Strategic and regulatory frameworks for guiding, enforcing or promoting activities to prevent unintentional injury to children and young people in the road environment

REVIEW 3 – FINAL REPORT V.3

An overview and synthesis of evidence relating to strategies and frameworks for planning, implementing, enforcing or promoting activities to prevent unintentional injury to children and young people on the road: legislation, regulation, standards and related strategies focusing on the design and modification of highways, roads or streets

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(as part of the joint WMHTAC/PenTAG CPHE Collaborating Centre)

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About the Peninsula Technology Assessment Group (PenTAG)

The Peninsula Technology Assessment Group is a multi-disciplinary research group which specialises in the synthesis of research evidence for informing health policy and practice. PenTAG is part of the Institute of Health Service Research at the Peninsula Medical School. PenTAG was established in 2000 and carries out independent Health Technology Assessments for the UK HTA Programme, systematic reviews and economic analyses for NICE (Technology Appraisal and Centre for Public Health Excellence) and systematic reviews as part of the Cochrane Collaboration Heart Group, as well as for other local and national decision-makers. The group is multi-disciplinary and draws on individuals' backgrounds in public health, health services research, computing and decision analysis, systematic reviewing, statistics and health economics. The Peninsula Medical School is a school within the Universities of Plymouth and Exeter.

For a full listing of current and past projects and publications, please visit our website: www.pms.ac.uk/pentag

Collaborations

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Declaration of authors' competing interests

No authors have any competing interests.

List of abbreviations

Abbreviation	Meaning
CI	Confidence interval (around an estimate, for a given level of statistical significance)
DfT	Department for Transport
EU	European Union
IRRD	International Road Research Documentation (literature database)
kph	Kilometres per hour
KSI	Killed or seriously injured
mph	Miles per hour
MVC	Motor vehicle crash
NA	Not applicable
NR	Not reported
NTIS	National Technical Information Services (literature database)
PenTAG	Peninsula Technology Assessment Group
RTM	Regression-to-mean
SRTS	Safe Routes To Schools (program/programme)
TRIS	Transportation Research Information Services, of the (US) Transportation Research Board (literature database)
TRL	Transport Research Laboratory
UK	United Kingdom
USA	United States of America
WMHTAC	West Midlands Health Technology Assessment Collaboration

Glossary of key terms

Term	Definition
Casualty	A person who has received an injury (fatal or non-fatal)
Citations	US term for recorded traffic offences
Common site ban	Banning of the sale of alcohol at the same site as petrol (service stations)
Enabling legislation	a piece of legislation by which a legislative body grants an entity or appropriate officials the authorisation or legitimacy to take a certain action(s)
Halo effect	The spread of an intervention's effectiveness (e.g. a speed camera at reducing speed) beyond its immediate location or over time
Legislation	Laws usually enacted following debate and amendment within a national or regional legislative body (e.g. parliament)
Regression to mean	Statistical tendency for relatively high values in a series of outcome measurements to be followed by lower values (especially important to consider where intervention may be prompted by high values e.g. at locations where high numbers of crashes have recently been experienced). Conversely, may also refer to the tendency for higher values to follow relatively low values.
Regulations	Official statements, which may sometimes be legally binding, that can be issued without the need for new legislation at national, regional and local level
Report	A term used in some studies/countries for a recorded traffic offence
Standard	An agreed, repeatable way of doing something. It is a published document that contains a technical specification or other precise criteria designed to be used consistently as a rule, guideline, or definition. They are voluntary, but may be referred to or made compulsory by other laws or regulations.
Warrant	a pre-defined level of conditions at which intervention is considered to be required

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1. Summary

1.1. Introduction

It is widely held that legislation and regulations, and other policies and standards that are imposed at a strategic level (typically across whole countries or regions), can play an important role in preventing injuries, including unintentional injuries to children. It is also clear that some level of enforcement, encouragement and/or awareness of those laws, regulations or standards is usually necessary for them to have their intended impact.

This review aims to identify and summarise research and other evidence relating to the effectiveness of those laws, regulations and standards - and alternative methods of enforcing or encouraging compliance with them – which either primarily aim to prevent unintentional injuries on the road; especially in situations where children and young people (aged under 15 years) are likely to comprise most or some of the potential beneficiaries.

1.2. Aim

To locate, review and synthesise studies of the performance of strategic policies and regulatory or legal frameworks for guiding or promoting the planning or implementation of measures relating to the design and modification of highways, roads and streets in order to reduce speeds, promote safer driving, separate flows of different types of road user, or promote safer behaviours amongst other road users

The review questions were:

1. In what ways can legislation, regulation and/or standards (either with or without specific activities or factors which may enforce them or encourage compliance with them), improve the planning, implementation or operation/effectiveness of:

    a. Traffic calming and related road/street design modifications to reduce speeds and encourage safer driving (e.g. 20mph zones, home zones, signing related to speed limits etc.)

    b. Cycle routes or networks and pedestrian routes or networks

c. Safe Routes to Schools initiatives

2. Are mass media campaigns effective as a tool for encouraging compliance with such legislation, regulation and/or standards?

3. Which other activities or circumstances are associated with greater compliance with legislation, regulations and/or standards (relating to injury prevention or child safety)

1.3. Methods

Identification of evidence

Included studies will have focussed on:

- Strategic policies and regulatory or legal frameworks, (and/or activities to promote or ensure their enforcement); activities to increase compliance and awareness of these initiatives, such as mass-media campaigns (when this wholly or partly aims to encourage awareness of and compliance with the above).
    - Where such legislation, regulation (etc.) is intended to influence or potentially influences the planning and implementation of the specified road and street modifications.

Using the following study designs:

- Any comparative study designs (i.e. randomised and non-randomised controlled trials, before and after studies, case control studies, ecological studies, cross-sectional studies, prospective and retrospective cohort studies) where there are comparisons of groups of people or places or activities both with and without the specified legislation, regulation etc.

Outcome measures:

- Measures of compliance (with legislation, regulation, standards) relevant to the aim of the policy/regulatory change.
- Rates of unintentional injuries, severity of unintentional injuries, or number of care episodes (e.g. hospitalisations) relating to unintentional injuries.

- Rates of relevant safety behaviours (e.g. number of children crossing at a safe place; number of motorists adhering to speed limits,, proportions of children travelling to school by different modes) or incidents (e.g. traffic collisions, vehicle collisions with pedestrians), or other relevant 'intermediate outcomes'.
- Stakeholder reported importance/role of the *strategic policies and regulatory or legal frameworks* in affecting the **planning and implementation** of the specified types of intervention
- Stakeholder reported importance/role of the *strategic policies and regulatory or legal frameworks* in improving the **operation and/or use** of the specified types of intervention

Search and synthesis methods

Search methods used for identifying studies comprised: bibliographic database searching, tagged references from two parallel CPHE reviews on related topics ("Systematic reviews of effectiveness and cost-effectiveness of road and street design-based interventions aimed at reducing unintentional injuries in children", and, "An overview and synthesis of international comparative analyses and surveys of injury prevention policies, legislation and other activities"), named websites searches and reference checking.

Studies (titles and abstracts) were selected against the inclusion/exclusion criteria by one reviewer. Data extraction and quality assessment was conducted by the same reviewer. Data synthesis was mainly via data extraction to Evidence Tables (Appendix 4 – IN DOCUMENT BOUND SEPARATELY) and summary tables within the relevant section of this report (using formats recommended by NICE CPHE).

Some information and insights from other relevant reports is also presented, but clearly marked as not part of the main, formal review of quantitative research evidence.

1.4. Findings

Our systematic searches of bibliographic databases and other electronic sources yielded over 4,000 hits at either abstract and title level or with titles only (e.g. from the TRIS database). Examining these titles/titles and abstracts led to 137 requests for full text papers or reports which appeared likely to meet the review's inclusion criteria, or for which it was not possible to exclude.

Of the 137 full paper requests, 15 were found to be unobtainable from the British Library or locally, and 7 were still on order from inter-library sources at the time of the final report (as at 2nd June 2009). Of the 115 papers/reports which have been obtained in full-text, 18 were found to be empirical comparative evaluations of strategies included in this review. The 18 papers/reports comprise:

13 studies evaluating **other (non-device-specific) methods of speed enforcement**

2 studies evaluating the impact of **speed-related mass media campaigns** in conjunction with traffic law enforcement

3 studies evaluating the use of **quantified road safety targets** within policies

Also, through screening abstracts and titles it became apparent that there were a number of recent systematic reviews of speed detection/enforcement devices, including a Cochrane review from 2006 (Wilson et al. 2006). Rather than overstretching our resources to review largely the same sizeable collection of studies (26 in the Cochrane review), with the prior agreement of NICE we conducted a review of three recent (2005, 2006, 2008) systematic reviews of speed enforcement devices/programs (Pilkington & Kinra 2005;Thomas et al. 2008;Wilson, Willis, Hendrikz, & Bellamy 2006).

We found **no quantitative comparative evaluations** relating to:

other legislation, regulations and standards, or their enforcement;

the planning and implementation of cycle or walking paths or networks

the planning and implementation of Safe Routes To Schools programmes

other frameworks for strategic (e.g. national) policy intending to improve road safety or prevent injuries to children in the road environment.

1.5. Evidence Statements

Evidence Statement 1. Impact on road safety of speed enforcement devices

There is moderate evidence from 3 recent systematic reviews that speed enforcement devices (cameras, lasers or radar) will often reduce road injuries, and serious/fatal injury crashes/collisions in the vicinity of the devices (Pilkington & Kinra 2005[+];Thomas, Srinivasan, Decina, & Staplin 2008[+];Wilson, Willis, Hendrikz, & Bellamy 2006[++]). The Pilkington and Kinra 2005 review also concluded that similar size of speed reduction effects were observed over wider geographical areas around the enforcement device sites. The size of the observed reductions in different studies, and in different localities within studies, varies considerably. Similarly, in those studies where enforcement devices were temporarily placed at certain locations, the duration of speed reductions after removal of the devices (the 'time halo') varied from 1 day to 8 weeks (Wilson et al, 2006[++]). However, none of the systematic reviews were able to identify factors which were consistently associated with higher injury or crash reductions (such as automated vs non-automated detection, mobile vs fixed, covert vs overt, urban vs motorway, or on roads with different speed limits). Nor did included studies consistently state what the penalties or fines would be for detected speeding, although the Cochrane review implied there was a relationship between size of pre-/post- reduction in speeding vehicles and the speed threshold set (Wilson et al, 2006[++]).

This evidence is judged as directly applicable to the UK. This is because some of the studies were from the UK, and the results from these studies were generally consistent – in direction of effect, if not always size of effect – with the studies from other developed countries in the reviews. However, where reported (e.g. Wilson et al, 2006[++]), it seems that most evaluations of the effectiveness of speed enforcement devices have been conducted either in rural or semi-rural areas, or on roads with speed limits of 60kph or over. Therefore the relevance of this evidence for reducing road injuries in environments where children are likely to be pedestrians is probably limited.

Evidence Statement 2. Impact on road safety of intensified and/or rationalised police enforcement activities

There is weak evidence from 3 controlled before and after studies (in Australia, Israel and California) that increased or rationalised police enforcement of traffic speeds reduces injury crashes ([+]Newstead et al. 2001), car accidents ([+]Hakkert et al. 2001) and collisions, injury collisions, fatalities and speed-related fatalities ([-]Davis et al. 2006). There is also weak evidence from 3 multivariate analyses of longitudinal road accident/injury data (in New Zealand, California and Greece) that increased levels of police enforcement of traffic speeds reduces injury crashes and all injuries ([-]Povey et al. 2003), fatal accidents ([+]McCarthy 1999), and injury accidents ([+]Yannis et al. 2008). There is also moderate evidence from 1 controlled before and after study, on motorways in the Netherlands, that increasing the intensity of enforcement – from apprehending 1 in 100 speeding offenders, to 1 in 25, to 1 in 6 – produces statistically significant ($p<0.05$) reductions in mean speed (1kmh for 1:25 vs 1:100; and 3.5kmh for 1:6 vs 1:25) ([+]De Waard & Rooijers 1994).

This evidence is judged as partially applicable to road safety policy in the UK. This is because in the included studies there are a number of differences in the way police forces are organised and contribute to speed enforcement. Also, in the role of the police in enforcing speed limits through speed traps and mobile cameras/radar needs to be considered in the context of the widespread use of fixed site automated cameras around the UK road network.

Evidence Statement 3. Impact on road safety of convictions and reports for traffic offences

There is inconsistent evidence from 1 case cross-over study and 1 multivariate regression-based analyses of longitudinal data (from Canada, and Israel respectively), that higher rates of issuing traffic convictions reduces fatal road accidents ([+]Beenstock et al. 2001;[++]Redelmeier et al. 2003). The case cross-over study found a short-term effect on the future risk of fatal accidents, but the multivariate regression analysis found no effect on fatal road accidents. It should be noted that: the accident risk reduction effects of the conviction on the convicted driver appear to last less than 4 months ([++]Redelmeier, Tibshirani, & Evans 2003); that speeding convictions with penalty points were associated with a larger relative risk reduction than those without (51% vs 0%, p=0.011); that a 1% increase in convictions is estimated to cause accidents (fatal and non-fatal) to fall by only 0.00358% ([+]Beenstock, Gafni, & Goldin 2001); and that only large scale increases in enforcement have a measurable effect on road accidents ([+]Beenstock, Gafni, & Goldin 2001). Neither of these two studies separately reported any estimates of effectiveness in relation to non-fatal injuries or non-fatal road accidents. Apart from the different effectiveness result relating to receiving penalty points (Redelmeier et al 2003, above) neither of the studies reported any other impact of different possible punishments following conviction or apprehension (e.g. different levels of fines or points, or attendance at speed awareness courses); in fact, most studies about speed enforcement gave no details of the range of consequences of being caught speeding.

This evidence is judged as partially applicable to road safety policy in the UK. This is because in the UK the specific balance of fines and penalty points for speeding, and the more widespread network of fixed speed cameras may alter the responsiveness of British drivers to mobile police-administered speed enforcement. In addition, for various reasons, these 2 studies were only judged as partially [+] and poorly applicable [-] within their own country.

Evidence Statement 4. Impact on road safety of increasing financial penalties for speeding

There is inconsistent evidence from 1 regression-based analyses of longitudinal vehicle speed data (from Norway), and 1 uncontrolled before and after study (from Pennsylvania USA), that increasing fines for speeding offences reduces speeding ([+]Babusci et al. 2006;[+]Elvik & Christensen 2007). In the Norwegian study of over 60 speed-monitored road sections around the country, gradual but substantial increases in fines over a 9-year period produced either no increase, or both increases and decreases in the percentage of drivers complying with the speed limits (at the two types of sites, and with alternative regression models)([+]Elvik & Christensen 2007). However, in the USA study, the combination of introducing a doubling of fines and improved signing about the 'double fine zone' on 5 designated Highway Safety Corridors achieved statistically significantly lower percentages of drivers exceeding the speed limit (-2% to -15%) and lower percentages exceeding the speed limit by more than 10mph (-1% to -21%), at 1 month and 6 months after the introduction of double fines and new signing.

This evidence is judged as partially applicable to road safety policy in the UK. This is because in the UK the existing balance and perceived cost of fines and impact of penalty points for speeding, together with the perceived risks of apprehension, may be quite different to those in Norway in the 1990s and the USA. In addition, for various reasons, these 2 studies were only judged as partially applicable within their own countries.

Evidence Statement 5. Impact of driver licence penalty points systems

There is weak evidence from 1 small uncontrolled before and after study (in Ireland), that introducing a driver licence Penalty Points System reduces the number of hospital-treated road traffic trauma cases ([-]Donnelly et al. 2005). Although the number of Road Traffic Accident injuries in the 6-month period after the introduction of the Penalty Points System (70) was nearly half that in two 6-month periods before its introduction (124, 125), this could be due to a range of other background changes in traffic safety or hospital admissions (and the statistical significance of the changes is not assessed). There is suggestive evidence of an even greater relative reduction in serious head injuries (from 29 and 34, down to 18) and thoracic injuries (from 29 and 26, down to 13)

This evidence is judged as not applicable to national road safety policy in the UK since a driver licence penalty point system already exists here. Also, because most of the data came from only one hospital in one region of Ireland, the study was judged as only partially applicable to the rest of Irelend.

Evidence Statement 6. Impact of methods for communicating traffic infringements

There is moderate evidence from 1 RCT with survival analysis and 1 controlled before, during and after study of longitudinal data (in Oregon USA, and The Netherlands), that the use of appropriately worded letters to communicate traffic offences (or high accident records) can affect subsequent speeds or accident rates ([+]De Waard & Rooijers 1994;[++]Jones & Jones 1997). In the study in Oregon ([++]Jones & Jones 1997), amongst a large sample of speeding offenders and those with a recent poor accident record, on average those randomly assigned to receive the standard letter (including a list of recent accidents and violations, and clearer threat of further sanctions) had fewer subsequent accidents over the next 2 years than those who received the 'soft sell' letter; however, there were age and gender differences in responsiveness to each letter type, with women and those older than 44 more likely to have relatively fewer accidents following the soft sell letter). In the study on motorways in The Netherlands ([+]De Waard & Rooijers 1994), the road section where people received a mailed fine preceded by a feedback letter reduced mean speeds by 3.1kmh, and without the letter by 2.0kph (but the statistical significance of the difference between the two reductions was not reported).

This evidence is judged as partially applicable to road safety policy in the UK. This is because in the UK the existing balance and perceived financial cost of fines and penalty points and social stigma for speeding offences may be quite different to those in the USA or in the Netherlands. In addition, for various reasons, these 2 studies were only judged as partially applicable within their own country.

Evidence Statement 7. Impact of media campaigns alongside speed enforcement

There is inconsistent evidence from 2 regression-based analyses of longitudinal data (from Australia, and New Zealand), that having media campaigns alongside speed enforcement helps reduce casualty crashes or crash severity (Cameron et al. 2003[+]) or reduce fatalities or fatal crashes (Guria & Leung 2004[+]).

This evidence is judged as partially applicable to national road safety policy in the UK. This is because in the UK and its constituent countries there may be different responsiveness to new road safety media campaigns in the light of the effectiveness of past media campaigns. Also, the UK has a denser road network with higher traffic volumes, and there is a probably a different

background level of automated and other speed enforcement activity which may alter the potential gains of media campaigns.

Evidence Statement 8. Impact of having quantified national road safety targets

There is inconsistent evidence from 3 international before and after studies, that having national quantified road safety targets helps reduce road injuries (Elvik 2001[+];Elvik 1993[+];Wong et al. 2006[+]).

This evidence is judged as partially applicable to national road safety policy in the UK. This is because in the UK and its constituent countries there are already a number of national road safety targets, so to add more (or prematurely change those already set) may have less of an impact than in countries where (a) no or very few quantified road safety targets exist and (b) there is more progress to be made in achieving the road injury rates of those countries with the best road safety performance.

2. Introduction

It is widely held that legislation and regulations, and other policies and standards that are imposed at a strategic level (typically across whole countries or regions), can play an important role in preventing injuries, including unintentional injuries to children (Åberg 1998;CEREPRI and APOLLO WP3 partners 2007;Schieber et al. 2000;Sethi et al. 2008;Waller 2002). It is also clear that some level of enforcement, encouragement and/or awareness of those laws, regulations or standards is usually necessary for them to have their intended impact.

2.1. Legislation, regulations and standards

2.1.1. Legislation

Legislation is widely recognised as an important part of a comprehensive and coordinated multi-sectoral approach to injury prevention:

> Mounting a response to injuries requires more than one sector, and the lack of ownership and leadership of the task has led to fragmented activity and a lack of coordination. A wealth of evidence indicates that the way forward is to use a combination of approaches: environmental modification, engineering of safer products, legislation to require these changes and education to stress the importance of using safety equipment.
>
> Foreword (p.XI) to the *European Report on Child Injury Prevention*, WHO Europe, 2008 (Sethi et al, 2008).

In the field of road injury prevention there are a number of well-known successes, where legislation has undoubtedly played a key role in encouraging important safety behaviours in many developed countries. These include: speed limits, drink-driving, seat belts and child restraints (car seats) and booster seats.

Legislation, however, is not a one-off process, and continuous efforts to improve the effectiveness of legislation, and adapt to new risks are evident in many developed countries (e.g. the use of mobile phones while driving). As an example, Box 1 below summarises the law making activity of State legislatures during 2007 in relation to improving road safety in the USA.

Box 1. Selected law making activity in US States to improve road safety in 2007

Speed Limits. Legislators in 25 states debated bills regarding speed in 2007, and 10 states passed laws. Many of these bills related to work zone and school zone safety, including provisions regarding excessive speed in these areas. Other bills aimed to increase fines and penalties for those convicted of speeding.

Automated Enforcement. In 2007, 27 states considered nearly 90 bills related to the use of cameras to enforce traffic laws such as speeding and red light running. Most states with such programs have passed enabling legislation.

School Bus Safety. Both the federal government and states have looked at ways to ensure the continued high level of safety of travel by School Bus. In 2007, 97 bills were introduced regarding school bus safety. Some proposals would have required installation of seat belts on school buses, while others would have prohibited school bus drivers from using mobile phones while operating the school bus.

Pedestrian and Bicycle Safety. In 2007, 27 state legislatures debated nearly 85 bills regarding pedestrian and bicycle safety. Many of the bills would have increased fines and penalties for motorists who do not obey current pedestrian safety laws. Other bills up for debate dealt with whether motorized scooters should be allowed on pedestrian walkways and bike paths.

NB. Many other bills debated and laws passed related to: vehicle occupant protection, impaired driving, distracted driving, driver's licensing, aggressive driving, and motorcycle safety.

Source: Traffic Safety and Public Health: State Legislative Action 2007 (Savage et al. 2007).

3. Aims & Methods

3.1. Objectives and rationale

To locate, review and synthesise studies of the performance of *strategic policies and regulatory or legal frameworks** for guiding or promoting the planning or implementation of measures relating to the design and modification of highways, roads and streets** in order to reduce speeds, promote safer driving, separate flows of different types of road user, or promote safer behaviours amongst other road users

**'Strategic policies and regulatory or legal frameworks', will include:*

- Legislation (primary and secondary), regulation, standards and their enforcement
- Mass-media campaigns and initiatives (when this wholly or partly aims to encourage awareness of and compliance with the above)

**The types of measures of interest are:

• traffic calming

• 20 mph zones

• home zones

• international examples such as 'woonerven' in the Netherlands: streets or a group of streets that have been redesigned to slow traffic and promote non-motorised traffic

• 'naked streets' where road markings, lines, traffic lights, signs and kerbs and so on are removed to create uncertainty in road users and force them to slow down, and other psychological traffic calming designs

• 'quiet lanes' and other rural examples of traffic calming schemes

• signing related to speed limits

• walking and cycling networks

• 'Safe Routes to Schools' initiatives

3.2. Review questions

2. In what ways can legislation, regulation and/or standards (either with or without specific activities or factors which may enforce them or encourage compliance with them), improve the planning, implementation or operation/effectiveness of:

    a. Traffic calming and related road/street design modifications to reduce speeds and encourage safer driving (e.g. 20mph zones, home zones, signing related to speed limits etc.)

    b. Cycle routes or networks and pedestrian routes or networks

    c. Safe Routes to Schools initiatives

4. Are mass media campaigns effective as a tool for encouraging compliance with such legislation, regulation and/or standards?

5. Which other activities or circumstances are associated with greater compliance with legislation, regulations and/or standards (relating to injury prevention or child safety)

3.3. Identification of evidence

Relevant strategies

Included studies will have focussed on:

- Strategic policies and regulatory or legal frameworks, (and/or activities to promote or ensure their enforcement); activities to increase compliance and awareness of these initiatives, such as mass-media campaigns *;

    * when this wholly or partly aims to encourage awareness of and compliance with the above.

- Where such legislation, regulation (etc.) is intended to influence or potentially influences the planning and implementation of the specified road and street modifications.

Relevant research

Study designs:

- Any comparative study designs (i.e. randomised and non-randomised controlled trials, before and after studies, case control studies, ecological studies, cross-sectional studies, prospective and retrospective cohort studies) where there are comparisons of groups of people or places or activities both with and without the specified legislation, regulation etc.

Outcome measures:

- Measures of compliance (with legislation, regulation, standards) relevant to the aim of the policy/regulatory change.
- Rates of unintentional injuries, severity of unintentional injuries, or number of care episodes (e.g. hospitalisations) relating to unintentional injuries.
- Rates of relevant safety behaviours (e.g. number of children crossing at a safe place; number of motorists adhering to speed limits,, proportions of children travelling to school by different modes) or incidents (e.g. traffic collisions, vehicle collisions with pedestrians), or other relevant 'intermediate outcomes'.
- Stakeholder reported importance/role of the *strategic policies and regulatory or legal frameworks* in affecting the **planning and implementation** of the specified types of intervention
- Stakeholder reported importance/role of the *strategic policies and regulatory or legal frameworks* in improving the **operation and/or use** of the specified types of intervention

In addition to those studies which provide quantitative evidence of the impact of regulatory frameworks and strategic policies etc., we also identified and briefly summarise other non-evaluative papers or reports where they seemed highly relevant to the overall topic of this review. These papers and reports (reported in the findings as 'Other relevant studies') were identified via the same process of screening titles and abstracts as the included studies.

To clearly distinguish their different process of identification and inclusion, such critical review or discussion papers are found in sections called 'Evidence from other relevant papers/reports'.

3.3.1. Search methods

Search methods used for identifying studies comprised: bibliographic database searching, tagged references from two parallel CPHE reviews on related topics ("Systematic reviews of effectiveness and cost-effectiveness of road and street design-based interventions aimed at reducing unintentional injuries in children", and, "An overview and synthesis of international comparative analyses and surveys of injury prevention policies, legislation and other activities"), named websites searches and reference checking. The first review mentioned above is of particular importance as the search strategy and methodology for that review incorporated street-design terms with accident terms which would have been the starting point of this review had it not already been completed. The search methodology also incorporated author suggestions, expert contacts, author citation, websites, and an extensive search of reference lists of reports and reviews. (See Appendix 2, p.82, for full search methodology.)

A pragmatic literature search was conducted in the following electronic bibliographic databases: Cochrane Injuries Group register via The Cochrane Library, Transport Research Information Service (TRIS), Medline, Social Science Citation Index, Health Management Information Consortium (HMIC). The following resources were also searched; Transport Research Laboratory, UK Department for Transport (DfT), Institute of Highway Incorporated Engineers, and Royal Town Planning Institute. (See Appendix 3, p.89.)

3.3.2. Inclusion of relevant evidence

3.3.2.1. Inclusion criteria

Study design

Any comparative study designs (i.e. randomised and non-randomised controlled trials, before and after studies, case control studies, ecological studies, cross-sectional studies, prospective and retrospective cohort studies) where there are comparisons groups of people or places or activities both with and without the specified legislation, regulation etc.

Study focus

Focus on strategic policies and regulatory or legal frameworks, (and/or activities to promote or ensure their enforcement); activities to increase compliance and awareness of these initiatives,

such as mass-media campaigns (when this wholly or partly aims to encourage awareness of and compliance with the former), and,

Where such legislation, regulation (etc.) is intended to influence or potentially influences the planning and implementation of the specified road and street modifications.

Language and years

Published in the English language, from 1990 or after.

3.3.2.2. Exclusion criteria

Study focus

Studies were not included if they mainly related to:

- Driver behaviours other than speeding (e.g. drink-driving, wearing of seatbelts)
- the effectiveness of speed limits (i.e. locally specific traffic laws) in controlling the speed of motorised traffic.
- Strategies where adults are the dominant and/or intended beneficiaries or in settings where children are unlikely to be present in the road/street environment (other than as passengers in vehicles, e.g. roadwork zones)

3.3.3. Study selection

Study selection was conducted by one reviewer (RA) reading the titles and abstracts of the 3,123 hits generated by the iterative bibliographic searches (see search strategy), the 1,284 hits (titles, no abstracts) generated from the TRIS database, plus 41 possible includes for this review which were tagged by the lead reviewer (KA) of the related review of effectiveness studies (for NICE Public Health Intervention Guidance).

Examining these titles/titles and abstracts led to 137 requests for full text papers or reports which appeared likely to meet the review's inclusion criteria, or which it was not possible to exclude.

Of the 137 full paper requests, 15 were found to be unobtainable from the British Library or locally, and 7 were still on order from inter-library sources at the time of the final report (as at 02 June 2009). Of the 105 papers/reports which have been obtained in full-text, 18 were found to be empirical comparative evaluations of strategies included in this review. The 18 papers/reports comprise:

13 studies evaluating **non-automated methods of speed enforcement**

2 studies evaluating the impact of **speed-related mass media campaigns** in conjunction with traffic law enforcement

3 studies evaluating the use of **quantified road safety targets** within policies

Also, through screening it became apparent that there were a number of recent systematic reviews of speed detection/enforcement devices, including a Cochrane review from 2006 (Wilson, Willis, Hendrikz, & Bellamy 2006). Rather than overstretching our resources to review largely the same sizeable collection of studies (26 in the Cochrane review), with the prior agreement of NICE we conducted a review of three recent (2005, 2006, 2008) systematic reviews of speed enforcement devices/programs (Pilkington & Kinra 2005;Thomas, Srinivasan, Decina, & Staplin 2008;Wilson, Willis, Hendrikz, & Bellamy 2006).

We found **no quantitative comparative evaluations** relating to:

other legislation, regulations and standards, or their enforcement;

the planning and implementation of cycle or walking paths or networks

the planning and implementation of Safe Routes To Schools programmes

other frameworks for strategic (e.g. national) policy intending to improve road safety or prevent injuries to children in the road environment.

3.4. Methods of analysis and synthesis

3.4.1. Data extraction

Key data about methodology and results will be extracted for each included study into an evidence table, modeled on those found in the NICE CPHE methods guidance and adapted where appropriate to the identified study designs.

3.4.2. Methods of quality appraisal

Included quantitative comparative studies were quality-assessed using a structured format appropriate for the study design. These were based on those presented in the CPHE Methods Guidance 2009 documentation (Appendix G).

Quality assessment and data extraction were undertaken by a single reviewer. There was insufficient time or reviewer resources available to conduct the originally planned checking of a sample of studies.

3.4.3. Analysing and synthesising the findings

For the included quantitative comparative studies, no formal quantitative pooling of effectiveness results was possible or desirable (especially given the wide range of non-automated enforcement and other strategies in our review).

Synthesis was therefore narrative, by comparing and contrasting the findings of different studies, and trying to relate any consistencies or differences in findings between studies to key differences in intervention, implementation context and/or study methods.

For each review question or type of strategic policy the main findings are then summarised in an Evidence Statement, together with information on the quality and applicability of the relevant studies. In Evidence Statements, the *strength of the evidence* of one or more included quantitative comparative studies was summarised using the terminology specified in the NICE guidance on methods for the development of public health guidance (2nd edition, 2009); that is: either 'no evidence', 'weak evidence', 'moderate evidence', 'strong evidence', or 'inconsistent evidence'. This classification was based on the reviewer's overall judgement taking into

account the number of studies supporting the evidence statement, the average quality of those studies, and the consistency of their results.

For the **other relevant studies** not included in the main review, but judged nevertheless to be of probable interest to the PDG and of relevance to the scope of the NICE Guidance, a different approach was taken which does not involve synthesis. Instead, with the agreement of NICE CPHE, the key points of each such report or paper are summarised in a paragraph or two (much like an 'annotated bibliography'). Presenting this information aims to give an indication of the kinds of examples and arguments that have been made in the transport/road safety and injury prevention literature on a particular strategic policy issue. They are intended to be illustrative (either in the absence of empirical comparative evaluations, or to provide additional context to them) rather than exhaustive or comprehensive. Such studies are described in the main results sections, but their different status is clearly indicated by being in sections titled '*Evidence from other relevant papers/reports*'.

4. Findings: Legislation and regulations

4.1. Laws, regulations and speeding

This review has not specifically examined the effectiveness of speed limits (i.e. locally specific traffic laws) in controlling the speed of motorised traffic. (NB. The ongoing review for PHIAC, to inform NICE Public Health Intervention Guidance on preventing unintentional injuries to children on the road is reviewing the effectiveness of 20mph zones, and traffic calming measures which may include a reduction of the speed limit).

However, in the report Section 6, on *Enforcement*, we have reviewed:

- the **effectiveness of speed enforcement devices** for preventing road traffic injuries (through a review of recent systematic reviews), and
- the **effectiveness of various non-device-specific means of enforcing speed limits**.

4.2. Laws, regulations and the planning and implementation of traffic calming

4.2.1. Comparative evaluation studies of laws and regulations relating to the planning and implementation of traffic calming

We found no quantitative comparative evaluation studies which have directly evaluated the impact of changes in legislation or regulations on the planning and implementation of traffic calming.

4.2.2. Evidence from other relevant papers/reports

This is not to say that there is no evidence that legislation can, and very often does, play an important part in promoting the more effective and efficient planning and implementation of traffic calming and other road safety measures which may benefit children. Examples include:

- Legislation in Scotland making it easier for local authorities to introduce mandatory and enforceable 20mph zones (Burns et al. 2001)

- National legislation in Denmark forcing the introduction of 30kph speed limits and road layout changes in many residential streets (Engel & Thomsen 1992).
- In the USA, there are examples of State legislation to develop and implement programs to improve safety in school zones (e.g. the 1996 School Zone Safety Act, of Washington State) (Saibel et al. 1998)
- Legislation which permits the doubling of fines or other alterations to penalty systems for driving offences (Babusci, Ticatch, Bickar, & Schneeberger 2006)
- Legislation promoting the designation of Highway Safety Corridors in US states (Fontaine & Read 2006); once-designated leading to a range of changes in law enforcement, the education of road users and engineering of highways.

In England, a fairly recent report on Traffic Calming from the Department for Transport clearly shows how the planning and implementation of traffic calming has been both enabled and controlled by various pieces of legislation (Department for Transport 2007b). Table 1, below, shows some of the legislation relating to traffic calming together with some of the main intended effects.

Table 1. Legislation and regulations relating to traffic calming in England (circa 2007)

Legislation or regulation	Intended effect
Highways Act 1980 Sections 90A to 90F	Road humps can only be constructed on roads with speed limits of 30 mph or less Requirements to advertise, and to consult the police Provides assurance that road humps constructed in accordance with the regulations (or specially authorised, or constructed prior to adoption of the highway) are not treated as obstructions
Road Hump Regulations (revised) 1986 & 1996	Allowed humps between 75 and 100 mm high (previously had to be round-top humps 100 mm high and 3.7 metres long) allowed local authorities to choose the most appropriate hump profile
Highways (Road Humps) Regulations, 1999 (Statutory Instrument 1999 No. 1025)	Allows local authorities to install humps (including speed cushions) on roads with a speed limit of 30mph or less, without the need for special authorisation, provided the humps are between 25mm and 100mm high, at least 900mm long in the direction of travel, and have no vertical face greater than 6mm. Removed certain provisions for road humps within 20 mph zones Made local highway authorities responsible for the design and placement of road humps
The Traffic Signs Regulations and General Directions 2002 (TSRGD)	Stipulates required road markings for road humps, speed cushions and thermoplastic humps
The Traffic Calming Act 1992	Allows works to be carried out 'for the purposes of promoting safety and preserving or improving the environment'
The Highways (Traffic Calming) Regulations 1993 and 1999	Clarified the powers available to local highway authorities to construct particular measures for traffic calming purposes (gateways, pinch points, islands, overrun areas, rumble devices, build-outs and chicanes). In 20 mph zones, warning signs for these traffic calming features may be omitted
The Transport Act 2000	Allows local traffic authorities to designate Home Zones and Quiet Lanes. Designation requirements are set out in the Quiet Lanes and Home Zones (England) Regulations 2006

Source: Section 2.1 of: *Traffic Calming*, Local Transport Note 1/07 (Department for Transport 2007b).

4.3. Laws, regulations and the planning and implementation of cycle or walking paths and networks

4.3.1. Comparative evaluation studies of cycle or walking paths/networks

We found no quantitative comparative evaluation studies which have examined the impact of changes in legislation on the planning and implementation of cycle paths/networks, or walking paths/networks.

4.3.2. Evidence from other relevant studies

This is not to say that there is no evidence that legislation or other official guidance can, and very often does, play an important part in promoting the more effective and efficient planning and implementation of cycle paths and networks.

Although not mandatory, the Institution of Highways and Transportation publication *Guidelines for Planning and Design of Cycle-Friendly Infrastructure* includes detailed advice on good road design for cyclists (Institution of Highways and Transportation 1996). There are also other publications and pieces of guidance in different countries which provide design standards for cycling infrastructure (either in the presence of traffic calming measures or not) (e.g. the DfT's Traffic Advisory Leaflet 01/97 *Cyclists at Road Narrowings*).

4.4. Laws, regulations and the behaviours of pedestrians and cyclists

4.4.1. Comparative evaluation studies of laws relating to the behaviour of pedestrians or cyclists

We found no quantitative comparative evaluation studies which have examined the impact of changes in legislation on the behaviours of pedestrians or cyclists.

4.4.2. Evidence from other relevant studies

J. Pucher and L. Dijkstra. Making walking and cycling safer: Lessons from Europe. *Transportation Quarterly* 54 (3):25-50, 2000.

J. Pucher and R. Buelher. At the Frontiers of Cycling: Policy innovations in the Netherlands, Denmark and Germany. *World Transport Policy & Practice* 13 (3):8-56, 2007.

A number of reviews of strategies for making walking and cycling safer suggest that legislation can play an important part in promoting safer walking and cycling (Pucher & Buelher 2007;Pucher & Dijkstra 2000). There are a number of examples of legislation which aim to alter the perceived risks of fast or careless driving, where pedestrians or cyclists may be present. In Germany and the Netherlands, for example (Pucher & Dijkstra 2000):

- The motorist is invariably found by the police or the courts to be partly at fault, even where pedestrians or cyclists have made illegal moves; and they are more often found to be entirely at fault where the accident victims are children or the elderly.
- In collisions between pedestrians or cyclists and motorised vehicles, the insurance company for the motorised vehicle automatically pays damages, regardless of guilt (in Belgium and the Netherlands)
- Far stricter ticketing and fines for pedestrians and cyclists who violate traffic regulations (e.g. in Germany, pedestrians crossing the road on red can easily receive a ticket and a fine; also, cyclists running red lights or riding at night without functioning lights can also attract similar penalties)

4.5. Laws, regulations and the planning and implementation of Safe Routes to Schools Programmes

4.5.1. Comparative evaluation studies of laws relating to Safe Routes to Schools programmes

We found no quantitative comparative evaluation studies which have examined the impact of changes in legislation on the planning and implementation of Safe Routes to School Programmes.

4.5.2. Evidence from other relevant papers/reports

However, this is not to say that there is no evidence that legislation can, and probably does, play an important part in promoting the more effective and efficient planning and implementation of Safe Routes to Schools Programmes. In the USA in particular, the federal legislation which underpins the federal Safe Routes to Schools (SRTS) Programme had (from 2005 to 2008) committed over $75 million to state-level implementation agencies, covering about 2,700 participating schools, (Government Accountability Office 2008). Examples include:

- The establishment of the **USA's Safe Routes to Schools Programs** was mandated by Congress, by the 2005 SAFETEA-LU federal legislation (*Safe, Accountable, Flexible, Efficient Transport Equity Act: A Legacy for Users*) (Government Accountability Office 2008). The Federal Highways Administration (FHWA) is responsible for administering the $612 million over 5 years to state Departments of Transport to implement state SRTS programmes, and for infrastructure and non-infrastructure projects benefiting school children in kindergarten through to eighth grade. More specifically, the legislation required:
    - Each participating state to hire a full-time SRTS coordinator
    - The FHWA to establish a national SRTS 'clearinghouse' to develop and disseminate information and provide technical assistance to participating states and programs (this became the National Center for Safe Routes to School)
    - The FHWA to establish a national SRTS task force to study and develop a strategy for advancing SRTS nationwide (this became the National Safe Routes to School Task Force)
- **School Travel Plans** in England provide the overarching policy framework for **Safe Routes to Schools** schemes in the UK (Cairns S 2009).

5. Findings: Standards

According to the British Standards Institute, a standard is:

> "an agreed, repeatable way of doing something. It is a published document that contains a technical specification or other precise criteria designed to be used consistently as a rule, guideline, or definition."
>
> "Standards are designed for voluntary use and do not impose any regulations. However, laws and regulations may refer to certain standards and make compliance with them compulsory."
>
> Source: BSI website (www.bsi-global.com) About Standards: What is a Standard?

Standards can therefore relate to a variety of activities and infrastructure in the road environment.

5.1.1. Comparative evaluation studies of standards relating to road/street planning and design

We found no comparative empirical evaluation studies which have directly evaluated the impact of standards on road safety or injury outcomes.

5.1.2. Evidence from other relevant papers/reports

This is not to say that there is no evidence that standards can, and very often do, play an important part in promoting the safer design of roads or the more effective and efficient planning and implementation of traffic calming and other road safety measures which may benefit children. Examples are described in the following sections.

Road design standards and safety

D. O'Cinneide. THE RELATIONSHIP BETWEEN GEOMETRIC DESIGN STANDARDS AND SAFETY. in: International Symposium on Highway Geometric Design Practices. Anonymous. Anonymous. Transportation Research Board. 1998.

Key points: Road design standards specify things like the minimum width and curvature/alignment of roads of different purpose/type, the ideal or minumum geometric properties of road intersections, or the quality of the materials used to construct the road carriageway. A 1998 conference paper by O'Cinneide provides a comprehensive overview of

what was known about the relationship between geometric road design standards and safety outcomes (O'Cinneide 1998). They concluded that (p.44-5):

> "The relationship between geometric design factors and accident rates is complex and not fully understood … although it has been clearly shown that very restrictive geometric elements such as very short sight distance or sharp horizontal curvature result in considerably higher accident rates and that unusually severe combinations of elements cause an unusually severe accident problem."

Furthermore, there are difficulties in studying the relationship because of,

> "differences in definitions and parameters used, types of accidents included, the omission of traffic volume, speed and composition information, presence of cyclists or roadside development, lack of statistical control etc. Also comparisons between studies carried out in different countries must be treated with caution because of differences in driver behaviour, enforcement practices and the actual road environment"

Despite these difficulties, other reports claim "that improvements in the engineering of roads has been one of the main factors behind the reduction in casualties on the roads of EU countries in recent years" and the same report, of an eight-country study in the EU (SWOV and SAFESTAR partners 2002), asserts that:

> "Standards play a vital role in road design. Not all countries have a full range of design standards applied to their road networks and this situation contributes to the size of the road safety problem on the continent as a whole"

We also found another (non-systematic) review on the subject of road design standards and safety, which is summarised in the following section.

National road design standards

F. C. M. Wegman and M. Slop. SAFETY EFFECTS OF ROAD DESIGN STANDARDS IN EUROPE. in: International Symposium on Highway Geometric Design Practices. Transportation Research Board. 1998.

Although we found no within country studies, a review by Wegman included a comparison of some of the national standards for different road design elements (Wegman & Slop 1998). For example in relation to the safe design of bends in the road, for a road with a *design speed* of 100kph, the minimum horizontal curve radius in the 18 countries which had a standard for this ranged from 650m (in Finland) down to 350m (in Greece); in fact across the 18 countries with a

standard, there were 11 different standards for this minimum radius. Similarly, for roads with a design speed of 60kph, there were six different standards for minimum horizontal curve radius across the 15 countries which had a standard. However, such comparisons do not convey that some country's standards take into account the actual speeds on roads, as well as design speed, and also consider the succession of different elements leading up to a particular curve or bend.

Department for Transport. Manual for Streets. London:Department for Transport. 2007.

The 'Manual for Streets' is an officially endorsed manifesto for creating residential streets which, as well as necessarily being routes for vehicles, are also pleasant and safe spaces for people to move around in (Department for Transport 2007a).

International road design standards

F. C. M. Wegman and M. Slop. SAFETY EFFECTS OF ROAD DESIGN STANDARDS IN EUROPE. in: International Symposium on Highway Geometric Design Practices. Transportation Research Board. 1998.

The same paper discussed above (Wegman & Slop 1998), also provided a chronological summary of the few international agreements for road design and traffic operations which have been created in Europe. A major one was the European Agreement on Main International Traffic Arteries (AGR) in 1975, which included a classification of international roads and included annexes on geometric characteristics (of horizontal and vertical alignment, cross-sections, intersections and 'equipment, environment, landscaping and maintenance). Following the Maastricht Treaty in 1993 another agreement, amongst all EU members, was the creation of the Trans-European Road Network (TERN) which includes(ed) a rolling programme of work on road classification.

However, the paper does not report on the extent to which these initiatives have fostered more consistent road safety design standards across Europe nor, for example, their adoption by newer EU member states.

Standards ('warrants') for determining locations for automated speed enforcement

A. O'Brien, R. Brindle, and R. Fairlie. Some Australian Experiences with Warrants. in: Transportation and Sustainable Communities for the Transportation Professional. 1997 ITE International Conference. Anonymous. Anonymous. 65-76, 1997.

The use of **'warrants' for choosing where and when to implement traffic calming measures**. A warrant is a pre-defined level of conditions at which intervention is considered to be required. A paper from Australia shows how warrants for neighbourhood traffic management tend to rely on reaching thresholds of: traffic speed; traffic volume; accident experience, and; levels of 'offensive' traffic (such as commercial vehicles or non-local traffic) (O'Brien et al. 1997). Attaching points to each of these indicators, and combining them with a formula, can then classify the 'level of need' of a given location for traffic calming or other speed reduction interventions. However, it is acknowledged that "the use of warrants as a sole basis of action can lead to severe local disharmony" (p.69), recognising the reality of other political and local community pressures on the implementation of local traffic management. On the basis of a survey of warrants-based systems used by councils throughout Australia, O'Brien concludes that the best warrant systems have:

- Political and community acceptance
- Technical merit
- Ease of application
- Transparency of operation

Despite advocating the use of warrants, the paper does not say how they should be based on evidence concerning the effectiveness (or cost-effectiveness) of the relevant traffic calming interventions, and how such effectiveness varies according to the criteria included in the warrants.

6. Findings: Enforcement

There are numerous specific strategies and interventions which aim to enforce legislation or regulations to prevent road traffic accidents and related injuries. A significant proportion of the research literature focuses on the impact of enforcing the laws relating to: seat belt use; in-car child seats and restraints; driving while under the influence of alcohol ('drink-driving'); driving while under the influence of drugs; minimum legal driving age; graduated driving licences (Blais & Dupont 2005). These types of legislation fell outside the scope of this review.

Instead, this review sought studies in which different methods or levels of law/regulation enforcement related to:

- Speed limits and speed reduction
- Laws or regulations relating to safer road or street design

Road traffic law enforcement studies in which speeding demonstrably, or probably, comprised a substantial proportion of the offences detected or activities targeted were included.

6.1. Review of recent systematic reviews of speed enforcement devices and road safety

Below we present a review of three recent systematic reviews of automated speed enforcement devices, including a Cochrane review which was published in 2006 (Pilkington & Kinra 2005;Thomas, Srinivasan, Decina, & Staplin 2008;Wilson, Willis, Hendrikz, & Bellamy 2006). None of the three systematic reviews found any studies in which speed enforcement devices were used specifically to reduce injuries in children, or on roads where children are more likely to be road users.

See **Error! Reference source not found.** (on p.**Error! Bookmark not defined.**) for a fuller description of each of these systematic reviews.

Table 2. Summary characteristics of recent systematic reviews of automated speed enforcement strategies

Author, & year	Subject of the review Search years	Study designs included	Outcomes summarised	No. of included studies, Synthesis approach
Wilson et al. 2006 (Cochrane Collaboration review)	Effectiveness of automated speed enforcement devices for preventing road traffic injuries Studies published up to 2004	• RCTs • Controlled before and after studies • Interrupted time series studies	• % of speeding drivers above speed limit (or designated speed threshold) • Average speeds* • Absolute or % pre/post change in speed* • Duration of speed reduction • Crashes • Deaths • Injuries * in areas with and without speed cameras/devices	26 studies (4 UK) (of which 13 reported injuries or injury crashes, and 7 reported fatalities or crashes resulting in fatalities) Narrative synthesis
Thomas et al. 2008	Effectiveness of automated speed enforcement programs Studies published up to September 2005	• Evaluations with "detailed descriptions of study methods and results" (apparently not restricted by study design)	• Crashes • Injury/casualty crashes • Serious/hospital injury crashes • Casualties • Fatal crashes	13 studies (4 UK) Narrative synthesis
Pilkington et al. 2005	Effectiveness of speed cameras in preventing road traffic collisions and related casualties Studies published up to February 2004	• Controlled trials, • Observational studies (incl. before and after studies	• Collisions • Deaths • Injuries	14 studies (4 UK) Narrative synthesis

Taken together these three reviews have identified five UK-based studies (Christie et al. 2003;Gains et al. 2003;Gains et al. 2004;Hess 2004;Mountain et al. 2004)

Table 3. Summarised injury reduction findings of the reviews of automated speed enforcement

Author, & year	Subgroups (No. of studies)	Reduction in injuries or injury crashes (No. of studies)	Reduction in fatalities or fatal crashes (No. of studies)
Wilson et al. 2006 (Cochrane Collaboration review)	All studies (26)	8% to 46% for injury crashes (7) Relative crash rates (relative to controls) ranged from 0.66 to 0.98 (7)	13% to 17% for fatal crashes (2), and no fatal crashes post-intervention in one study. Serious and fatality crashes combined: 26% to 58%
	Interrupted time series studies (2)	Reduction in crash victim numbers of 31 to 140 (1) Casualty reduction of 19% to 31% (1)	NR
Thomas et al. 2008	Fixed cameras (4)	20% to 25% injury crashes (3)	
		45.7% weighted injury crashes [within 250m of sites] to -20.9% [within 2km of sites] (1)	22.8% [p=0.0051] casualty crashes [= injury + fatal] (1) 89.8% [95% CI: 22.1 to 98.7] fatal crashes (1)
	Conspicuous mobile cameras (5)	21% to 51% injury crashes (2) 51% injury crashes on 30mph roads (1)	
	Inconspicuous mobile cameras (3)	20.9% [95% CI: 13.3% to 27.9%] daytime casualty crashes (1) Urban (Melbourne): 21.1% [95% CI: 12.4% to 28.9%] (1) Rural Victoria: 19.5% [95% CI: 10.7% to 27.5%] (1)	27.9% in crash severity ratio [= fatal crashes ÷ serious & minor crashes] (1)
	Comprehensive automated enforcement (UK local road safety partnerships	33% personal injury crashes (1)	40% killed and seriously injured crashes [NB. even higher at fixed camera sites in urban locations]
Pilkington et al. 2005		12% to 65% for injuries	17% to 71% for deaths

Box 2. Authors' injury outcome conclusions of the included systematic reviews

Wilson et al. 2006, (Cochrane Collaboration), as summarised in the abstract:

"All studies reporting crash outcomes reported an absolute pre/post reduction in all crashes and injury-related crashes. In the vicinity of camera sites these pre/post reductions ranged from 14% to 72% for all crashes, 8% to 46% for injury crashes, and 40% to 45% for crashes resulting in fatalities or serious injuries. Compared with controls, the relative improvement in pre/post crash numbers resulting in any type of injury ranged from 5% to 36%." … "the consistency of reported positive reductions in speed and crash outcomes across all studies suggests that speed enforcement devices are a promising intervention for reducing the number of road traffic injuries and deaths."

Thomas et al. 2008, pp.124-125:

"It appears highly likely that automated fixed speed enforcement programs will result in safety improvements in high crash locations. The best estimates of injury crash reductions attributable to fixed camera systems fall in the range of 20% to 25% at treated locations." … "Effects on fatal and other severity crashes are less certain but also declined in general"

Pilkington et al. 2005, abstract

"Reductions in outcomes across studies ranged from 5% to 69% for collisions, 12% to 65% for injuries, and 17% to 71% for deaths in the immediate vicinity of camera sites. The reductions over wider geographical areas were of a similar order of magnitude" … "Existing research consistently shows that speed cameras are an effective intervention in reducing road traffic collisions and related casualties."

Although all three reviews concluded that speed enforcement devices or programs are generally effective at reducing injuries and injury crashes/collisions, they also all highlighted the generally poor methodological quality of the studies available. This mostly related to: the absence of any RCTs (when they could be feasible), the typical lack of description or control of various potential confounders (such as types of road and speed limits, volumes of traffic, method of choosing intervention sites, intensity of enforcement, likelihood and amount of speeding fines, conspicuity of camera locations, and regression to the mean). Variation between studies in all of these factors could explain the wide range of injury and crash reduction estimates across studies.

Differences between the three reviews

Each of the reviews had slightly different aims, and search and other methods. The key differences were that: the 2006 Cochrane review focussed on a broader range of effectiveness measures beyond injuries and collisions (e.g. speeding,) and on all types of speed enforcement devices (i.e. radar and lasers as well as cameras); the 2005 Pilkington and Kinra review

specifically focused on speed cameras (not other speed measurement devices), and the Thomas et al review was restricted to automated (i.e. unmanned) speed enforcement activities.

There were seven studies which were common to all three reviews, and the later review by Thomas and colleagues included four studies published in 2004 and 2005 which the two earlier had not included. Compared with the 2006 Cochrane review, the lower number of studies found by both the 2005 Pilkington and Kinra review and the later 2008 Thomas et al review (26 vs 14 and 13) appears to be partly explained by: the apparently more extensive electronic and other searching of the Cochrane review; its inclusion of studies of radar or laser-based speed detection devices as well as cameras, and; including both automated and non-automated speed enforcement programs. The Cochrane review also included speed as well as injury and crash outcomes (so 5 of the 26 studies reported speed outcomes only) as a study inclusion criterion (although ultimately 21 of the 26 studies reported crash or injury outcomes).

In summary, there is significant overlap in the evidence covered by the three reviews, so limited weight should be given to the consistency of their overall conclusions. However, the best of the three reviews in terms of quality of review methods - and similarity of the scope for this review for NICE CPHE - (the Cochrane review by Wilson and colleagues, limited to controlled studies and interrupted time-series studies) does not contradict the findings of the other two reviews, even given their slightly more restricted aims and study inclusion criteria. Also, the four 2004 and 2005 studies included in the Thomas et al 2008 review (but not published in time for the other two reviews) confirm the overall direction in which most results were already pointing; this gives some indication that had we updated the Cochrane review the broad findings would be unlikely to alter.

Evidence Statement 1. Impact on road safety of speed enforcement devices

There is moderate evidence from 3 recent systematic reviews that speed enforcement devices (cameras, lasers or radar) will often reduce road injuries, and serious/fatal injury crashes/collisions in the vicinity of the devices (Pilkington & Kinra 2005[+];Thomas, Srinivasan, Decina, & Staplin 2008[+];Wilson, Willis, Hendrikz, & Bellamy 2006[++]). The Pilkington and Kinra 2005 review also concluded that similar size of speed reduction effects were observed over wider geographical areas around the enforcement device sites. The size of the observed reductions in different studies, and in different localities within studies, varies considerably. Similarly, in those studies where enforcement devices were temporarily placed at certain

locations, the duration of speed reductions after removal of the devices (the 'time halo') varied from 1 day to 8 weeks (Wilson et al, 2006[++]). However, none of the systematic reviews were able to identify factors which were consistently associated with higher injury or crash reductions (such as automated vs non-automated detection, mobile vs fixed, covert vs overt, urban vs motorway, or on roads with different speed limits). Nor did included studies consistently state what the penalties or fines would be for detected speeding, although the Cochrane review implied there was a relationship between size of pre-/post- reduction in speeding vehicles and the speed threshold set (Wilson et al, 2006[++]).

This evidence is judged as directly applicable to the UK. This is because some of the studies were from the UK, and the results from these studies were generally consistent – in direction of effect, if not always size of effect – with the studies from other developed countries in the reviews. However, where reported (e.g. Wilson et al, 2006[++]), it seems that most evaluations of the effectiveness of speed enforcement devices have been conducted either in rural or semi-rural areas, or on roads with speed limits of 60kph or over. Therefore the relevance of this evidence for reducing road injuries in environments where children are likely to be pedestrians is probably limited.

6.1.1. Evidence from other relevant studies

Effectiveness of automated speed enforcement devices in school zones (Freedman et al. 2006)

Although we had no intention of updating any of the systematic reviews, we found a controlled before and after study, published after the searches of the three (included) systematic reviews, which focused on the impact of automated speed enforcement in school zones, in Portland, Oregon (USA) (Freedman et al. 2006). Since this appears to be the only existing study which evaluates the effectiveness of speed enforcement devices in an area where children are likely to be the main intended beneficiaries of safer driving, we summarise it below.

A demonstration project at five school zones, involving the deployment of devices in vans two to three times per week, was evaluated by comparison with five matched school zones in Portland without automatic speed enforcement. All the zones have a 20mph speed limit 24 hours a day.

Flashing beacons also signified when it was school hours, in both intervention and comparison school zones.

The results are summarised in Table 4 below. During the operation of the speed enforcement vans, the eighty-fifth percentile speeds were reduced by approximately 5mph (compared with before the trial) when the beacon was not flashing. The 85th percentile speed reduction was 8 to 9mph when the beacon was flashing compared with no speed enforcement or beacon, i.e. before the trial. Despite having control areas, there was no equivalent data from control sites during those days and times when the zones were being enforced, so this study should strictly only be regarded as an uncontrolled before and after study (see Table 4).

Table 4. 85th percentile speeds in demonstration and control sites, and before during and after

Project stage	Demonstration sites (mph)		Control sites (mph)	
	Beacon off	Beacon ON	Beacon off	Beacon ON
Before	32.4	29.8	31.2	27.0
During (no enforcement)	31.6	27.6	30.8	27.0
During (WITH enforcement)	27.8	23.4	N/A	N/A
After	31.6	28.0	30.6	27.0

Source: Demonstration project of automated speed enforcement in school zones, in Portland, Oregon (National Highway Traffic Safety Administration 2007).

6.2. Review of evaluations of other (non-device-specific) speed enforcement strategies

We identified **thirteen empirical studies** which evaluated the impact of other (i.e. non-device-specific) strategies for enforcing speed limits.

Of these, only three focused on enforcement changes that specifically aimed to reduce speeding (Davis, Bennink, Pepper, Parks, Lemaster, & Townsend 2006;De Waard & Rooijers 1994;Redelmeier, Tibshirani, & Evans 2003), while most (9) focused on various strategies for intensifying or changing police enforcement activities which covered both speeding and other

road traffic offences (such as drink-driving and the wearing of seat-belts). One study, on the impact of the introduction of a driver's licence penalty points system in Ireland, implied that speeding was the main targeted behaviour but did not describe the types of driving offence which may incur the penalty points (Donnelly, Murray, & Cleary 2005). The different types of enforcement strategies evaluated were:

- Intensification of police patrol activities (with or without new systems for targeting roads and times) (6 studies, conducted in Australia, USA, Greece, New Zealand, and Isreal)
- Changes in convictions for traffic offences (2 studies, one conducted in Canada and one in Israel)
- Increasing fixed financial penalties for driving offences (2 studies, one conducted in Norway, one in the USA)
- Introduction of driver licence penalty points systems (1 study, conducted in Ireland)
- Alternative methods for communicating infringements (2 studies, one conducted in the USA and one conducted in the Netherlands)

Given the relatively high proportion of studies into the effects of speed enforcement devices which were conducted in the UK (previous section in this chapter), it is notable that there are no studies from the UK into these other strategies for enforcing speed limits.

In terms of the outcomes measured in these studies, they measured the impact of the enforcement activities on:

- Fatalities or fatal crashes, 5 studies (Davis, Bennink, Pepper, Parks, Lemaster, & Townsend 2006;McCarthy 1999;Newstead, Cameron, & Leggett 2001;Redelmeier, Tibshirani, & Evans 2003)
- Crashes/collisions with casualties/injured persons, 3 studies (Davis, Bennink, Pepper, Parks, Lemaster, & Townsend 2006;Povey, Frith, & Keall 2003;Yannis, Papadimitriou, & Antoniou 2008)
- Number of injuries, 1 study (Donnelly, Murray, & Cleary 2005)
- Severity of injury, 1 study (Davis, Bennink, Pepper, Parks, Lemaster, & Townsend 2006)

- Crashes or road accidents, 5 studies (Beenstock, Gafni, & Goldin 2001;Davis, Bennink, Pepper, Parks, Lemaster, & Townsend 2006;Hakkert, Gitelman, Cohen, Doveh, & Umansky 2001;Jones & Jones 1997;Newstead, Cameron, & Leggett 2001)
- Vehicle speed, 4 studies (Babusci, Ticatch, Bickar, & Schneeberger 2006;De Waard & Rooijers 1994;Elvik & Christensen 2007;Povey, Frith, & Keall 2003)
- Traffic violations or 'citations', 2 studies (Babusci, Ticatch, Bickar, & Schneeberger 2006;Jones & Jones 1997)

None of the studies which reported numbers of injuries or injury crashes reported outcomes for child and adult crash/collision victims separately (see Table 5 on following pages).

See **Error! Reference source not found.** (on p.**Error! Bookmark not defined.**) for a fuller description of each of these studies, and Appendix 5 (p.98) for the table showing detailed methodological quality assessment.

Table 5. Empirical evaluations relating to speed enforcement strategies on the road: summary characteristics

Author, year	Enforcement strategy	Target behaviours	Data & Country	Study design	Outcomes
Newstead et al. 2001	Random Road Watch program (widespread and low-level policing strategy, using static marked police vehicles, randomly allocated to locations and times)	Potentially all driving offences detectable from static police cars (including speeding)	Monthly crash statistics by location and over time, **Queensland, Australia**	Controlled before and after study of gradual roll-out of the program, with comparison of both areas exposed and not exposed to the program, *and* times of day exposed/not exposed. Plus statistical modelling.	Crash frequency (and four levels of crash frequency, by severity)
Hakkert et al 2001	Year-long concentrated police enforcement project focusing on 'preferred' road sections	Severe violations such as: speeding, not keeping to the right, non-compliance with traffic signs	National data on police activity and monthly accident data, in **Israel**	Controlled before and after study, and Interrupted time series analysis	'Severe accidents'
Davis et al. 2006	Vigorous traffic violation enforcement program (increased police motorcycles with radar guns)	Traffic speed (in high collision areas)	Trauma registry for city & county of Fresno (2002-2004), **California, USA**	Controlled before and after study	Motor vehicle crashes Injury collisions Fatalities Speed-related fatalities Injury severity
Povey et al 2004	Introduction of dedicated State Highway Patrol in 2001/02	Drink-driving, speeding and safety belt use	National speed survey data and injury crash data for 1996-2002, in **New Zealand**	Statistical modelling of longitudinal data over the period	Injury crashes Average & 85th percentile speeds

Author, year	Enforcement strategy	Target behaviours	Data & Country	Study design	Outcomes
McCarthy 1999	Level of enforcement as assessed by number of traffic arrests (for speeding, driving while under influence , hit-and-run, other)	Speeding, driving while under influence, hit-and-run.	Monthly fatality data for 418 incorporated and 57 unincorporate d cities in **California**, for 108 months from 1981 to 1989.	Econometric analysis (Poisson regression with fixed effects) of panel data set	Road fatalities
Yannis et al 2008	Intensification of police enforcement (increasing the number of roadside controls)	Speeding and drink-driving	Regional police and infringement data, and casualty data for a 4-year period (1998-02) in **Greece**	Multilevel statistical analysis of longitudinal accident data	No. of road accidents with casualties No. of fatalities
Redelmeie r et al 2003	Traffic convictions & penalty points	Speeding	Licensed and suspended drivers in **Ontario, Canada**	Case-crossover	Risk of fatal crash
Beenstock et al.2001	Police reports issued for driving offences	Various driving offences: 33% speeding, 19% licence offences, 5% non-use of seat-belts	Monthly accident data by location in **Israel** (31 months data at 135 road locations)	Statistical modelling of a panel dataset	Non-urban road accidents
Elvik & Christense n 2007	Increasing fixed penalties for traffic offences	Speeding, wearing of seatbelts	Annual data (1995 -2004) on fixed penalty rates in **Norway**,	Regression analysis of longitudinal data	Percentage of vehicles speeding
Babusci et al. 2006	Highway safety corridor new signing and double fines	Moving traffic violations	Police records and study speed recordings, in **Pennsylvania USA**	Uncontrolled before and after study	Speeds Vehicle volumes Vehicle gaps Citation history

Author, year	Enforcement strategy	Target behaviours	Data & Country	Study design	Outcomes
Donnelly et al. 2005	Introduction of a driver's licence 'Penalty Points System' for driving offences	Speeding (NB. not stated whether penalty points may be issued for other driving offences)	Hospital administrative records for same months over three years (2000/1 to 2002/3) in **Dublin & Waterford regions, Ireland**	Uncontrolled before and after study	Road-traffic-related injuries No. of femoral shaft fractures
Jones 1997	Two types of driver improvement letter (received on basis of accident or traffic violation record)	Accidents and traffic violations	**Oregon, USA**, State records of drivers and their traffic violations and preventable accidents.	Cox regression survival analysis of one-year's letters and 2 years follow-up data (including for control 'no letter' drivers)	Survival time without: Crashes Moving violations Major violations
De Waard & Rooijers 1994	Different methods (face-to-face versus mailing of speed tickets) and intensity levels of enforcing speed limits on motorways	Speeding	Vehcle speed records on six motorway sections in the **Netherlands** (5 intervention, 1 control)	Controlled before, during (1 month) and after study	Driving speeds

Notes:

6.2.1. Intensification of police patrol activities

In contrast, our searches found **six empirical evaluation studies of the intensification of police patrols** (sometimes alongside other systematic approaches to changing the location and timing of police patrols) (Davis, Bennink, Pepper, Parks, Lemaster, & Townsend 2006;Hakkert, Gitelman, Cohen, Doveh, & Umansky 2001;McCarthy 1999;Newstead, Cameron, & Leggett 2001;Povey, Frith, & Keall 2003;Yannis, Papadimitriou, & Antoniou 2008). We only included studies where speeding was the only or a significant target driver behaviour.

Three of the studies, by Newstead and colleagues (2001), Hakkert and colleagues, and Davis and colleagues (2006) were essentially controlled before and after studies, while the other three were more dominantly statistical (regression) analyses of longitudinal data.

Rather than intensified policing *per se*, **Newstead et al's** study in Queensland evaluated a systematic approach to widespread low-level policing (Newstead, Cameron, & Leggett 2001). It followed several other previous randomised scheduling police enforcement programmes during the 1980s and early 1990s in the region (in Tasmania, in New Zealand and in New South Wales). The Random Road Watch intervention in Queensland (rolled out from 1992 to 1997) specifically involved: each of the 270 participating police divisions defining approximately 40 road segments in their area; patrol times between 6am and midnight were also divided into two-hour segments; and then schedules for police enforcement operations at these time and road segments were devised by randomselection. Enforcement comprised stationing a marked police vehicle at the selected site for the chosen two-hour duration, to undertake normal traffic enforcement duties, including issuing tickets for any traffic offences detected. There was no parallel publicity campaign.

The evaluation method was a form of before and after study, using Poisson regression to analyse crash frequency data in potentially enforced areas, and in areas never enforced under the programme (therefore adjusting for background trends in crash frequencies). Times of the day were also divided into potentially enforced and never enforced (midnight to 6am) times. To estimate the net effect of the programme, crash trends at sites and times influenced by the randomised policing programme, before and after its implementation, were compared with crash trends at sites and times uninfluenced by the programme.

There were statistically significant reductions in crash frequency, at all crash severity levels, due to the programme. In the metropolitan south region, the all crash reduction due to the programme was 17.4% compared with 11.2% in the non-metropolitan regions. The reductions were greatest for the more severe types of crash (a 31% reduction in fatal crashes, and a 13% reduction in those leading to hospitalisation, in non-metropolitan regions). Apart from fatal crashes, the crash reduction attributable to the programme increased over time, in general with the greatest effect estimated in the third year after introducing the programme. Although these results are favourable for the programme across the whole of Queensland, programme effects varied considerably across police regions, by level of urbanisation and over time (e.g. the estimated reduction in fatal crashes was 49% in the Northern region, but there was no

estimated reduction in the Far northern region, reductions of between 14% and 37% in the other five regions.

The study by **Hakkert et al** (2001) evaluated a year-long period of concentrated police enforcement on selected road sections across Israel from April 1997 (the '700-project'). It used a controlled before and after study design and focused on about 700km of road (or 20% of Israel's inter-urban road network). The targeted road sections accounted for about 60% of all inter-urban accident locations. The increase in enforcement was supported by an 11 to 14 percent increase in staff and vehicle fleet plus a similar increase in enforcement tools. Also, within the targeted 700km of road sections, traffic volumes and accident frequency determined higher levels of police enforcement activity. Severe traffic violations were the main target of the campaign, including speeding and non-compliance with traffic signs, and during the first four months there was a related publicity campaign.

Before and during the project data there was (i) continuous monitoring of levels and types of police activity (ii) periodic assessment of driver behaviour (questionnaires and speed measurement), and (iii) monitoring of changes in accident numbers and severity within the project area. Speeds and traffic volumes were monitored at 25 sites within the targeted road sections, and 6 sites outside the 700-project area. Data analysis of the accident data from January 1995 to March 1998 was by two methods: one which calculated an odds ratio using both intervention and control group data, and one which compared to regression models of time series data from before and after (i.e. during) the intervention. Using the first method, in five designated regions with different levels of police presence (higher vs lower) only one area experienced a statistically significant reduction in severe accidents (OR 0.61, 95% CI: 0.39 to 0.93; in the 'center, high police presence area'). Nevertheless, in three of the other four areas there was a statistically non-significant reduction in severe accidents relative to control sites (ORs: 0.78, 0.83, 0.52).

Davis et al. 2006 reported the impact of increased speed enforcement using 20 new police motorcycles and radar guns, and 64 extra traffic division officers (from 20 before the programme) in California. The injury prevention programme was implemented in high collision areas in Fresno City (intervention area) and compared with Fresno County (control area). The study data was for 2002 to 2004, which covered one year before the traffic enforcement and two years after. The researchers estimated changes over this period in motor vehicle collisions, fatal collisions, fatalities related to speed and injury severity. In Fresno City there were

statistically significant ($p<0.001$ to $p<0.02$) reductions in motor vehicle crashes, injury collisions, fatalities, and fatalities related to speed. There was also a decrease on hospital admissions of motor vehicle crash victims. The equivalent data for the county of Fresno showed no such reductions (although no statistical test of the difference in time-trend was performed).

The following three studies, by McCarthy, Yannis and colleagues, and Povey and colleagues did not have any explicit before and after design, but instead used multivariate analysis of longitudinal crash or injury data to investigate potential explanatory factors, including the level of police enforcement.

McCarthy (1999) analysed monthly road fatality data from 1981 to 1989 in 575 small areas within Califorinia. Using Poisson regression with fixed effects he analysed the potential effect of highway speed limits, seat belt use laws, the availability of alcohol, restrictions on the sale of petrol and alcohol at the same premises, and traffic enforcement. Overall, traffic enforcement – as measured by per capita traffic arrests – was estimated to reduce fatal accidents more than drinking and driving, speed limits or seat belt use laws. A unit increase in Per Capita Speeding Arrests was estimated to reduce monthly fatal accidents by 0.046%, which was ten times the estimated reduction expected due to arrests for drink driving.

Yannis et al. (2008) examined the impact of the intensification of roadside controls for speeding and drink-driving in different regions of Greece on the number of accidents with casualties and the number of fatalities. They developed multivariate multi-level models of casualty data and regional police infringement data for four years (1998 to 2002). The other included county-level explanatory variables in the time-series data (in addition to the two main geographical levels of regions and counties, and a constant) were: the number of accidents, the number of alcohol controls, the number of speed infringements, the population (natural log of), number of vehicles per 100 inhabitants, the percentage of roads in the county's network that are National roads. Two of the eight different model specifications examined the impact of speed controls, and showed that there was a significant overall effect of enforcement in reducing both road accidents and fatalities. Interestingly, whereas regional variations in the effect of enforcement on accidents was highly significant, this was not found to explain regional variations in fatalities.

Povey et al. (2003) used linear regression models to examine the relationship between police enforcement activity, vehicle speeds and injury crashes in New Zealand between 1996 and 2002. This period followed the 1995 introduction of the Supplementary Road Safety Package

which was a high intensity publicity and enforcement programme, and ongoing enforcement included a variety of mass media promotion (television, radio, billboards). In addition, during 2001 and early 2002, a dedicated State Highway Patrol was introduced to New Zealand State Highways. Speed data were from annual vehicle speed surveys conducted by New Zealand's Land Transport Safety Authority. The regression model of traffic speed and speed enforcement over time showed that each increase of 10,000 speed camera infringements were associated with an estimated reduction in open road mean speeds of 0.7%. There was a greater estimated reduction of 1.1% in 85th percentile speeds due to such increased enforcement. The second regression analysis then showed that an estimated injury crash reduction of 12% (95% CI: 3% to 20%) was associated with a 1kph reduction in mean open road speed. The equivalent estimated reduction in fatal and serious injury crashes, and fatal and serious injuries, was 7% but this estimate was not significant.

The study by **De Waard and Rooijers** (1994) examined the impact on driving speeds on six motorway sections in the Netherlands of both different methods of enforcement (on-view stopping and ticketing vs mailing of fines) and varying the intensity of enforcement. The study measured speeds before, during (for 1 month) and after study using induction loops. For the intensity of speed enforcement part of the study, three different levels of apprehension were implemented: stopping 1 in every 100 speeding offenders, every 1 in 25, or every 1 in 6. They found that increasing the intensity of enforcement – from apprehending 1 in 100 speeding offenders, to 1 in 25, to 1 in 6 – produced statistically significant ($p<0.05$) reductions in mean speed (1kmh for 1:25 vs 1:100; and 3.5kmh for 1:6 vs 1:25). Although the data from the control motorway section was not used to adjust these effect estimates, the authors reported a small but statistically non-significant increase in average driving speed in the control area during the trial.

Evidence Statement 1. Impact on road safety of intensified and/or rationalised police enforcement activities

There is weak evidence from 3 controlled before and after studies (in Australia, Israel and California) that increased or rationalised police enforcement of traffic speeds reduces injury crashes ([+]Newstead, Cameron, & Leggett 2001), car accidents ([+]Hakkert, Gitelman, Cohen, Doveh, & Umansky 2001) and collisions, injury collisions, fatalities and speed-related fatalities ([-]Davis, Bennink, Pepper, Parks, Lemaster, & Townsend 2006). There is also weak evidence from 3 multivariate analyses of longitudinal road accident/injury data (in New Zealand, California

and Greece) that increased levels of police enforcement of traffic speeds reduces reductions in injury crashes and all injuries ([-]Povey, Frith, & Keall 2003), fatal accidents ([+]McCarthy 1999), and injury accidents ([+]Yannis, Papadimitriou, & Antoniou 2008). There is also moderate evidence from 1 controlled before and after study, on motorways in the Netherlands, that increasing the intensity of enforcement – from apprehending 1 in 100 speeding offenders, to 1 in 25, to 1 in 6 – produced statistically significant ($p<0.05$) reductions in mean speed (1kmh for 1:25 vs 1:100; and 3.5kmh for 1:6 vs 1:25) ([+]De Waard & Rooijers 1994).

This evidence is judged as partially applicable to road safety policy in the UK. This is because in the included studies there are a number of differences in the way police forces are organised and contribute to speed enforcement. Also, in the role of the police in enforcing speed limits through speed traps and mobile cameras/radar needs to be considered in the context of the widespread use of fixed site automated cameras around the UK road network.

6.2.2. Evidence from other relevant studies

A previous systematic review on 'the capability of intensive police programmes to prevent severe road accidents' (Blais & Dupont 2005) was only able to identify one study relevant to the present review ((an evaluation of the Random Road Watch programme in Queensland, AustraliaNewstead, Cameron, & Leggett 2001). Most of the studies found by the Blais review evaluated the impact of random breath testing, sobriety checkpoints, photo-radar, mixed programmes and red-light cameras.

6.2.3. Convictions and reports for traffic offences

Redelmeier et al. (2003) analysed a database of the 8,975 licensed drivers in Ontario (Canada) who had fatal crashes from 1988 to 1999 inclusive (11 years). They used a case cross-over design to investigate the protective effect of recent convictions on individual drivers. For all drivers in the study period there were 21,501 driving convictions from the date of receiving a full licence to the date of a fatal crash (approximately one conviction per driver every five years).

The risk of a fatal crash in the month after a conviction was about 35% lower than in a comparable month with no conviction for the same driver (95% CI: 20% to 45%, $p=0.0002$). This benefit lessened substantially by two months post-conviction, and the benefit was not

significant by three to four months. The benefit was not altered by age, previous convictions or other measured personal characteristics. Nor was there any difference for fatal crashes of differing severity. The benefit was not seen in drivers whose licences were already suspended. In a subgroup analysis by type of conviction, speeding convictions in which the driver received penalty points were associated with a larger relative risk reduction of a fatal crash than speeding convictions without penalty points (51% vs 0%, p=0.011).

Beenstock et al. (2001) analysed monthly road accident data by location in Israel along with data for the monthly number of police reports' issued for various driving offences on defined road sections. The dataset was for 135 road sections during 31 months (1993 to 1995). The driving offences included speeding (33%), licence offences (19%) and non-use of seat belts (5%). They used various regression based statistical modelling methods (e.g. Poisson fixed effect, random effects, and negative binomial models).

They found no statistically significant association between levels of police reports for driving offences and the small-area rate of accidents. However, they found that only high-intensity enforcement had any measurable effect (the p-value for predicting the number of accidents only fell to 0.076 after the exponent of the monthly number of traffic offences on a road section increased to four, also suggesting that the policing effect was non-linear). Regardless of statistical significance, the magnitude of the association was also very small; on average, if policing was increased by 1% the expected number of accidents falls by only 0.00358%. Also, the effect of increased enforcement tended to dissipate rapidly after the dose of enforcement reduced. The level of traffic law enforcement had no discernible effect on fatal road accidents. Lastly, there was only weak evidence that the level of policing in one road section has a wider effect on other road sections.

Evidence Statement 3. Impact on road safety of convictions and reports for traffic offences

There is inconsistent evidence from 1 case cross-over study and 1 multivariate regression-based analyses of longitudinal data (from Canada, and Israel respectively), that higher rates of issuing traffic convictions reduces fatal road accidents ([+]Beenstock et al. 2001;[++]Redelmeier et al. 2003). The case cross-over study found a short-term effect on the future risk of fatal accidents, but the multivariate regression analysis found no effect on fatal road accidents. It should be noted that: the accident risk reduction effects of the conviction on the convicted driver

appear to last less than 4 months ([++]Redelmeier, Tibshirani, & Evans 2003); that speeding convictions with penalty points were associated with a larger relative risk reduction than those without (51% vs 0%, p=0.011); that a 1% increase in convictions is estimated to cause accidents (fatal and non-fatal) to fall by only 0.00358% ([+]Beenstock, Gafni, & Goldin 2001); and that only large scale increases in enforcement have a measurable effect on road accidents ([+]Beenstock, Gafni, & Goldin 2001). Neither of these two studies separately reported any estimates of effectiveness in relation to non-fatal injuries or non-fatal road accidents. Apart from the different effectiveness result relating to receiving penalty points (Redelmeier et al 2003, above) neither of the studies reported any other impact of different possible punishments following conviction or apprehension (e.g. different levels of fines or points, or attendance at speed awareness courses); in fact, most studies about speed enforcement gave no details of the range of consequences of being caught speeding.

This evidence is judged as partially applicable to road safety policy in the UK. This is because in the UK the specific balance of fines and penalty points for speeding, and the more widespread network of fixed speed cameras may alter the responsiveness of British drivers to mobile police-administered speed enforcement. In addition, for various reasons, these 2 studies were only judged as partially [+] and poorly applicable [-] within their own country.

6.2.4. Increasing fixed financial penalties for driving offences

Elvik and Christensen (2007) compared the rates of fixed financial penalties for driving offences with the percentage of vehicles speeding, during the years 1995-2004 in Norway. The fixed penalties were usually given on the spot by a police officer soon after the offence, with immediate payment avoiding a court hearing or a trial. Over the ten-year period for example, fixed penalties for speeding offences increased from 400NOK to 500NOK for minor violations (e.g. breaking the 60kph speed limit by less than 5kph) to increases from 2,000NOK to 5,000NOK for more serious speeding offences (e.g. breaking the 60kph speed limit by between 20kph and 25kph). Data on vehicle speeds over the study period was either from permanent traffic counting stations or from speed camera sites which were in continuous operation from 1995 to 2003 (and where speed is measured by inductive loops and violators are

photographed). This longitudinal data was analysed using regression analysis (linear and logistic) to control for long-term violation rates and between-site differences in violation rates.

For speeding, no effect of the gradually increasing fixed penalties was found. Close to speed camera sites however there was a tendency for the violation rate to go down (by 1.4 percentage points), but this was not statistically significant at the 5% level. These mixed findings in relation to speeding contrast with those for seat belt use, where higher fixed penalties were associated with increased compliance with the law.

Babusci et al. 2006 evaluated the impact of a combination of doubling fines with changed signing to indicate the double fine zone, on five sections of highway in Pennsylvania (USA), as part of a 'Highway Safety Corridor' programme. They were all multi-lane highways selected on the basis of the number or rate of speed-related crashes; the targeted safety corridor sections were between three and 14 miles long. The evaluation study was an uncontrolled before, during and after study with measurement of vehicle speeds, vehicle volumes, vehicle gaps and citation history. Measurement was not continuous but in short week periods (four to seven days) before during and after the enforcement programme.

The combination of introducing a doubling of fines and improved signing achieved statistically significantly lower percentages of drivers exceeding the speed limit (-2% to -15%) and lower percentages exceeding the speed limit by more than 10mph (-1% to -21%), at 1 month and 6 months after the introduction of double fines and new signing.

Evidence Statement 2. Impact on road safety of increasing financial penalties for speeding

There is inconsistent evidence from 1 regression-based analyses of longitudinal vehicle speed data (from Norway), and 1 uncontrolled before and after study (from Pennsylvania USA), that increasing fines for speeding offences reduces speeding ([+]Babusci, Ticatch, Bickar, & Schneeberger 2006;[+]Elvik & Christensen 2007). In the Norwegian study of over 60 speed-monitored road sections around the country, gradual but substantial increases in fines over a 9-year period produced either no increase, or both increases and decreases in the percentage of drivers complying with the speed limits (at the two types of sites, and with alternative regression models)([+]Elvik & Christensen 2007). However, in the USA study, the combination of

introducing a doubling of fines and improved signing about the 'double fine zone' on 5 designated Highway Safety Corridors achieved statistically significantly lower percentages of drivers exceeding the speed limit (-2% to -15%) and lower percentages exceeding the speed limit by more than 10mph (-1% to -21%), at 1 month and 6 months after the introduction of double fines and new signing.

This evidence is judged as partially applicable to road safety policy in the UK. This is because in the UK the existing balance and perceived cost of fines and penalty points for speeding, together with the perceived risks of apprehension, may be quite different to those in Norway in the 1990s and the USA. In addition, for various reasons, these 2 studies were only judged as partially applicable within their own countries.

6.2.5. Introduction of driver licence penalty points systems

Donnelly et al. (1995) used the hospital administrative records in two parts of Ireland (Dublin and County Waterford) to assess the impact of the introduction of penalty points on drivers' licences on road-related injuries. A part of this before and after study used discharges for femoral shaft fractures as a proxy for road traffic-related hospital discharges. The study compared data for three six-month periods (November to April in 2000-01, 2001-02, and 2002-03) in Beaumont hospital, six Dublin teaching hospitals and Waterford regional hospital. The penalty points system had been introduced on the 31st of October 2002 – just before the third data collection period.

The number of road traffic accident related discharges at Beaumont hospital almost halved from 124 and 125 in the first two periods to 70 in the period following the introduction of the penalty points system. Similarly, femoral shaft fractures at the Dublin teaching hospitals reduced from 20 and 25 to 16. There were no statistical tests of these or other differences, and the number of femoral shaft fractures in the Waterford hospital was too low prior to the policy change (six in six months) for it to be worth reporting. Also, in the discussion the authors noted caution since six-monthly road traffic-related fatalities had changed from 189 and 211 before the introduction of the penalty points, to 141 after, but rising to 174 during the same months a year later (2003-04).

Evidence Statement 3. Impact of driver licence penalty points systems

There is weak evidence from 1 small uncontrolled before and after study (in Ireland), that introducing a driver licence Penalty Points System reduces the number of hospital-treated road traffic trauma cases ([-]Donnelly, Murray, & Cleary 2005). Although the number of Road Traffic Accident injuries in the 6-month period after the introduction of the Penalty Points System (70) was nearly half that in two 6-month periods before its introduction (124, 125), this could be due to a range of other background changes in traffic safety or hospital admissions (and the statistical significance of the changes is not assessed). There is suggestive evidence of an even greater relative reduction in serious head injuries (from 29 and 34, down to 18) and thoracic injuries (from 29 and 26, down to 13)

This evidence is judged as not applicable to national road safety policy in the UK since a driver licence penalty point system already exists here. Also, because most of the data came from only one hospital in one region of Ireland, the study was judged as only partially applicable to the rest of Irelend.

6.2.6. Alternative methods for communicating traffic infringements

Jones (1997) evaluated the impact of two types of 'driver improvement letter' for people with high accident or high traffic violation records in Oregon, USA. He used cox regression survival analysis of one year's letters and following a number of outcomes over two years: crashes, moving violations, and 'major violations'. Identified drivers were randomly assigned one of the two letter types. The first type of letter was the 'standard letter', which listed past traffic violations and preventable accidents with dates, and which stated that it was "a courtesy reminder of your driving record" followed by the following warning: "If you have additional traffic tickets or preventable accidents within 12 months of this letter, you may receive a warning letter from the Division, or be required to attend a Driver Improvement Interview". It this emphasised negative consequences. The second type of letter – the 'soft sell letter' – emphasised positive motivators, for example saying that "Most Oregon drivers go more than four years without a traffic ticket or accident" and "We want to encourage you to give more attention and effort to safe driving" and similar toned encouragement to read the enclosed pamphlet.

The survival analysis showed that the standard letter was consistently and statistically significantly associated with lower levels of accidents than the soft-sell letter (Wald statistic 7.42, significance = 0.006), and equivalent to about 0.7% higher survival without an accident at two years. However, while the standard letter was most effective in younger drivers, the soft sell letter was more effective for drivers aged over 45 years. Also, the standard letter was more effective for men than women at reducing collisions. More unusually however, for women, receiving no letter had a slightly higher impact (but still statistically significantly) than for women receiving either type of driver improvement letter. Lastly, while there were no significantly different impacts on moving violations, those receiving letters (both types) had significantly higher major-violation-free survival.

The study by **De Waard and Rooijers** (1994) examined the impact on driving speeds on six motorway sections in the Netherlands of both different methods of enforcement (on-view stopping and ticketing vs mailing of fines) and varying the intensity of enforcement. (See above for the results on the intensity of enforcement part of the study). Two of the six arms (i.e. motorway sections) of the study also compared methods of communicating traffic infringements after stopping every sixth offender: (i) offenders being sent a personal feedback letter immediately (aim within 24 hours), stating their speeding offence, which speed was measured, where and when detected, and that a fine would be forwarded; or (ii) no such letter was sent and normal processes for sending fines were adhered to. The study also compared on-view stopping of offenders with the mailing of fines (with driver identified through licence plate number). On the road section where people received a mailed fine preceded by a feedback letter mean speeds reduced by 3.1kph, and without the letter by 2.0kph (but the statistical significance of the difference between the two reductions was not reported).

Evidence Statement 4. Impact of methods for communicating traffic infringements

There is moderate evidence from 1 RCT with survival analysis and 1 controlled before, during and after study of longitudinal data (in Oregon USA, and The Netherlands), that the use of appropriately worded letters to communicate traffic offences (or high accident records) can affect subsequent speeds or accident rates ([+]De Waard & Rooijers 1994;[++]Jones & Jones 1997). In the study in Oregon ([++]Jones & Jones 1997), amongst a large sample of speeding offenders and those with a recent poor accident record, on average those randomly assigned to receive the standard letter (including a list of recent accidents and violations, and clearer threat of further sanctions) had fewer subsequent accidents over the next 2 years than those who

received the 'soft sell' letter; however, there were age and gender differences in responsiveness to each letter type, with women and those older than 44 more likely to have relatively fewer accidents following the soft sell letter). In the study on motorways in The Netherlands ([+]De Waard & Rooijers 1994), the road section where people received a mailed fine preceded by a feedback letter reduced mean speeds by 3.1kph, and without the letter by 2.0kph (but the statistical significance of the difference between the two reductions was not reported).

This evidence is judged as partially applicable to road safety policy in the UK. This is because in the UK the existing balance and perceived financial cost of fines and penalty points and social stigma for speeding offences may be quite different to those in the USA or in the Netherlands. In addition, for various reasons, these 2 studies were only judged as partially applicable within their own country.

7. Findings: Encouraging compliance through media campaigns

7.1. Media campaigns alongside speed enforcement measures

A number of published reviews have summarised examples of where speed enforcement strategies involve a related mass media campaign (Rothengatter J.A. 1997;Vaa et al. 2004). Also, a much more recent review, of 45 media campaigns to reduce speeding in 20 countries, has noted the mixture of emotive and rational/informational messages that they tend to contain (Phillips & Torquato 2009). Some campaigns primarily aimed to remind drivers of speed enforcement using facts and information, with emotional persuasion only used to convey the risk of detection (viz. *We'll catch you, In a flash!*). However, none of the media campaigns in the Phillips review were evaluated with respect to their possible effects on observed driver behaviour (e.g. speeding) or accident data.

7.1.1. Evidence from quantitative comparative evaluation studies

Ultimately, our searches identified only **two quantitative comparative evaluation studies** (published in English from 1990 onwards) which evaluated mass media campaigns in relation to speeding and speed enforcement (Cameron, Newstead, Diamantopoulou, & Oxley 2003;Guria & Leung 2004). Their summary characteristics are shown in Table 6 below.

See **Error! Reference source not found.** (on p.**Error! Bookmark not defined.**) for a fuller description of each of these studies; and Appendix 5 (p.98) for a table showing detailed methodological quality assessment.

(NB. The two reviews by Vaa and colleagues, and by Rothengatter and colleagues, have mainly summarised a number of earlier (pre-1990) evaluations involving mass media campaigns, but the original studies are mainly published in Dutch or Swedish (Rothengatter J.A. 1997;Vaa, Assum, Ulleberg, & Veisten 2004).)

Table 6. Empirical evaluations of mass media campaigns alongside speed enforcement strategies: summary characteristics

Author, year	Media & enforcement strategy	Target behaviours	Data & Country	Study design	Outcomes
Guria & Leung, 2004	Emotion and shock advertising as major part of 'Supplementary Road Safety Package'	Speeding Drink driving Seat belts	Police data on police hours, advertising expenditure, other socio-economic variables, in **New Zealand**	Regression analysis of longitudinal data (1971-2000; including an interaction term for enforcement with advertising)	Fatal crashes Fatalities Non-motorcycle fatalities
Cameron et al. 2003	Speed-related mass media publicity, alongside variable speed camera enforcement	Speeding	Police records of speed camera activity in **Victoria, Australia**	Poisson regression and logistic regression of longitudinal data alongside a factorial design variation of speed camera activity and mass media advertising (1996-2000)	Casualty crashes Crash (injury) severity

Evidence Statement 7. Impact of media campaigns alongside speed enforcement

There is inconsistent evidence from 2 regression-based analyses of longitudinal data (from Australia, and New Zealand), that having media campaigns alongside speed enforcement helps reduce casualty crashes or crash severity (Cameron et al. 2003[+]) or reduce fatalities or fatal crashes (Guria & Leung 2004[+]).

This evidence is judged as partially applicable to national road safety policy in the UK. This is because in the UK and its constituent countries there may be different responsiveness to new road safety media campaigns in the light of the effectiveness of past media campaigns. Also, the UK has a denser road network with higher traffic volumes, and there is a probably a different background level of automated and other speed enforcement activity which may alter the potential gains of media campaigns.

7.1.2. Evidence from other relevant papers/reports

A 2004 study by **Vaa and colleagues** at the Institute of Transport Economics (TØI, Norway) on the *Effects of information campaigns on behaviour and road accidents – conditions, evaluation and cost-effectiveness* meta-analysed 86 results from 30 evaluation studies (Vaa, Assum, Ulleberg, & Veisten 2004). This included 18 campaigns against speeding (33 against drink-driving, 15 multi-theme campaigns, 9 on random breath testing). Overall, the pooled analysis suggest an effect size of -8.9% (95% CI -12.7% to -4.6%) on the number of road accidents. Table 7 below summarises other selected results from the meta-analysis.

Table 7. Selected meta-analysis findings from the Vaa et al. 2004 review

Type of media campaign (no of campaigns)	Effect on road accidents	95% Confidence Interval	Significant at p< 0.05 level?
Campaigns against speeding (n=18)	-8.5%	-19.9% to +3.4%	No
Multi-theme campaigns (n=15)	+1.0%	-6.7% to +9.3%	No
Campaign alone	+0.9%	-8.6% to +11.7%	No
Campaigns with police enforcement	-12.7%	-18.9% to -6.2%	Yes
Campaigns + enforcement + education	-14.2%	-22.0% to -4.9%	Yes

Source: Table S.2 and Table S.3 of Vaa et al., 2004.

In summary, while multi-theme campaigns had no effect at all, the 18 campaigns to reduce speeding had a mean effect of -8.5% (although, this was not a statistically significant result). More importantly, given the focus of the present report, media campaigns *with police enforcement* achieved a reduction in accidents of approximately 13%, in contrast with no effect for mass media campaigns alone.

8. Findings: Other national and regional strategic approaches

8.1. Use of quantified road safety targets

8.1.1. Evidence from quantitative comparative evaluation studies

We identified three quantitative comparative evaluation studies of the impact of road safety targets on road safety outcomes (Elvik 2008;Elvik 1993;Wong, Sze, Yip, Loo, Hung, Lo, Wong, Sze, Yip, Loo, Hung, & Lo 2006). The main characteristics of the studies are described in Table 8 below. Their results are summarised and discussed on the pages following the Table.

See **Error! Reference source not found.** (on p.**Error! Bookmark not defined.**) for a fuller description of each of these studies; and Appendix 5 (p.98) for a table showing the detailed methodological quality assessment.

Table 8. Empirical evaluations of quantified road safety targets for preventing road-related injury

Author, year	Strategy	Goals of strategy	Data & Country	Study design	Outcomes analysed
Wong et al. 2006	National quantified road safety targets	To reduce fatal and non-fatal road injury rates to certain levels by a certain date	National data of setting of road safety targets & national annual road fatality numbers, for 1981-1999 14 countries (12 European plus Israel & USA)	Controlled before-and-after study, plus meta-analysis (9 countries which had road safety targets introduced during the 18-year period, each matched to 3 or more other countries which had (at that time) not)	Road fatalities
Elvik 2001 (NB 2-page Report Summary only available)	National and regional road safety targets	22 targets of national governments, 13 targets of local governments (3 countries)	National data from 15 countries,	Before and after study, and multivariate analysis of longitudinal data	Road safety indicators (not stated)
Elvik 1993	Regional quantified road safety targets	To reduce the number of injury accidents	Longitudinal accident rate data by Norwegian county compared for 1982-85 and 1986-89	(1) Before and after comparison, and (2) comparison of counties with ambitious quantified targets, with less ambitious quantified targets, and without quantified safety targets	Accident rate per kilometre of travel

The analysis by **Wong and colleagues** investigated the association between the setting of national quantified road targets and road fatality reductions, using data from 14 countries from 1981 to 1999 (Wong, Sze, Yip, Loo, Hung, Lo, Wong, Sze, Yip, Loo, Hung, & Lo 2006). Although basically a controlled before and after study, some countries with the later introduction

of targets (such as Poland, the USA and France) acted as controls for those (nine) treatment countries with national targets set in earlier years. (The treatment countries were Norway, The Netherlands, Denmark, Finland, Sweden, New Zealand, Ausralia, Hungary, and Spain.) The association between target setting and road fatality reductions was tested using data for the three years before and the three years after the introduction of the target, and comparing this data from both the treatment country and its comparison countries. An 'aggregate analysis', comparing treatment country fatality reductions with the total fatality reductions in the three or more comparison countries, was carried out, and as well as a 'disaggregate analysis' (comparing countries with targets with each comparison country separately).

Of the nine 'treatment' countries eight demonstrate a better safety performance than their comparison countries after setting a target (of which five were statistically significant at the 1% level; The Netherlands, Denmark, Finland, Hungary and Spain). The fatality reductions in these five countries ranged from 15.3% to 38.5%. In only one country, Sweden, did fatalities increase slightly (but this change was not statistically significant). With the disaggregate analyses, the associations are more mixed. While Norway, The Netherlands, Australia and Hungary had a better safety performance than each one of their comparison countries, in Finland, and Sweden were only statistically significantly better than Spain (at 1% or 10% significance level), and Denmark's performance was only better than Poland's (but not France's or the USA's). The meta-analysis estimated that the overall fatality reduction associated with quantified targets was 17.4% (significant at the 1% level). Most of the country-specific results of this study were consistent with Elvik's earlier study (Elvik 2001).

Elvik's 2001 study used a similar methodology to examine the impact of 22 targets in 15 countries (Elvik 2001). [NB What follows is mainly based on the 2-page summary published by the Institute of Transport Economics, Oslo. A copy of the full report is being sought] Although – at least for the nine countries in common with Wong and colleagues' analysis - there were improvements in safety following the introduction of targets in all but two comparisons, for only four were the improvements statistically significant (see selected Elvik 2001 results in Table 2 of Wong et al., 2006). With evident concern about the accuracy of the data and the validity of the methods used, Elvik ended up concluding that "one cannot rule out the possibility that errors in data or analyses explain study findings" and that the study "does not provide a credible basis for estimating the effects on safety performance of quantified road safety targets" (pp.i-ii of report's Summary).

Elvik's 1993 study used a taxonomy of different road safety targets, and four levels of analysis to assess the impact of different quantified targets on the accident rates in 16 Norwegian counties (Elvik 1993). The impact of possible confounding factors and regression to the mean were also explicitly considered and explored. The targets examined over the period were initially ambitious (county-level target reductions in the number of accidents of 30% to 35% for 1982-85) and then declined over the years (15% to 20% for 1986-89, and 0% to 5% for 1990-93). The results are also different by time period; reductions in the number of accidents were associated with the targets in the earlier, 1982-85 period, but the results for the later periods are more mixed. However, in general, those counties with more ambitious safety targets did better, although the size of the differences in accident rate reductions diminished in the later periods. He also concluded that frequent revisions to quantified road safety targets may diminish their influence on policy-making, and that the full implications of activities to attain the targets (in terms of opportunity costs and benefits, and impacts on mobility/access) should be taken into account when setting targets.

Evidence Statement 5. Impact of having quantified national road safety targets

There is inconsistent evidence from 3 international before and after studies, that having national quantified road safety targets helps reduce road injuries (Elvik 1993[+];Elvik 2001[+];Wong, Sze, Yip, Loo, Hung, Lo, Wong, Sze, Yip, Loo, Hung, & Lo 2006[+]).

This evidence is judged as partially applicable to national road safety policy in the UK. This is because in the UK and its constituent countries there are already a number of national road safety targets, so to add more (or prematurely change those already set) may have less of an impact than in countries where (a) no or very few quantified road safety targets exist and (b) there is more progress to be made in achieving the road injury rates of those countries with the best road safety performance.

8.1.2. Evidence from other relevant papers/reports

As Elvik observed, any quantified target is a compromise between idealism and realism. There appears in particular to be a tension between making targets ambitious enough to motivate policy makers, yet keeping them attainable enough that they do not become ignored as

unrealistic (Elvik 1993;Elvik 2008). In a recent critique by Elvik, again of a system of road safety management objectives in Norway (Elvik 2008), he draws upon both empirical research and theoretical perspectives to suggest that the conditions under which quantified targets are most likely to achieve success in road safety (see Box 3 below). In his critique he illustrates why (he believes) the national system of road safety management by objectives has not been implemented: because of a lack of support from politicians; because some outcomes are beyond the jurisdiction of the Norwegian government; because some targets are too ambitious; and because there are also too many targets.

Box 3. Elvik's suggested seven conditions for successful use of road safety targets

1. Targets which are strongly endorsed by the top management of government (i.e. politicians), and with a firm commitment from government to achieving them
2. Targets which are challenging, yet in principle achievable
3. There should no be too many targets in view of the available policy instruments available to achieve them
4. The agency(ies) tasked with choosing how to achieve the targets should have authority to determine the priority to be given to all available policy instruments
5. The responsible agencies should be supplied with sufficient funding to implement all cost-effective road safety measures
6. There should be a system for monitoring progress towards targets, and providing feedback to responsible agencies on their performance
7. Incentives should exist to ensure commitment to targets from all agencies responsible for achieving them

A descriptive article by Cardoso and colleagues, shows the influence and adoption of supra-national road safety targets (e.g. those proposed by the EU) in one country, on **Portugal's 2002 National Road Safety Plan** (Cardoso et al. 2004). Recognising the country's poor road safety record relative to other EU countries, they directly adopted the target proposed by the EU, of a

50% reduction in the total number of people killed or seriously injured, by 2010. Also, adapting the target in relation to Portugal's traffic system and accident patterns, a more ambitious target of a 60% reduction in accidents involving pedestrians or two-wheeled motor vehicle riders was set. No data was presented on progress towards these targets.

In summary, in addition to the methodological challenges involved in isolating the effect of such strategic policies, there is a wide range of conditions which appear to alter the impact of quantified targets (Elvik 2008). When quantified targets are set by international organisations, like the EU or the OECD, they may especially influence member countries which lag behind in road safety compared with the average or best performing in the same organisation (Cardoso, Lemonde De Macedo, Trigoso, & Bettencourt 2004).

8.2. Other strategic approaches

We found no quantitative comparative evaluations of any other strategic approaches. All of the evidence discussed in sections **Error! Reference source not found.** to 8.2.4 below is from critical review or discussion papers.

8.2.1. Community and local level road safety planning

Traffic calming as part of local road safety strategy and local transport plans (Section 2.2 in Traffic Calming, Local Transport Note 1/07 (Department for Transport 2007b).

National Highway Traffic Safety Administration. **Community Traffic Safety Programs: Review and Analysis**. Anonymous. HS-808 115:10p, 1994.

L. Carnis. **The automated speed enforcement system in Great Britain: between a technical revolution and administrative continuity**. *International Review of Administrative Sciences* 73 (4):597-610, 2007.

8.2.2. Involvement of health services and health professionals in road safety policy-making and advocacy

Hospitals as lead agencies in community or city-wide safety programmes or coalitions:

D. Laraque, B. Barlow, M. Durkin, and M. Heagarty. **Injury prevention in an urban setting: challenges and successes**. *Bulletin of the New York Academy of Medicine* 72 (1):16-30, 1995.

Key points: Although the *Harlem Hospital Injury Prevention Program* (HHIPP) was primarily about a multi-faceted inner city programme to prevent all types of injury to children (including those due to violence) in a poor area of New York City, this paper usefully illustrates a number of possible levels of involvement of hospitals and health professionals in leading or contributing to community-based injury prevention initiatives. Although few of the activities actually focused on road injury prevention, the role of medical services or health professionals was evident in the following ways.

- The *Harlem Hospital Injury Prevention Program* was the lead agency for the *Healthy Neighbourhoods/Safe Kids Coalition*
- The *Kids, Injuries and Street Smarts* (KISS) sub-program involved developing a community-wide injury prevention curriculum, including wider education of the public about the New York City Emergency Medical Service, and how to call or get help from it
- Local paediatricians played a key role, and secured some funding from the American Academy of Pediatrics, to develop a coalition and develop various youth bicycle clubs, with a focus on both safer cycling and delinquency prevention (and therefore intentional injury prevention)
- The hospital also provided premises for some of the program activities (e.g. Harlem Hospital Dance Clinic).
- Health professionals were involved in data collection, analysis and evaluation of the programme. They were also seen as playing a role in the development of trust between all segments of the community concerned with the welfare of children

Involvement of medical professionals in policy and action:

T. St.Mars. **2006 ENA National Scorecard on State Highway Laws: a road map for injury prevention**. [Review] [28 refs]. *Journal of Emergency Nursing* 33 (3):265-270, 2007.

Key points: In November 2006, the Emergency Nurses Association (ENA, of USA) and the ENA Injury Prevention Institute/ENCARE issued the 2006 National Scorecard on State Highway Laws. The scorecard focuses on five areas of safety law and policy: (1) primary enforcement seat belt law; (2) child passenger safety law; (3) graduated driver licensing; (4) universal/all-rider motorcycle helmet law, and; (5) “addressing the capacity for establishing a statewide trauma

system for responding to injuries". The scorecard approach collates equivalent information from all states on these laws, regulations and capacities, allowing a comparison of their status between states as well as a national snapshot of progress towards consistent State Highway Laws across the USA.

However, the paper does not describe the extent to which this information is now either being used to advocate changes in laws or regulations in individual states, or is promoting the improvement of statewide trauma systems.

8.2.3. Road safety planning and targeting ethnic groups

F. Daniels, W. Moore, C. Conti, L. C. N. Perez, B. M. Gaines, R. G. Hood, I. J. J. Swain, R. Williams, and C. T. Burgess. **The role of the African-American physician in reducing traffic-related injury and death among African Americans: Consensus Report of the National Medical Association**. *Journal of the National Medical Association* 94 (2):108-118, 2002.

Key points: A literature review identified that African Americans suffer from a disproportionately high rate of traffic-related injury and death. Public information campaigns have successfully improved traffic safety practices among the general public, but in large part have been unsuccessful among minority populations. The National Medical Association-convened consensus panel concluded that this may be due to:

- A failure to use techniques and safety campaign/education messages that are culturally sensitive to African Americans
- Campaigns that have targeted geographic and social centres where African Americans are not broadly present
- Lack of awareness of the disproportionate effect motor vehicle crashes are having on African Americans.

In addition, poor compliance with safety legislation may be related to lower levels of education amongst African Americans. The consensus panel proposed that "Scientifically based, culturally appropriate intervention strategies need to be devised and implemented by African

American institutions and organisations to improve traffic safety practices and reduce the high rate of traffic-related injury and deaths among African Americans." (Daniels et al. 2002 p.109)

8.2.4. The integration of road safety planning with other areas of policy making

K. Dopart. INTEGRATED PUBLIC SAFETY AND HIGHWAY OPERATIONS: A POLICY FRAMEWORK AND ANALYSIS. in: National Summit on Transportation Operations. Anonymous. Anonymous. Federal Highway Administration ; American Association of State Highway and Transportation Officials ; American Public Transportation Association ; ITS America ; Institute of Transportation Engineers. 14p, 2001.

P. Hasson and V. Feypell De La Beaumelle. INTEGRATION OF ROAD TRANSPORT SAFETY AND ENVIRONMENT POLICIES. *Japan Railway & Transport Review* 18:40-45, 1998.

Also, the Manual for Streets (2007) is an example of a guideline to encourage such integrated planning.

9. Discussion

9.1. Limitations of the review

This review has been primarily conducted by one reviewer. This is clearly not ideal, and the specific stages of the review process which would have benefited from a second reviewer checking or repeating choices are: the selection of included studies from those retrieved in full text; the assessment of the quality of included studies. Although some consistency may arise from having one reviewer perform all these stages, it may also introduce systematic biases.

The fact that so much transport and safety research exists in the grey literature, in obscure reports and conference proceedings, or as reports produced by regional or local authorities, means there are practical difficulties in obtaining some reports. At the time of submission of this final report we had conceded that 15 reports originally requested were unobtainable, and 7 others which had been ordered from inter-library sources had not yet arrived. The former are simply unobtainable. If any of those on order turn out to be includable quantitative comparative evaluations we shall table an addendum to the report for the PDG meeting.

9.2. Methodological considerations

Amongst the included quantitative comparative evaluations there was only one RCT, and all the other studies were almost all either before-and-after studies, or time-series analysis of longitudinal data. At one level this simply means that there is considerable scope for bias due to unmeasured confounders. In road safety research, changes in traffic volumes (i.e. exposure to risk) and regression to the mean are key problems. However, for those studies with very long time-series of data, and where there was no explicit targeting of the strategies to high accident areas or road sections, regression to mean may be less of a concern.

We also found very few studies which collected data or discussed the possible inadvertent effects of the speed enforcement or other strategic policies evaluated. For example, speed enforcement zones could potentially lead to higher volumes of traffic on the adjacent road network, or divert drivers likely to speed onto other parts of the road network.

At another level, the wide variety of non-randomised observational study designs leads to correspondingly varied methods for analysing and presenting results. This makes it difficult to

quality assess individual studies, and also difficult to compare results across groups of studies of a similar strategy.

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Appendices

Appendix 1 Review protocol

Review Protocol

Strategic and regulatory frameworks for guiding, enforcing or promoting activities to prevent unintentional injury to children and young people in the road environment

Overall PUIC Programme details outlined by the CPHE Scope

This project is one of five pieces of work informing NICE guidance on how to prevent unintentional injuries among children and young people aged under 15. The others are:

- Preventing unintentional injuries among under 15s: Correlates review'. This identified and quantified factors (e.g. cultural, social, economic, environmental and organisational) that have been shown to be related to the incidence of unintentional childhood injury.
- 'Preventing unintentional road injuries among under 15s: road design'. This guidance will focus on the design and modification of highways, roads and streets. It will be developed using the public health intervention process.
- 'Preventing unintentional injuries among under 15s in the external environment'. This guidance is expected to cover sports and leisure. It will be developed using the public health intervention process. A scope will be produced at a later date.
- 'Preventing unintentional road injuries among under 15s: education and protective equipment'. This guidance is expected to cover safety equipment such as helmets and visibility clothing. It will be developed using the public health intervention process.

Population groups that will be covered

- Children and young people aged under15, particularly those in disadvantaged circumstances (for example, those living with families on a low income, living in overcrowded housing or with a lone parent).
- Parents and carers of children and young people aged under15.

Population groups that will not be covered

- Anyone aged 15 or over, except the parents or carers of children and young people aged 15 or over.

Interventions/Activities that will be covered

- Activities/interventions that will be covered by the Programme guidance

This guidance will focus on: design and modification to highways, roads and streets, the supply and/or installation of home safety equipment, home risk assessments and prevention activities in the external environment. It will cover the following measures:

- primary and secondary legislation
- regulation and standards
- enforcement.

The guidance will also cover compliance with the above and supporting mass-media campaigns.

In addition, it will cover the following in relation to preventing unintentional injuries in children under 15:

- injury surveillance, data collection and analysis
- workforce training, support and capacity building.

Steps will be taken to identify ineffective as well as effective approaches.

Activities/measures that will not be covered by the Programme guidance

Legislation, regulation, standards, enforcement and compliance relating to:

The technical efficacy of products (including, for example, airbags, brakes and smoke detectors).
Tertiary prevention, including emergency services, treatment and rehabilitation to limit long-term impairments and disability caused by injury.

Titles

Long title:

An overview and synthesis of evidence relating to strategies and frameworks for planning, implementing, enforcing or promoting activities to prevent unintentional injury to children and young people on the road: legislation, regulation, standards and related strategies focusing on the design and modification of highways, roads or streets.

Short title:

Strategies and frameworks for planning, implementing, enforcing or promoting activities to prevent unintentional injury to children and young people in the road environment.

Key deliverables and dates

Agreement of search strategy with CPHE	17th March 2009
Interim progress teleconference/meeting: To discuss the nature and volume of the emerging evidence, decisions that may arise and how best to summarise and synthesise the data.	22nd April 2009
Draft Final Report (with draft evidence statements)	19th May 2009
Final Report	2nd June 2009

Aim

To locate, review and synthesise studies of the performance of *strategic policies and regulatory or legal frameworks** for guiding or promoting the planning or implementation of measures relating to the design and modification of highways, roads and streets** in order to reduce

speeds, promote safer driving, separate flows of different types of road user, or promote safer behaviours amongst other road users

**The types of measures of interest are:

• traffic calming

• 20 mph zones

• home zones

• international examples such as 'woonerven' in the Netherlands: streets or a group of streets that have been redesigned to slow traffic and promote non-motorised traffic

• 'naked streets' where road markings, lines, traffic lights, signs and kerbs and so on are removed to create uncertainty in road users and force them to slow down, and other psychological traffic calming designs

• 'quiet lanes' and other rural examples of traffic calming schemes

• signing related to speed limits

• walking and cycling networks

• 'Safe Routes to Schools' initiatives.

**'Strategic policies and regulatory or legal frameworks', will include:*

- Legislation (primary and secondary), regulation, standards and their enforcement
- Mass-media campaigns and initiatives (when this wholly or partly aims to encourage awareness of and compliance with the above)

Audience

The audience for this review will be the Programme Development Group (PDG) members.

Question(s) to be addressed

3. In what ways can legislation, regulation and/or standards (either with or without specific activities or factors which may enforce them or encourage compliance with them), improve the planning, implementation or operation/effectiveness of:

    a. Traffic calming and related road/street design modifications to reduce speeds and encourage safer driving (e.g. 20mph zones, home zones, signing related to speed limits etc.)

    b. Cycle routes or networks and pedestrian routes or networks

    c. Safe Routes to Schools initiatives

6. Are mass media campaigns effective as a tool for encouraging compliance with such legislation, regulation and/or standards?

7. Which other activities or circumstances are associated with greater compliance with legislation, regulations and/or standards (relating to injury prevention or child safety)

9.2.1. Key outcomes

Measures of compliance (with legislation, regulation, standards) relevant to the aim of the policy/regulatory change.

Rates of unintentional injuries, severity of unintentional injuries, or number of care episodes (e.g. hospitalisations) relating to unintentional injuries.

Rates of relevant safety behaviours (e.g. number of children crossing at a safe place; number of motorists adhering to speed limits,, proportions of children travelling to school by different modes) or incidents (e.g. traffic collisions, vehicle collisions with pedestrians), or other relevant 'intermediate outcomes'.

Stakeholder reported importance/role of the *strategic policies and regulatory or legal frameworks* in affecting the **planning and implementation** of the specified types of intervention

Stakeholder reported importance/role of the *strategic policies and regulatory or legal frameworks* in improving the **operation and/or use** of the specified types of intervention

Methods

Systematic review of published and unpublished studies.

Time period to be covered:

Studies conducted or published since 1990

Inclusion criteria for studies:

Included studies will

- Focus on strategic policies and regulatory or legal frameworks, (and/or activities to promote or ensure their enforcement); activities to increase compliance and awareness of these initiatives, such as mass-media campaigns *;

  * when this wholly or partly aims to encourage awareness of and compliance with the above.

  - Where such legislation, regulation (etc.) is intended to influence or potentially influences the planning and implementation of the specified road and street modifications.
  - Any comparative study designs (i.e. randomised and non-randomised controlled trials, before and after studies, case control studies, ecological studies, cross-sectional studies, prospective and retrospective cohort studies) where there are comparisons groups of people or places or activities both with and without the specified legislation, regulation etc.

Quality assessment and data extraction

Included studies will be quality assessed using a structured format appropriate for the study design. Where appropriate, these will be based on those found in the CPHE Methods Guidance 2009 documentation and agreed with the team at CPHE.

Key data about methodology and results will be extracted for each included study into an evidence table, modeled on those found in the NICE CPHE methods guidance and adapted where appropriate to the identified study designs.

Quality assessment and data extraction will be undertaken by a single reviewer and 10% checked by a second reviewer.

Data synthesis and presentation

Data from the included studies will be analysed and synthesised, and evidence statements will be produced. We anticipate that narrative synthesis methods will be used rather than formal data pooling.

Initial key documents identified

Cairns S, Newson C, Davis A et al (forthcoming) 'Making school travel plans work: Research report'. Report for the Department for Transport.

Annex A – Other websites that could be searched

To be developed

Annex B – NICE review format

Appendix 2 Search Methodology and Strategy [1]

For the reviews to inform preventing unintentional injuries to children in the road (intervention) guidance:

Systematic reviews of effectiveness and cost-effectiveness of road and street design-based interventions aimed at reducing unintentional injuries in children

Searches were performed to find relevant primary research using a comparative design, qualitative studies, and cost-effectiveness studies. Database protocol driven searching, targeted searching, author suggestions, expert input, citation searching, named website searches, and citations from a parallel review were utilised.

All searches were limited to those published in English since 1990 where possible.

Bibliographic Databases:

The following databases were searched between 29 Jan, 2009 and 17 February, 2009

ASSIA (Applied Social Science Index and Abstracts) via CSA
Database of Abstracts of Reviews of Effectiveness (DARE); NHS EED; HTA all via the Centre for Reviews and Dissemination database
EconLit via EBSCO
HMIC via Search 2.0
Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1950 to Present
PsycINFO 1806 to February Week 2 2009 via OVID online
ISI Web of Knowledge Social Sciences Citation Index (SSCI)--1956-present
ERIC via Dialog Datastar
SafetyLit (online)
EPPI Centre databases: TRoPHI, DoPHER, and Bibliomap (online)
The Campbell Collaboration (online)
Transport Research Information Service (TRIS) via TRIS online

Bibliographic Databases Search Strategy

The Medline search strategy example follows and was "translated" according to the appropriate thesaurus terms for each individual database. Where a database did not have a thesaurus or does not have a search facility to incorporate thesaurus searching, text words only were used. All searches where possible were limited to English language and from 1990-current.

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1950 to Present

Search Date: 29012009

1. safe route*.mp.

2. (walk* adj3 bus*).mp.

3. traffic club*.mp.

4. (woonerven or woonerf).mp.

5. 1 or 2 or 3 or 4

6. ((walk* or Pedestrian*) adj2 (network* or path* or route* or footpath or sidewalk or verge)).mp.

7. ((cycle* or bicycle or walk*) adj2 (track* or trail* or network* or route* or lane*)).mp.

8. ((safe* adj2 cycl*) or (safe* adj2 walk*)).mp.

9. cycle* path*.mp.

10. Bicycling/

11. Walking/

12. (cycl* or bicycl* or walk* or play* or travel*).mp.

13. 6 or 7 or 8 or 9 or 10 or 11 or 12

14. (injur* or accident* or death* or fatal* or collision or crash*).tw.

15. (road* or street* or highway* or traffic*).tw.

16. 14 and 15

17. 13 and 16

18. ((traffic or pedestrian or home) adj2 zone*).tw.

19. (20 mph or 20 mi per hr).mp. or 20mi/hr or 20m/hr or 20 miles per hour.mp. or 20 mi ph.mp.

20. 30km.mp.

21. ((30 km and (hour or hr)) or (30 kilo meter* and (hour or hr)) or ((30 kilometre or 30 kilometer) and (hour and hr))).mp.

22. ((street* or road* or lane*) and (quiet or naked)).ti,ab.

23. ((speed or road or street) and (humps or bumps or lumps)).ti,ab.

24. (sleeping adj policeman).ti,ab.

25. (central adj2 (refuge* or reservat*)).tw.

26. (hierarchy and (road* or street* or highway*)).tw.

27. ((road* or street* or highway or traffic) adj3 (design or environment* or manage* or layout or lay out)).tw.

28. (chicane* or speed cushion or rumble or jiggle bars).tw.

29. (cross* adj2 (pelican* or zebra or puffin or signal*)).tw.

30. (traffic adj2 calm*).tw.

31. (traffic adj4 (flow or restraint* or engineer* or security)).tw.

32. or/18-31

33. 32 and 14

34. (urban or suburb* or residential or (limited adj access) or pedestrian or neighbourhood).tw.

35. (sign* and (reduc* or restrict* or limit* or prevent*)).tw.

36. Accident Prevention/ and (reduc* or restrict* or limit* or prevent*).tw.

37. "Location Directories and Signs"/

38. Environment Design/

39. Accidents, Traffic/

40. ((speed* or volume*) and (reduc* or restrict* or limit* or prevent*)).tw.

41. or/34-40

42. 41 and 16

43. (reduc* or restrict* or limit* or prevent*).tw.

44. 42 and 43

45. (animals not humans).sh.

46. 5 or 17 or 33 or 44

47. 46 not 45

48. limit 47 to (english language and yr="1990 - 2009")

Targeted Bibliographic Database Searches

After screening the results from the protocol driven search strategy, a "targeted" search of specific named programmes and additional traffic calming terms was done in the bibliographic databases on the 31 March 2009:

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1950 to Present

- Transport Research Information Service (TRIS) via TRIS online

Below is the Medline strategy for the targeted search.

1 neighbourhood road safety initiative.tw.

2 leigh park*.tw.

3 play it safe.tw.

4 child pedestrian injury prevention project.tw.

5 CPIPP.tw.

6 streetwise kids club.tw.

7 streetwise kids club*.tw.

8 street-wise kids club.tw.

9 school travel plan.tw.

10 school travel plan*.tw.

11 school safety zones.tw.

12 feet first a step ahead.tw.

13 vision zero.tw.

14 LATM.tw.

15 danish bun*.tw.

16 dynamic striping.tw.

17 local area traffic management.tw.

18 dynamic road marking.tw.

19 SUNflower.ti.

20 injur*.tw.

21 20 and 19

22 verkehrsberuhigung.tw.

23 liveable street*.tw.

24 cut your garden hedge.tw.

25 SAFE WAY TO SCHOOL.tw.

26 free foot spaces.tw.

27 11 or 21 or 7 or 26 or 17 or 2 or 22 or 1 or 18 or 23 or 16 or 13 or 25 or 6 or 3 or 9 or 12 or 14 or 15 or 8 or 4 or 24 or 10 or 5

Websites:

The following organisation's websites were searched for relevant publications:

UK Department for Transport (DfT) (http://www.dft.gov.uk/)
Transport Research Laboratory (TRL) (http://www.trl.co.uk/)
Public Health Observatory website for the South West (lead on Injuries; http://www.swpho.nhs.uk/)
Public Health Observatory website for the South East (lead on Transport; http://www.sepho.org.uk/)
Every Child Matters (http://www.dcsf.gov.uk/everychildmatters/)
Institute of Highway Incorporated Engineers (http://www.ihie.org.uk/)
Transport 2000 (http://www.transport2000.org/)
Safe Routes to School (http://saferoutesinfo.org/)
(http://depts.washington.edu/hiprc/practices/topic/pedestrians/environment.html)

Review of References

Due to the difficulties of finding primary research as described in the methods section. References lists of reports and reviews were searched in order to utilise the contacts and database access that other research groups may have had available.

Citation Searching

Citation searches were done in ISI Web of Knowledge Social Sciences Citation Index (SSCI) on key authors.

Author Suggestions

A limited number of authors were contacted specifically in reference to potential qualitative research.

Expert Contacts

Staff of Sustrans (UK) and the National Center for Safe Routes to School (USA) were contacted along with experts in the field of transport policy evaluation.

Parallel review

References from a parallel review for the CPHE programme on preventing unintentional injuries in children, “A systematic review of risk factors for unintentional injuries among children and young people aged under 15 years: Quantitative correlates review of unintentional injury in children”, considered potentially includable for this review were tagged at time of screening.

Appendix 3 Search Methodology and Strategy [2]

For systematic review of:

Strategic and regulatory frameworks for guiding, enforcing or promoting activities to prevent unintentional injury to children and young people in the road environment.

Background

Associated NICE CPHE work

Two parallel pieces of CPHE work have fed into this review:

a) An overview and synthesis of international comparative analyses and surveys of injury prevention policies, legislation and other activities. and

b) Systematic reviews of effectiveness and cost-effectiveness of road and street design-based interventions aimed at reducing unintentional injuries in children

Citations of potential interest to this review were tagged at title/abstract screening stage. Review b) is of particular note as the search strategy and methodology for that review incorporated street-design terms with accident terms (see Appendix 2)

Reference Lists

Searching reference lists particularly of reviews and reports is a common component of finding studies for reviews. Due to the non medical mainstream element of this topic this is especially important as different organisations/individuals may have had access to specialised databases and/or grey literature. For example, searching reference lists in reports written by organisations such as TRL that may have access to specialist databases and/or contact with individuals and organisations that carry out road safety work should provide citations that would not be found using other search methods. This is particularly relevant for this subject, where the literature is less likely to be located in traditional bibliographic databases. Reference lists of identified reviews and reports were screened for inclusion.

Database Searches

Comparative studies were sought from the databases below:

Cochrane Injuries Group register via The Cochrane Library Wiley on line.

Transport Research Information Service via the TRIS online free access at: http://ntlsearch.bts.gov/tris/index.do hosted by the National Transportation Library

HMIC (or Kings Fund catalogue and DH data)

Medline

Science Citation Index Expanded (SCI-Expanded): ISI Web of Science

All searches were limited to those in English published since 1990 and where this is not possible these limits will be applied at inclusion/exclusion stage. Search Dates were between the 14 and 29 April, 2009.

Websites Searches

Institute of Highway Incorporated Engineers (http://www.ihie.org.uk)

Royal Town Planning Institute (www.rtpi.org.uk/)

TRL: Transport Research Laboratory

UK Department for Transport (DfT)

Mass-Media Campaigns

Mass media campaigns related to the questions being addressed were searched for within the same databases as stated under, “Bibliographic databases”. Specific terms for “mass-media” as an intervention were taken from previous NICE Public Health reviews with additional terms added after initial search.

EXPERT CONTACT AND SUGGESTIONS

Experts’ literature and contact suggestions were followed up

Search terms

Speed enforcement terms:

Example below from: The Cochrane Library 2009-2 (only searched within The Cochrane Injuries Group)

#1 SR-inj

#2 speed* NEAR/2 enforc*

#3 speed* NEAR/2 camera*

#4 enforc* NEAR camera*

#5 speed* NEAR/2 reduc*

#6 speed* NEAR/5 limit*

#7 speed* NEAR/5 reduc*

#8 speed* NEAR/4 limit*

#9 speed* NEAR/4 restrict*

#10 speed* NEAR/4 detect*

#11 speed* NEAR/4 strat*

#12 speed* NEAR/4 regulat*

#13 traffic NEAR/2 enforc*

#14 safe* NEAR/2 camera*

#15 automat* NEAR/2 enforc*

#16 (#2 OR #3 OR #4 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15)

#17 (#5 OR #6 OR #7 OR #8)

#18 (#1 AND #17)

#19 (#16 OR #18)

After intial screening the following terms were retrospectively searched for:

Speed management (schemes)

Compliance

Legislation, enforcement, strategies, compliance, standards and regulatory terms

Examples below from: OVID Medline.

The terms below were initially combined and searched for only in the title. The purpose of this was a) first to hone in on the most includable studies by finding those that state in the title what we are looking for and b) to be able to take those papers found and generate the most appropriate thesaurus and text terms in order to expand the search strategy and focus the procedure in relation to the resource constraints related to the project.

1 (road* or highway* or street* or traffic* or motor vehicle* or car).ti.

2 (safe* or injur* or accident* or death* or fatal* or crash* or casualty* or collision).ti.

3 (Program* or Strat* or Polic* or Legislat* or Regulat* or Complianc* or Standard* or enforce*).ti.

4 1 and 3 and 2

5 limit 4 to (english language and humans and yr="1990 -Current")

These terms along with the some additional ones that appeared to be useful were then searched for in the abstract.

Below is a chart of the terms used and how they were combined, where “d” is the number downloaded.

Medline (OVID)

Road	AND	Injur* or accident*	AND	Polic*	no
				Policy	135d
				policies	68d
				Legislat*	119d
				Regulat*	84d
				Prog*	
				Strat*	no
				Strateg*	no
				Enforce*	
				compliance	3d
Road	And	Safe*	AND	enforcement	66d
				Legislat*	6d
				Policy	41d
				policies	48d
				Regulat*	64d
				Strateg*	87d
				compliance	23d
road	and	Death* or fatal* or casual*		enforcement	58d
				Policies	4d
				Policy	90d

				compliance	11d
				Regulat*	40d
				Strateg*	138d
Road	And	Crash* or collision*	and	(Strategy or Polic* or Legislat* or Regulat* or Complianc* or Standard* or enforce*).ab.	
Accidents/trafficMeSH			and	(Program* or Strat* or Polic* or Legislat* or Regulat* or Complianc* or Standard* or enforce*).ab. Already downloaded from "road intervention" review {see appendix 7}	
Safety/MeSH with lj subhead	AND	(road* or highway* or street* or traffic* or motor vehicle*).ab.		D 42	
Traffic.TW.	And	Injur* or accident*	AND	policy	7d
Traffic.tw.	and	Injur* or accident*	AND	(policies or Legislat* or Regulat* or Strateg* or Enforce* D315 or Compliance or law*).tw.	

Terms added after initial sift:

Medline search date: 26.04.09

Consumer Product Safety/lj [Legislation & Jurisprudence]	**AND**	(road* or highway* or street* or traffic* or motor vehicle*).tw.		**0 d (**already in)
Road	**AND**	Injur* or accident*	**AND**	**Law***
Road	**And**	**Safe***	**AND**	**Law***
Accidents/trafficMeSH	**AND**			**Law***
Safety/	**AND**			**Law***

Mass Media terms

The following terms were used to identify papers related to mass media:

Example strategy is from Medline OVID

#1 (road* or highway* or street* or traffic* or motor vehicle*):ti,ab
#8 campaign*
#9 media
#10 MeSH descriptor Mass Media, this term only
#11 MeSH descriptor Health Promotion, this term only
#12 (Awareness or compliance or promotion):ti,ab
#13 (#8 OR #9 OR #10 OR #11 OR #12
#14 (#1 and #13)

#15 (poster*):ti,ab
#16 billboard*:ti,ab
#17 (televis* or tv):ti,ab
#18 (leaflet*):ti,ab
#19 (pamphlet*):ti,ab
#20 (postal):ti,ab

#22 mail*:ti,ab

#23 (#15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #22)

#24 (#1 AND #23)

#25 (#1 OR #24)

Appendix 4 Evidence Tables [*Holding page only*]

Appendix 5 Quality assessment of quantitative comparative evaluations

Methods checklist question:	**Newstead et al. 2001**	**Hakkert et al. 2001**	**Davis et al. 2006**	**Povey et al. 2004**	**McCarthy 1999**	**Yannis et al 2008**	**Redelmeier et al. 2003**	**Beenstock et al. 2001**	**Elvik & Chrstensen 2007**	**Babusci et al 2006**	**Donnelly et al 2005**	**Jones 1997**	**De Waard & Rooijers 1994**	**Guria & Leung 2004**	**Cameron et al. 2003**	**Wong et al. 2006**	**Elvik 2001**	**Elvik 1993**
Section 1: population																		
1.1 Is the source area well described?	+	++	+	+	++	++	++	+	+	+	-	+	+	+	++	NA		+
1.2 Eligible areas representative of the source areas of interest?	++	+	NR	+	++	+	++	++	++	NR	NR	++	NR	++	++	NA		++
1.3 Does the selected area represent the eligible area?	++	++	NR	++	++	+	++	+	-	NR	NR	++	NR	++	+	NA		++
Section 2 Method of allocation to intervention (or comparision)																		
2.1 Allocation to intervention (or comparison) groups - how was confounding minimised?	+	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	++	+	NA	NA	NA		NA
2.2 Interventions (and comparisons) well described and appropriate? [Description of intervention]	++	++	++	+	+	+	++	+	++	++	-	++	++	++	++	-		++
2.3 Allocation concealed?	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	+	NA	NA	NA	NA		NA
2.4 Participants and/or investigators blind to exposure and comparison?	NA	NA	NA	NA	NA	NA	++	NA	NA	-	NA	-	NA	-	NA	NA		NA

Methods checklist question:	**Newstead et al. 2001**	**Hakkert et al. 2001**	**Davis et al. 2006**	**Povey et al. 2004**	**McCarthy 1999**	**Yannis et al 2008**	**Redelmeier et al. 2003**	**Beenstock et al. 2001**	**Elvik & Chrstensen 2007**	**Babusci et al 2006**	**Donnelly et al 2005**	**Jones 1997**	**De Waard & Rooijers 1994**	**Guria & Leung 2004**	**Cameron et al. 2003**	**Wong et al. 2006**	**Elvik 2001**	**Elvik 1993**
[Blinding]																		
2.5 Exposure to intervention and comparison adequate?	++	+	+	+	NA	NA	NA	-	NA	++	++	+	++	+	++	+		+
2.6 Contamination acceptably low?	+	+	NR	NA	+	+	+	NR	NA	NR	++	++	+	NA	+	NA		NR
2.7 Were other interventions or their components similar in the areas compared?	NR	++	NR	+	-	+	NR	NA	NR	NA	NR	++	NR	NA	NR	NR		+
2.8 All participants accounted for at study conclusion?	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	++	NA	NA	NA	+		NA
2.9 Did the setting reflect usual practice?	++	++	++	++	++	++	++	+	+	+	+	++	+	+	++	++		++
2.10 Did the intervention or control comparison reflect usual practice?	++	++	++	++	++	+	++	+	+	++	+	++	+	+	++	++		++
Section 3: Outcomes																		
3.1 Outcome measures reliable?	+	+	+	+	+	++	++	+	++	++	+	+	++	++	++	++		+
3.2 Outcome measurement complete?	+	++	+	++	++	++	++	NA	++	+	+	++	+	++	+	++		+
3.3 Were all important outcomes assessed?	++	+	++	+	+	+	++	-	-	+	-	+	+	+	+	+		-

Methods checklist question:	**Newstead et al. 2001**	**Hakkert et al. 2001**	**Davis et al. 2006**	**Povey et al. 2004**	**McCarthy 1999**	**Yannis et al 2008**	**Redelmeier et al. 2003**	**Beenstock et al. 2001**	**Elvik & Chrstensen 2007**	**Babusci et al 2006**	**Donnelly et al 2005**	**Jones 1997**	**De Waard & Rooijers 1994**	**Guria & Leung 2004**	**Cameron et al. 2003**	**Wong et al. 2006**	**Elvik 2001**	**Elvik 1993**
3.4 Were outcomes relevant?	++	++	++	++	++	+	++	+	+	++	+	+	+	++	++	++		+
3.5 Similar timing of outcome measurements in exposure and comparison groups?	NA	++	++	NA	++	++	NA	NA	NA	NA	NA	++	++	NA	++	++		NA
3.6 Was follow-up time meaningful?	++	+	+	-	++	++	++	+	++	+	-	+	+	++	-	++		++
3.7 Similar outcome measurement methods used in exposure and comparison groups?	++	++	++	+	++	++	++	++	NA	++	+	++	++	++	++	++		++
Section 4: Analyses																		
4.1 Exposure and comparison groups similar at baseline? If not, were these adjusted?	+	NR	-	NA	NA	NA	NA	NA	NA	NA	NA	++	-	NA	NR	NA		NR
4.2 Intention to treat analysis? [ITT]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	++	NA	NA	NA	NA		NA
4.3 Estimates of effect size given or calculable?	++	++	NR	-	+	+	+	+	+	++	+	+	+	+	++	++		+
4.4 Analytical methods appropriate?	++	++	-	+	+	++	++	+	+	++	-	++	+	++	++	++		+
4.5 Precision/uncertainty of intervention effects given or	++	++	+	+	-	+	+	+	++	++	-	++	++	++	+	++		-

Methods checklist question:	**Newstead et al. 2001**	**Hakkert et al. 2001**	**Davis et al. 2006**	**Povey et al. 2004**	**McCarthy 1999**	**Yannis et al 2008**	**Redelmeier et al. 2003**	**Beenstock et al. 2001**	**Elvik & Chrstensen 2007**	**Babusci et al 2006**	**Donnelly et al 2005**	**Jones 1997**	**De Waard & Rooijers 1994**	**Guria & Leung 2004**	**Cameron et al. 2003**	**Wong et al. 2006**	**Elvik 2001**	**Elvik 1993**
calculable? Were they meaningful?																		
4.6 Was the study sufficiently powered to detect an intervention effect (if one exists)?	NA	NA	NA	NA	NA	NA	++	NA	NA	NR	NA	++	-	NA	NA	NA		NA
Section 5: Summary																		
5.1 Are the study results internally valid (ie unbiased)?	+	+	-	-	+	+	++	+	+	+	-	++	+	++	+	+	+	+
5.2 Are the findings generalisable to the source population (ie externally valid)?	++	++	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	-

Source: Appendix F, p.202 of: Methods for the development of NICE public health guidance (second edition), 2009.

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Appendix 7 Traffic calming legislation in England in 2007

The paragraphs below are an extract from Section 2, on traffic calming legislation, of Local Transport Note 1/07 on Traffic Calming (Department for Transport, 2007).

Vertical deflections

2.1.1 The primary legislation is contained in sections 90A to 90F of the Highways Act 1980 (as amended by the Transport Act 1981). The Act (sections 90A and 90B) makes it clear that road humps can only be constructed on roads with speed limits of 30 mph or less. There are exemptions for London (see paragraph 2.1.5). There are requirements to advertise, and to consult the police (section 90C). The Act also provides assurance that road humps constructed in accordance with the regulations, or specially authorised, or constructed prior to adoption of the highway, are not treated as obstructions (section 90E).

2.1.2 The original Road Hump Regulations allowed round-top humps 100 mm high and 3.7 metres long to be installed on roads in England and Wales with a speed limit of 30 mph or less. In 1986, revised Regulations allowed humps between 75 and 100 mm high. The subsequent Hump Regulations allowed flat-top humps and round-top humps between 50 and 100 mm high. Other hump profiles were not permitted under the 1990 Hump Regulations, although local authorities were allowed to apply to the DoT for special authorisation. Since 1996, the Regulations have allowed local authorities to choose the most appropriate hump profile.

2.1.3 The Highways (Road Humps) Regulations, 1999 (Statutory Instrument 1999 No. 1025) are the current regulations setting out provisions for road humps in England and Wales. They allow local authorities to install humps (including speed cushions) on roads with a speed limit of 30 mph or less, without the need for special authorisation, provided the humps are between 25 and 100 mm high, at least 900 mm long in the direction of travel, and have no vertical face greater than 6 mm. These regulations also remove certain provisions for road humps within 20 mph zones.

2.1.4 The 1999 regulations provide local highway authorities outside London with considerable flexibility in the design and placement of road humps. However, the regulations make local

highway authorities responsible for the design and placement, so authorities will need to ensure that an adequate duty of care is exercised.

2.1.5 The Greater London Authority Act 1999 allows local authorities in London to construct humps of any dimension on roads subject to any speed limit (without the need for special authorisation, but with a requirement to consult the Secretary of State). This greater freedom of action places greater responsibility on the London local authorities and Transport for London (TfL) to ensure that an adequate duty of care is exercised.

2.1.6 Humps where the height could be varied mechanically need particular consideration with regard to the safety of road users. Local authorities wishing to install such devices on the public highway are advised to consult the Department for Transport's Road User Safety Division on the need for special authorisation.

2.1.7 The use of transverse depressions in the carriageway has been suggested as an alternative to road humps, and has been tried in some countries (Hass-Klau *et al*, 1992). Their use can be better than humps in snowy conditions, but on public roads in the UK they would require special authorisation.

2.1.8 The Traffic Signs Regulations and General Directions 2002 (TSRGD) covers road markings for road humps, speed cushions and thermoplastic humps ('thumps').

Other traffic calming measures

2.1.9 The Traffic Calming Act 1992 amended the Highways Act 1980 by the addition of Sections 90G, 90H and 90I which allow works to be carried out 'for the purposes of promoting safety and preserving or improving the environment'. The 1992 Act made the first specific reference in legislation to traffic calming. However, it does not preclude the use of other powers in the Highways Act 1980 and elsewhere under which traffic calming features can be provided.

2.1.10 Other powers in the Highways Act 1980 include: section 64 (roundabouts), section 68 (pedestrian refuges), section 75 (variations in the relative width of carriageways and footways), section 77 (alterations in the level of a highway) and section 90 (build-outs, chicanes, pinch points, gateways, islands, overrun areas and rumble devices). There is no requirement in the Act limiting the installation of these measures to roads with a 30 mph speed limit or less.

2.1.11 The Highways (Traffic Calming) Regulations 1993 and 1999 clarified the powers available to local highway authorities to construct particular measures for traffic calming purposes. The measures include gateways, pinch points, islands, overrun areas, rumble devices, build-outs and chicanes (TAL 07/93). In 20 mph zones, warning signs for these traffic calming features may be omitted. However, warning signs should be provided where appropriate for non-traffic-calming features. 'Give way' markings to assign priority at a chicane would also still be required in a 20 mph zone.

2.1.12 The regulations allow the installation of rumble devices, provided they do not exceed 15 mm in height and no vertical face exceeds 6 mm in height.

2.1.13 As with road humps, the Greater London Authority Act 1999 allows local authorities in London to construct traffic calming measures of any type on roads subject to any speed limit (without the need for special authorisation but with a requirement to consult the Secretary of State). This greater freedom of action places greater responsibility on the London boroughs to ensure that an adequate duty of care is exercised.

2.1.14 The Transport Act 2000 allows local traffic authorities to designate Home Zones and Quiet Lanes. Designation requirements are set out in the Quiet Lanes and Home Zones (England) Regulations 2006 which also enable the making of use orders and

Appendix 8 New road design safety standards for Europe

The paragraphs below are an extract from the Final Report of the SAFESTAR project in eight European countries (SWOV and SAFESTAR partners 2002). They are *proposed* new safety standards, based on evidence presented within the main report. However, the report authors note that they also "cannot be considered complete because the research reviewed and carried out for the project could not fill all the gaps in our present knowledge." (SAFESTAR Final Report, Executive Summary).

NB. Section numbers refer to sections in the SAFESTAR Final Report, which is available at:

http://www.transport-research.info/Upload/Documents/200310/safestarrep.pdf

II.1 Motorways

The design of motorways should incorporate the following:

• An obstacle-free zones at least 9 metres wide on each side of the carriageway.

• Any inclines within these obstacle-free zone should not be steeper than 1 in 5 (20%) for slopes with a total height of more than 5 metres. Where the total height is 2 metres or less the slope should not be steeper than 1 in 6 (17%).

• The median strip should have a width of at least 20 metres except where an appropriate safety barrier is used.

• Where sections of hard shoulder (emergency lane) are identified as having a greater than normal risk of accidents they should be improved by an increase in width, the application of a rumble strip, or an improvement in lighting.

_ Where tunnels are used, the road layout within the tunnel should not be allowed to exert too much influence locally on the road user's choice of speed (for example, the sudden disappearance of the hard shoulder (emergency lane) will have a substantial influence on the choice of speed).

• At exits and entries situated within a tunnel the road user should always have a clear view forward of at least 100 metres.

II.2 Express roads

The design of express roads should incorporate the following:

• Use should be restricted to high-speed motorised traffic.

• The frequency of access and exit should be restricted.

• Vertical alignment over the brow of a hill (convex curve) should be such that the forward view should never be less than the distance required to stop safely.

• Vertical alignment through a dip or hollow (concave curve) should have a minimum radius of 3,000 m.

• The lane width on both single and dual carriageways should be 3.5 m.

• The cross-section of the carriageway should include a continuation of the paved area beyond the edge of the traffic lanes.

• The median strip should have a width of at least 20 metres except where an appropriate safety barrier is used.

• Where a safety barrier is used in a median strip a recovery zone should be used between the barrier and the traffic lanes. It should be wide enough to allow the recovery of vehicles to take place.

• The median strip should be free from slopes and obstacles.

• Where a single carriageway road climbs a significant incline a crawler lane (climbing lane) should be included on the uphill side of the road.

• Cuttings and embankments alongside the carriageway should not be steeper than 1 in 5 (20%).

II.3 Single carriageway rural roads

The design of single carriageway rural roads should incorporate the following:

• A lane width of 3.5 metres.

• Shoulders on each side of the traffic lanes to a width of 1.3 to 1.5 metres, giving a total carriageway width of approximately 10 metres.

• Cuttings and embankments alongside the carriageway which are not steeper than 1 in 5 (20%).

• Obstacle-free zones extending for at least 3 metres on each side of the carriageway.

• The horizontal alignment of the road should remain consistent (as defined in SAFESTAR Final Report).

• Road marking and signing within curves based on the strategy tested in SAFESTAR.

• Poor perception of a curve during both approach and negotiation should be prevented by improved marking and signing and by cutting back vegetation which might obscure the view.

• Amelioration of the speed at which a curve is entered by various devices.

• Avoidance or the reduction of consequences where a vehicle leaves the road by the use of hard shoulders, safety barriers, and high friction surfacing.

• The reduction of head-on collisions by the use of ghost islands and hard shoulders.

II.4 Major urban junctions

The design of major urban junctions should incorporate the following:

• A clear view for an adequate distance for all road users regardless of weather conditions or time of day.

• A maximum speed differential between road users of 30 km/h.

• A choice of junction type to maximise the effect of accident reduction.

• The arrangement of traffic streams so as to avoid as far as possible compromising the visibility and the prediction of the behaviour of road users.