safety (Baruya A., 1997; Kloeden et al., 1997 and Elvik et al., 2004).
In that context, dynamic speed limits (which decrease automatically speed under particular conditions) have demonstrated a positive impact on the traffic flow, as in Van Ness et al. (2010). This can also be considered as a positive side-effect for road safety.
Nevertheless the benefits of speed reductions on road safety seemed to vary between locations in De Pauw et al. (2014), where they observed significant effects on through roads but not at intersections.

### Meta-analysis

The literature review highlighted an important meta-analysis about the relationship between speed reduction and road safety. It is a very intensive work that started by a first report in 2004 (Elvik, 2004), containing 98 studies, followed by an updated report in 2009 (Elvik 2009) with 17 new studies. Finally, a re-analysis of all the results was performed in 2013 (Elvik 2013) in order to test another linkage function. Elvik (2013) is thus a meta-analysis based on 115 scientific articles and 460 estimates about the evaluation of speed reduction (including speed limit reduction) on fatal accidents and injury accidents from many countries across the world. The purpose of this work was also to test the best relationship between speed reduction and accidents: either the power model of Nilsson (Nilsson, 2004), or, an exponential function from Hauer and Bonneson (2006).

The general form of the Power Model is:

$$accident_{after} = accident_{before} \cdot \left(\frac{speed_{after}}{speed_{before}}\right)^{exponent}$$

Separate exponents are fitted for accidents at different levels of severity and for injured road users at different levels of severity. The Power Model implies that the effect on accidents of a given severity of a given relative change in speed is independent of initial speed.

The function developed by Hauer and Bonneson (2006) is formulated as follows:

$$\text{AMF (for a speed change from v to v} *) = e^{\alpha[v - v* + (\frac{\beta}{2}).(v^2 - v*^2)]}$$

AMF is the accident modification factor associated with a certain change in speed. Thus, an AMF of, for example, 0.80 corresponds to an accident reduction of 20%. Speed is stated in miles per hour. α and β are coefficients estimated by means of regression analysis. This equation implies that the effects of speed reduction would be more important at high level of initial speed.

The original results from of the Elvik (2013) meta-analysis are presented in Figure 1 and Figure 2.

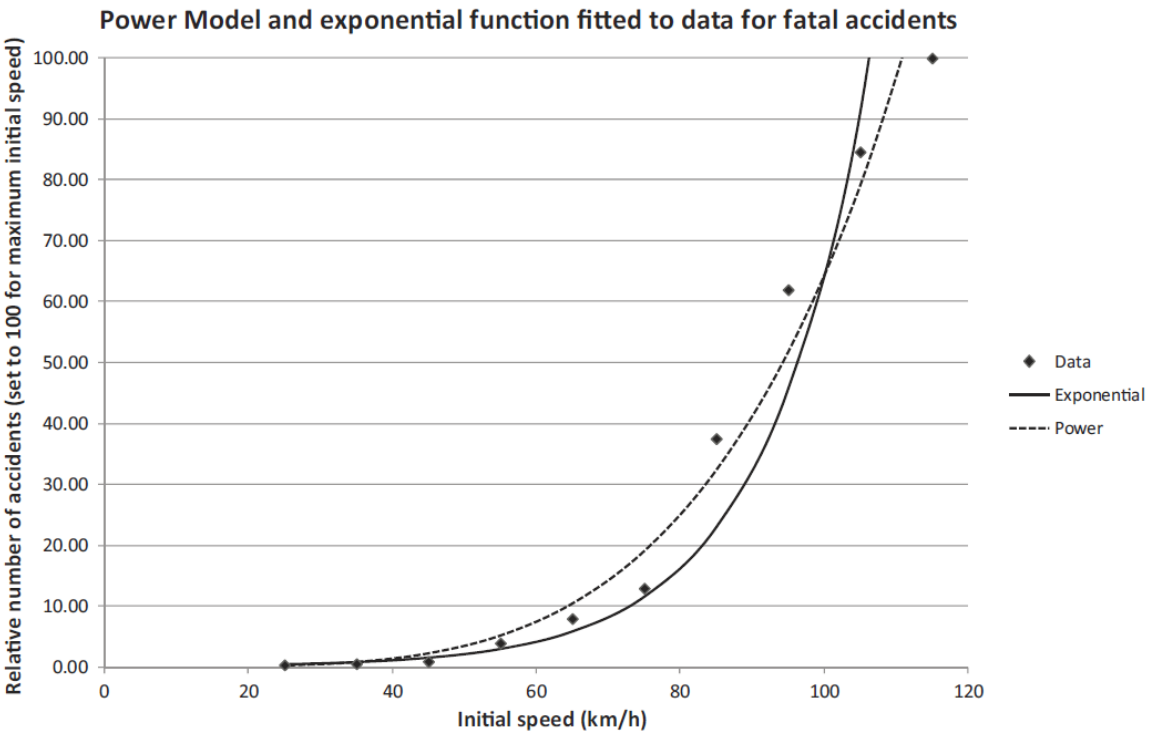


Figure 1: Power and exponential function fitted to the fatal accident data. From Elvik, 2013.

Figure 1 illustrates the relationship between the initial speed and the relative number of fatal accidents. The link between these two variables very clear: if the speed decreases, the relative number of fatal accident will decrease, too. Figure 1 also compares the power model with the exponential model. In the case of fatal accidents, it is not so clear to decide which one would be the best. Nevertheless, these two relationships describe that a speed decrease for high speed will be very efficient to improve road safety.

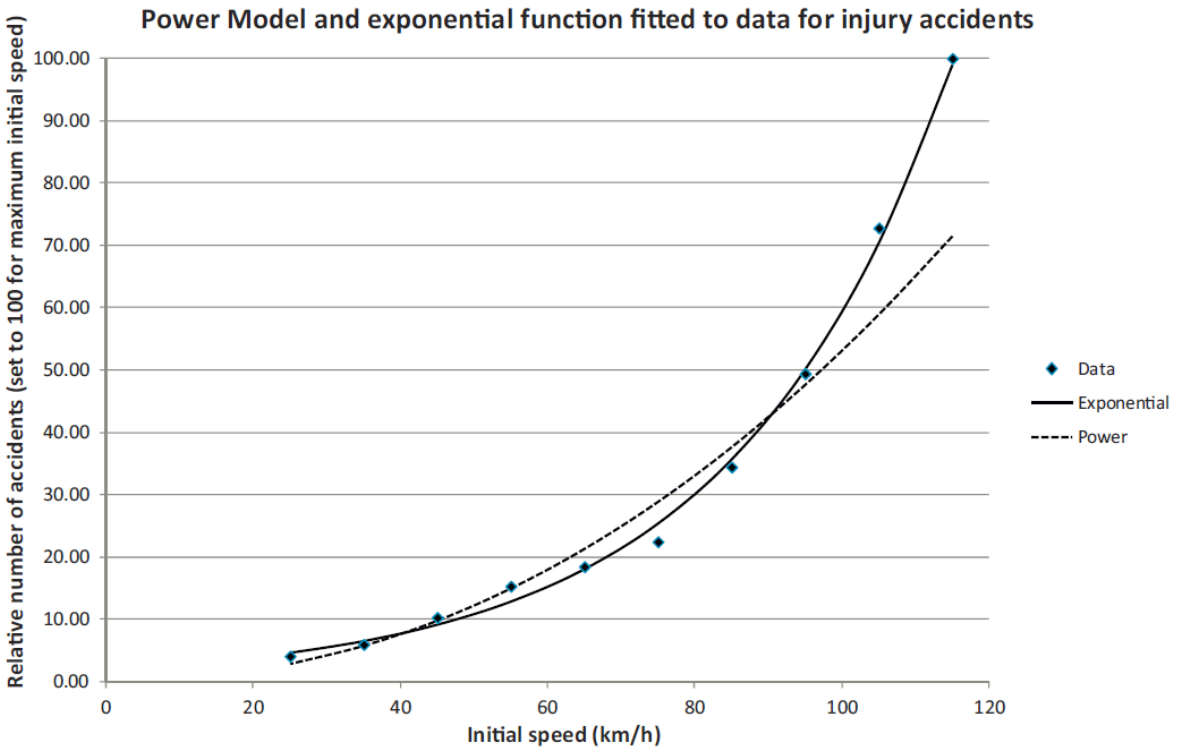


Figure 2: Power and exponential function fitted to the injury data. From Elvik, 2013.

Figure 2illustrates the relationship between initial speed and the relative number of injury accidents. The link between these two variables is very clear: if the speed decreases, the relative number of fatal accident will decrease too. Figure 2 also compares the power model with the exponential model. In the case of injury accidents, the exponential function fits the data very well. So a speed decrease for high level of initial speed will be very efficient to improve road safety.

## Description of analysis carried out

This synopsis was prepared as a review type analysis. A systematic review of the recent studies was carried out, and a recent and very exhaustive review from 2013 was found (Elvik 2013). Some more recent papers (Islam 2014, De Pauw et al. 2014, IRTAD report 2017) were then added to get the most global picture of the effects of speed limits reduction on road safety.
Both the results coming from the meta-analysis and the results from the other analyzed papers gave significant effects of speed limit reduction on road safety, with very high R squared (> 0.98). In that context, the green color was given to the speed limit reduction measure, because its effects seem unambiguous, and no negative effect was found in any of the studies.

## Conclusion

Speed is one of the four main killers on the road. On the other hand, speed directly affects road transport. In today's modern life, citizens want to have a high degree of mobility and the possibility to travel fast by air, rail or road has become a requirement of our societies. Thus, there is an essential consensus to be made between these two contradictions.

Speed limit reduction measures can be applied but the purposes vary from one place to another: it can be for road safety concerns, for environmental issues or simply political decisions. The synopsis has focused, of course, only on road safety related measures.
Regarding road safety concerns, the literature review highlighted that speed reduction measures are massively studied and applied in many countries all over the world. The geographical level of speed reduction zones vary from very locally (for instance using a traffic calming device) to regionally (the government changes the rule for many highways, for instance).
The change of speed limits is a quite common measure. Main results suggested that it had most of the time positive effects at all levels (locally and regionally).
Speed limit reduction measures were most often decreasing the mean speed of traffic flow, having positive consequences on road safety.
Crash related outcomes took also the benefits of speed reduction measures. Interestingly Elvik (2013) illustrated that when speed reduction was impacting road safety exponentially: high speed was even more positively impacted than lower speed. Fatal crashes and injury crashes decreased importantly with decreased speed limit.
No study showed negative effects of speed reduction on road safety.
However, some studies did not make statistical tests on their results, so more studies are still needed in order confirm all the positive trends described in the present review.

# 3 Supporting documents

### Literature reviewed by the Elvik (2013)

The meta-analysis of Elvik 2013 is based on a previous work from 2009. The 115 scientific articles used to prepare the meta-analysis are presented inTable 2. All studies related to speed limits are in **bold**

Table 2: Studies used in Elvik 2013 meta-analysis. All studies related to speed limits are highlighted in bold

| Authors | Year | Country | Measure evaluated | Number of estimates of effect |
|---|---|---|---|---|
| **Studies from the 2004 report** | | | | |
| **Munden** | 1966 | Great Britain | Speed enforcement | 12 |
| **Ekström et al** | 1967 | Sweden | Speed enforcement | 2 |
| **Hall et al** | **1970** | **Ireland** | **General speed limits** | **2** |
| **Jönrup and Svensson** | **1971** | **Sweden** | **Local speed limits** | **20** |
| **Rutley** | 1972 | Great Britain | Recommended speed | 7 |
| **Wahlgren** | **1972** | **Finland** | **Seasonal speed limits** | **3** |
| **Andersson and Nilsson** | **1974** | **Sweden** | **Local speed limits** | **3** |
| **Brodersen et al** | **1975** | **Denmark** | **General speed limits** | **3** |
| **Brodin and Ringhagen** | **1975** | **Sweden** | **Local speed limits** | **1** |
| **Burritt et al** | **1976** | **United States** | **General speed limits** | **1** |
| **Nilsson** | **1976** | **Sweden** | **Local speed limits** | **12** |
| **Scott and Barton** | **1976** | **Great Britain** | **General speed limits** | **2** |
| **Kemper and Byington** | **1977** | **United States** | **General speed limits** | **6** |
| **Brackett and Beecher** | 1980 | United States | Speed enforcement | 3 |
| **Daltrey and Healy** | **1980** | **Australia** | **General speed limits** | **4** |
| **Nilsson** | **1980** | **Sweden** | **Seasonal speed limit** | **6** |
| **Roop and Brackett** | 1980 | United Stares | Speed enforcement | 18 |
| **Amundsen** | **1981** | **Norway** | **Local speed limits** | **2** |
| **Christensen** | **1981** | **Denmark** | **General speed limits** | **2** |
| **Koshi and Kashima** | **1981** | **Japan** | **Local speed limit** | **3** |
| **Salusjärvi** | **1981** | **Finland** | **Local speed limits** | **24** |

| | | | | |
|---|---|---|---|---|
| **Baguley** | 1982 | Great Britain | Speed humps | 7 |
| Frith and Toomath | 1982 | New Zealand | General speed limit | 4 |
| **Salusjärvi** | **1982** | **Norway** | **Local speed limits** | **2** |
| **Amundsen** | **1983** | **Norway** | **Local speed limits** | **1** |
| **Borges et al** | 1985 | Denmark | Environmental streets | 5 |
| **Jørgensen et al** | **1985** | **Nordic countries** | **General speed limits** | **4** |
| **Sakshaug** | **1986** | **Norway** | **Local speed limits** | **4** |
| **Engel** | **1987** | **Denmark** | **General speed limits** | **1** |
| **Ullman and Dudek** | **1987** | **United States** | **Local speed limits** | **12** |
| **Dietrich et al** | **1988** | **Switzerland** | **General speed limits** | **8** |
| **Engel and Thomsen** | **1988** | **Denmark** | **General speed limits** | **3** |
| **Salusjärvi and Mäkinen** | **1988** | **Finland** | **Speed enforcement** | **4** |
| **Stølan** | 1988 | Norway | Environmental streets | 2 |
| **Gallaher et al** | **1989** | **United States** | **General speed limit** | **1** |
| **McCartt and Rood** | 1989 | United States | Speed enforcement | 6 |
| **Pigman et al** | 1989 | United States | States Unmanned radar | 4 |
| **Rijkswaterstaat** | **1989** | **Netherlands** | **General speed limit** | **2** |
| **Upchurch** | **1989** | **United States** | **General speed limit** | **3** |
| **US Dept of Transportation** | **1989** | **United States** | **General speed limit** | **2** |
| **Brown et al** | **1990** | **United Stat** | **General speed limit** | **6** |
| **Engel and Thomsen** | 1990 | Denmark | Speed humps | 2 |
| **Giæver and Meland** | 1990 | Norway | Speed humps | 3 |
| **Nilsson** | **1990** | **Sweden** | **Seasonal speed limits** | **4** |
| **Roszbach** | **1990** | **Netherlands** | **General speed limit** | **1** |

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|---|---|---|---|---|
| **Sidhu** | **1990** | **United States** | **General speed limit** | **6** |
| **Smith** | **1990** | **United States** | **General speed limit** | **2** |
| **Andersson** | 1991 | Sweden | Speed enforcement | 6 |
| **Angenendt** | 1991 | Germany | Environmental streets | 2 |
| **Freiholtz** | 1991 | Sweden | Environmental streets | 2 |
| **Jernigan and Lynn** | **1991** | **United Stat** | **General speed limit** | **1** |
| **Baier** | **1992** | **Germany** | **Speed limit zones** | **2** |
| **Baier et al** | 1992 | Germany | Environmental streets | 2 |
| **Godwin** | **1992** | **United States** | **General speed limit** | **2** |
| **Oei and Polak** | 1992 | Netherlands | Speed cameras | 4 |
| **Nilsson** | 1992 | Sweden | Speed cameras | 4 |
| **Schnüll and Lange** | 1992 | Germany | Environmental streets | 3 |
| **Sliogeris** | **1992** | **Australia** | **General speed limit** | **2** |
| **Aakjer-Nielsen and Herrstedt** | 1993 | Denmark | Environmental streets | 6 |
| **Herrstedt et al** | 1993 | Denmark | Environmental streets | 29 |
| **Engel and Andersen** | 1994 | Denmark | Environmental streets | 1 |
| **Sammer** | **1994** | **Austria** | **Local speed limits** | **2** |
| **Rock** | **1995** | **United States** | **General speed limit** | **3** |
| **Wheeler and Taylor** | 1995 | Great Britain | Environmental streets | 6 |
| **ETSC** | 1996 | Denmark | Speed humps | 10 |
| **Griborn** | 1996 | Sweden | Environmental streets | 1 |
| **Webster and Mackie** | 1996 | Great Britain | Speed humps | 3 |
| **Liu and Popoff** | 1997 | Canada | Driver speed choice | 1 |
| **Parker** | **1997** | **United States** | **Local speed limits** | **28** |
| **Aljanahi et al** | 1999 | Bahrain | Driver speed choice | 1 |

| | | | | |
|---|---|---|---|---|
| **Antov and Roivas** | 1999 | Estonia | Seasonal speed limits | 2 |
| **Buss** | 1999 | Germany | Temporary lane | 1 |
| **Eriksson and Agustsson** | 1999 | Denmark | Environmental streets | 1 |
| **Farmer et al** | **1999** | **United States** | **General speed limit** | **1** |
| **Lamm et al** | 1999 | Germany | Speed cameras | 3 |
| **Wheeler and Taylor** | 1999 | Great Britain | Environmental streets | 6 |
| **Andersson** | 2000 | Sweden | Speed enforcement | 2 |
| **Andersson** | **2000** | **Sweden** | **Local speed limits** | **4** |
| **Kronberg and Nilsson** | 2000 | Sweden | Speed cameras | 3 |
| **Peltola** | 2000 | Finland | Seasonal speed limits | 4 |
| **Wretling** | **2000** | **Sweden** | **Local speed limits** | **4** |
| **Abel and Matthes** | **2001** | **Germany** | **Local speed limits** | **17** |
| **Agustsson** | 2001 | Denmark | Environmental streets | 1 |
| **Burns et al** | **2001** | **Great Britain** | **Local speed limits** | **2** |
| **Keall et al** | 2001 | New Zealand | Speed cameras | 2 |
| **Ossiander and Cummings** | 2002 | United States | General speed limit | 1 |
| **Pez** | 2002 | Germany | Speed enforcement | 4 |
| **Taylor et al** | 2002 | Great Britain | Driver speed choice | 1 |
| **Andersson** | 2003 | Sweden | Speed cameras | 6 |
| **Goldenbeld et al** | 2003 | Netherlands | Speed enforcement | 1 |
| **Grendstad et al** | 2003 | Norway | Environmental streets | 6 |
| **Myrup and Agustsson** | 2003 | Denmark | Speed cameras | 6 |
| **Varhelyi et al** | 2003 | Sweden | ISA trial | 1 |
| **Nilsson** | 2004 | Sweden | Driver speed choice | 6 |
| **Ragnøy** | **2004** | **Norway** | **Speed limits** | **4** |

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|---|---|---|---|---|
| **Richter et al** | **2004** | **Israel** | **Speed limits** | **1** |
| **Stuster** | 2004 | United States | Speed enforcement | 14 |
| **Vernon et al** | **2004** | **United States** | **Speed limit** | **3** |
| **Studies added in the 2009 report** | | | | |
| **Dart** | **1977** | **United States** | **Speed limit** | **3** |
| **Erwing** | 1999 | United States | Traffic calming | 4 |
| **Povey, Frith and Keall** | 2003 | New Zealand | Police enforcement | 2 |
| **Webster and Layfield** | 2003 | Great Britain | Traffic Calming | 6 |
| **Mountain, Hisrt and Maher** | 2004 | Great Britain | Speed Cameras | 1 |
| **Cunningham , Hummer, Moon** | 2005 | United States | Speed Cameras | 6 |
| **Gains et al.** | 2005 | Great Britain | Speed Cameras | 1 |
| **Lindemann** | 2005 | Switzerland | Speed Cameras | 2 |
| **Mountain, Hisrt and Maher** | 2005 | Great Britain | Speed Cameras | 3 |
| **Kockelman** | **2006** | **United States** | **Speed limits** | **3** |
| **Long et al.** | **2006** | **Australia** | **Speed limits** | **6** |
| **Bobeski et al.** | 2007 | Australia | Police Enforcement | 2 |
| **Christensen and Ragnoy** | **2007** | **Norway** | **Speed limits** | **3** |
| **D'Elia, Newstead Cameron** | 2007 | Australia | Police enforcement | 2 |
| **Kloeden, Wooley, Mclean** | **2007** | **Australia** | **Speed limit** | **12** |
| **Reiff et al. (Elvik)** | **2008** | **Denmark** | **Speed limit** | **8** |
| **Shin, Washington, Schalkwyk** | 2009 | United States | Speed camera | 2 |

## Study results

**Table 3:** Studies on speed reduction measure analysed for this study. Effects on road safety are coded as: positive (↗), negative (↘), non-significant (–) or no test for significance reported (/).

| Author, Year, Country | Outcome variable | Estimates | Symbol on road safety | Effects for Road Safety |
|---|---|---|---|---|
| DePauw et al, 2014, Belgium | Injury crashes<br>Severe crashes | **Odds ratios**<br>All roads:<br>Injuries: 0.95<br>Severe injuries: 0.67<br>intersections:<br>Injuries: 1;11<br>Severe injuries: 0.94<br>Through roads:<br>Injuries: 0.89<br>Severe injuries:0.64 | All roads : ↗<br>Intersections: -<br>Through roads: ↗ | All roads : significant positive effect on road safety for severe injuries<br>Intersections : Non significant effect on road safety<br>Through roads: Significant positive effect on road safety for both injuries and severe injuries |
| Elvik, 2013, Many countries | Injuries<br>Fatal crash | **Non-linear regression : exponential function (weighted estimates)**<br>Injuries:<br>$R^2$=0.994<br>Constant: 1.983<br>Speed term= 0.034<br>Fatal accidents:<br>$R^2$=0.981<br>Constant: 0.072<br>Speed term= 0.069 | Injuries : ↗<br>Fatal accident: ↗ | Injuries and fatal accident fit very well with an exponential model as a function of initial speed |
| IRTAD, 2017, Many countries | Change of fatalities<br>Change of severe injuries<br>Change of crashes | / | / | Positive effect for road safety for all outcomes, but without statistical tests |
| Islam, 2014, Australia | Mean speed | **Absolute differences**<br>3 months after = - 3.86 km/h<br>6 months after = - 4.88 km/h | ↗ | Significant positive effect on road safety: decrease of speed |
| Long et al, 2006, Australia | Crash casualties | **Relative proportion**<br>- 20% | / | Positive effect on road safety, without statistical test results |

## Methodology

The scientific literature database that was investigated for this literature study was Google Scholar. It was analysed between the 5th and 11th of May 2017. Some limitations/ exclusions have to be applied: only papers after the year 2000, only relevant countries, meta-analyses were preferred,

simple experimental designs were preferred, and we tried to get the most common type of outputs regarding speed limit reduction. Table 4 presents the results of the database research using different keywords.

**Table 4:** Results from the google scholar database research

| search no. | search terms / operators / combined queries | hits |
|---|---|---|
| **#1** | measure reduction of speed limit meta-analysis | 18 100 |
| **#2** | effect reduction speed limits crashes | 116000 |
| **#3** | effect "speed limit reduction" crash | 636 |
| **#4** | effect "speed limit reduction" crash >2000 | 598 |

From this first research, only relevant titles were selected, and the number of relevant studies is presented in Table 5.

**Table 5:** Results Literature Search: Papers which has relevant titles

| Database | Hits |
|---|---|
| | |
| Google Scholar (remaining papers after limitations/exclusions) | >200 |
| **Studies to obtain full texts (after screening)** | **50** |

### Eligibility

Finally, full texts of the remaining articles had to be obtained, and 24 of the 50 papers were ready for analyses.

| | |
|---|---|
| **Total number of studies to screen full-text** | **50** |
| **Full-text could be obtained** | **24** |
| **Reference list examined Y/N** | **N** |
| **Eligible papers** | **24** |

### Prioritising Coding

The coding order was prioritised following the order below:

1. Meta-analysis.
2. Recent studies (if possible after 2010 for meta-analysis, after 2010 for the others)
3. Clear experimental design.
4. Tried to cover the most common outputs when dealing with speed reduction measure evaluation

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