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20mph Research Study

Supporting Technical Appendix
Rapid Evidence Review

November 2018

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Document history

Job number: 5133131			**Document ref:**			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.0	First draft	NN	LS	KK	KK	22/10/14
Rev 1.1	Second draft	NN	LS	KK	KK	19/12/14
Rev 1.2	Third draft	NN	LS	KK	KK	05/02/15
Rev 1.2	Final	NN	LS	KK	KK	06/03/15
Rev 2.0	Air quality section updated	JR	JR	JR	JR	30/11/16
Rev 3.0	Additional references added from Cairns et. al. (2014)	NN	JR	JR	JR	14/04/16
Rev 4.1	Additional references added from Burns et. al. (2001). Additional updates to Chap 3.	JR	JR	JR	JR	11/05/16
Rev 5.0	Bristol Evaluation Study (2018) added					15/02/18

Client	Department for Transport
Project	Provision of 20mph Research
Document title	Rapid Evidence Review
Job no.	5133131

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1. Introduction

1.1. Introduction

This Rapid Evidence Review (RER) **has been produced as a component of the Scoping Phase of a research project considering the effectiveness of 20mph speed limits**. Whilst the Department of Transport (DfT) recognise the wealth of information suggesting earlier 20mph zones are effective in reducing collisions and speeds, as well as leading to other benefits, there is an evidence gap on the effectiveness of 20mph speed limits and more recent 20mph zones. The primary aim of this review is to provide a better understanding of available evidence on 20mph limits, hybrid schemes and zones and substantiate the gaps in current understanding.

The review aims to identify, summarise and synthesise UK and International evidence relevant to the projects objectives given below:

1. Evaluate the effectiveness of 20mph speed limits in terms of the range of outcomes and impacts;
2. Examine the perceptions and attitudes of different user groups towards 20mph speed limits; and
3. Evaluate the processes and factors which contribute to the effectiveness of 20mph speed limit schemes..

1.2. Government Context

Before 1991, the Road Traffic Regulation Act 1984 did not permit local authorities to set speed limits below 30mph. Since then the DfT have issued a number of 20mph speed Circulars and Acts (see below), that allowed reduced speed limits to be applied in appropriate circumstances:

- Department of Transport (DoT) (1990) Circular Roads 4/90;
- Department of the Environment, Transport and the Regions (DETR) (1999a) Road Traffic Regulation Act (Amendment) Order 1999. SI (No 1608);
- Department of the Environment, Transport and the Regions (DETR) (1999b) 20mph Speed Limits and Zones Traffic Advisory Leaflet 9/99;
- DfT (2006) Circular 01/2006 Setting Local Speed Limits
- DfT (2013) Circular 01/2013 Setting Local Speed Limits

1.2.1. Circular Roads 4/90 (1990)

In 1990, DoT issued Circular Roads 4/90 which set out guidelines for the introduction of 20mph speed limits. The Circular required highway authorities to apply for consent from the Secretary of State to introduce a 20mph zone and it could only be introduced as part of a physically calmed ‘zone’ or on short sections of road with a proven crash record. Initially, these were for a temporary period of up to 18 months, to allow the authority to build the measures and ensure that the average speeds are at or below 20mph as defined in Circular Roads 4/90.

The initiative was based on experience internationally, which had demonstrated that lower speed limits could have safety benefits when combined with traffic calming measures to ensure that vehicles maintained low speeds through the zone. Road safety publicity messages at the time, such as the *“Kill Your Speed, Not a Child”* campaign highlighted 20mph speeds as crucial to reducing the risks of injury in a collision.

1.2.2. Road Traffic Regulation Act 1984 (Amendment) Order (1999)

Statutory Instrument 1999 No 1608, the Road Traffic Regulation Act 1984 (Amendment) Order 1999 amended the Act so that traffic authorities were no longer required to apply to the Secretary of State for permission to introduce a 20mph zone. Two distinct types of 20mph speed limit are possible:

- 20mph limits indicated by speed limit (and repeater) signs only (normally apply to individual or small numbers of roads but increasingly cover larger areas; and
- 20mph zones, designed to be 'self-enforcing' through the introduction of traffic calming measures (e.g. speed humps, chicanes).

Supporting guidance on implementing 20mph limits was provided in the Traffic Advisory Leaflet 9/99 (1999) '*20mph Speed Limits and Zones'*, which included detail on the spacing of repeater signs and the advice that that the form of speed limit chosen should not require unreasonable levels of enforcement by the police.

1.2.3. DfT Circular 01/2013 Setting Local Speed Limits

In 2013, DfT provided revised guidelines on the setting of speed limits, updating previous guidance. It emphasised the options available to authorities in introducing 20mph limits in urban areas and to assess speed limits in rural areas based on safety criteria:

- Authorities are able to set 20mph speed limits in areas where local needs and conditions suggest the current speed limit is excessive;

- The 01/2013 Circular recommends that where there is expected to be a positive effect on road safety, traffic authorities can use their power to introduce 20mph speed limits or zones on:

    - ❖ Major streets where there are, or could be significant numbers of journeys on foot, and/or where pedal cycle movements are an important consideration, and this outweighs the disadvantage of longer journey times for motorised traffic; and
    - ❖ Residential streets where the streets are being used by people on foot and on bicycles, there is community support, and the characteristics of the street are suitable.

- The Circular recommends that local authorities consider 20mph speed limits over larger areas with several roads where mean speeds are 24mph or less; and

- The Circular allows the application of 'hybrid' schemes combining 20mph speed limits with 20mph zones; and 20mph speed limits that apply only at certain times of day and are indicated by variable message signs (e.g. outside a school).

Traffic authorities are asked to have regard to this guidance, although it is not mandatory.

The Circular presents research into signed only 20mph speed limits suggesting they generally result in slight traffic speed reductions, and are therefore most appropriate for areas where vehicle speeds are already low (e.g. on roads that are very narrow due to engineering or on-road car parking). It is noted that if the mean speed is already at or below 24 mph on a road, introducing a 20mph speed limit through signage alone is likely to lead to general compliance with the new speed limit.

The Circular notes that self-enforcement has a key role in making 20mph speed limits work, particularly without the support of physical calming measures. Enforcement is therefore a crucial element for consideration as part of any speed limit scheme. The DfT and the Association of Chief Police Officers suggest that there should be no expectation on the police to provide additional enforcement beyond their routine activity, unless this has been explicitly agreed.

The Circular also notes the importance of capturing the full range of effects and benefits, which is supported by the accompanying Speed Limit Appraisal Tool which helps assess the effects of setting lower speed limits.

1.2.4. Main Evaluation Considerations

The guidance summaries highlight a number of considerations for the main evaluation research, with the most significant themes being around:

- How the guidance and scheme classification has evolved and will continue to evolve over time;
- How the DfT classify the 'suitability' of roads to implement a 20mph speed restriction; and
- Understanding how critical adequate enforcement is to scheme success.

Guidance also advises that the mean speed of a road should already be at or below 24mph to enable a good level of compliance amongst drivers in an area solely controlled by 20 mph signage. In addition the police, whilst supporting 20mph speeds, advocate implementing schemes which do not require unreasonable levels of enforcement beyond their routine activity. Therefore, where speed data is available for a case study scheme, it is important to investigate the mean speed of the road or area pre-scheme to see how successful it has been at fulfilling any speed reduction objectives post-scheme.

1.3. Report Structure

The remaining report is structured as follows:

- **Chapter 2: Approach to the Rapid Evidence Review** - presents the approach to the rapid evidence review (RER) and the publications reviewed;
- **Chapter 3: 20mph Speed Limits** – provides a summary of evidence relating to past research from the UK and Europe;
- **Chapter 4: 20mph Zones** - presents the findings of evidence relating to past research from the UK and Europe;
- **Chapter 5: 20mph Schemes and Shared Space** - summarises evidence relating to shared space schemes;
- **Chapter 6: Road Safety** - reflects the evidence review of accidents, collisions, casualties and traffic speeds;
- **Chapter 7: Speed Limits: Compliance and Education** - focuses on compliance to 20mph speed limits and the value of road safety campaigns;
- **Chapter 8: Road Collisions and Affecting Factors** - presents findings from the research on how different user and social groups have different rates of road casualties;
- **Chapter 9: 20mph Limits and Environmental Factors** - presents the overview of evidence on the effect of speed limits on social and environmental factors and
- **Chapter 10: Encouraging Active Travel** - provides a summary of evidence around the health benefits of encouraging active travel through the reduction of speeds and traffic flows.

2. Approach to the Rapid Evidence Review

2.1. Overview

The Rapid Evidence Review (RER) has been guided by the principles of the Magenta Book and completed in a structured manner, recording:

- Basic information including - Title, author, date of publication, journal and/or evidence source, geographic coverage, indicators covered by the publication;
- Focus of the publication - Information on whether the publication refers to the relevant speed issues, different social groups and their reaction to transport policy measures around speed and road safety; and
- Succinct review of each evidence source and key findings.

The review has primarily focussed on 'empirical' evidence, with a specific goal to try to identify any 'evidence gaps' that were present, whether related to a type of 20mph scheme, effect or vulnerable group.

2.2. Search Strategy

Relevant papers, publications, reports and journals were sought through an electronic key word search (Appendix A) on the following websites, covering the initial dates 2009 to 2014.

- ScienceDirect;
- Scholar.google.com;
- Websites of leading UK universities with a strong focus on transport and road safety, including: UCL, UWE, University of Oxford, Leeds ITS;
- European Transport Conference website;
- DfT website;
- Council websites, including Birmingham City Council, Portsmouth City Council, Bristol City Council;
- Most relevant legal acts such as the Road Traffic Regulation Act (1984); and
- Relevant academic journals and other papers in electronic libraries.

An initial screening of the paper abstracts and electronic filtering to identify those with the highest relevance to the key search terms enabled the prioritisation of appropriate evidence for the RER. This list was reduced and approximately 100 publications were identified for review. During the review a number of appropriate documents were identified, signposting to original or other relevant research and evidence, which were subsequently reviewed. The number of publications reviewed totalled 134 (see Appendix B), the majority of which were written on UK and Europe based studies and evidence. Whilst every effort has been made to identify all eligible publications, we cannot exclude the possibility of any selection bias.

The list of publications includes papers and reports covering speed limits, speed zones, collisions, traffic calming, and other topics including the effects of vehicle speed on the surrounding environment. A pro-forma was prepared, as part of the review process to capture the following information from each evidence source:

- Authors, title, year of publication;
- Information on which categories/social groups covered by the paper; and
- Brief summary of key points;

The selected papers were then fully reviewed and key evidence and messages captured under several topic themes as follows in the remaining report chapters.

3. 20mph Speed Limits – UK and European Evidence

3.1. Introduction

By definition, 20mph speed limit schemes occur where the speed limit has been reduced to 20mph without the implementation of any physical measures to reduce vehicle speeds[1]. Drivers are alerted to the reduced speed limit with a series of 20mph speed limit roundel repeater signs[2].

Such schemes are becoming more prominent within the UK, in part as a reflection of the widespread application of 30kph limits across many parts of continental Europe. Other key drivers for widespread implementation include the budget constraints faced by local authorities, with 20mph speed limits costing less than 20mph zones to implement and maintain. There has also been a growing acknowledgment of the role 20 mph limits can play in reducing road conflicts and enhancing the local walking and cycling environment.

In support of this changing viewpoint the DfT has continued to revise and update its guidance to make it easier for local authorities to introduce such limits, without the need for any physical calming (see section 1.2). The following sections in this chapter synthesise the findings on the general outcomes of 20mph speed limits, with later chapters focussing on specific outcomes including speed reduction, casualties, environmental and health benefits.

3.2. Summary of UK Evidence

According to RoSPA[1] (2012) and Cairns et al. (2014), the first 20mph limit was introduced in Tinsley, Sheffield on the junction between Raby Street and Sheffield Road; back in 1991. Since then speed limit schemes, in various forms have been introduced in Bristol, Liverpool, Oxford, Portsmouth and York. However more recently a new wave of 20 mph limits have emerged, with firm plans, or actual implementation of the speed limit occurring across a large number of local authorities, providing a timely opportunity to evaluate the effectiveness of such schemes.

Between 1998 and 2000, a national trial programme of advisory 20mph speed limits was undertaken, involving 75 residential areas across Scotland (Burns et al., 2001). The study found a reduction in average speed at 60% of sites following implementation of the 20mph speed reduction initiative. There was also a considerable drop in the number of recorded accidents per year after the introduction of the trial 20mph schemes. See Table 3-1 for further information.

Findings from the monitoring of two pilot 20mph speed limits in Portsmouth and Bristol were published respectively in 2010 and 2012. Whilst both studies reported a small reduction in average speeds within the 20mph speed limit areas, concerns were subsequently raised around the approach to the research and findings reported.

Early data from the Bristol 20 mph signed only pilot indicated slight reductions in average daytime speeds of 1.4 mph and 0.9 mph in the southern and eastern inner areas respectively, with 65% of roads seeing a reduction in mean speeds (Bristol City Council, 2012). A further evaluation study was published in early 2018, following the role-out of 20mph limits across the remainder of the city.

Atkins (2010) reported on the before and after research undertaken by Portsmouth which monitored speeds at 223 sites before and 18 months post implementation (Table 3.3). This suggested a reduction in the average speed of 1.3mph in areas with an average speed of <24mph and 6.3mph in areas with average speeds of >24mph. The report also noted a 22% reduction in casualties compared to a national reduction of 14% in comparable areas. Primary research undertaken found that resident perceptions on speed reductions in the area were mixed with 54% stating no change and 40% stating they felt speeds had decreased.

[1] Speed Limit Circular 01/2013. DfT.
[2] 20 mph limits are signed with standard terminal speed limit signs at entry and at least one repeater sign within the limit, (although sufficient repeater signs should be placed to inform road users of the speed limit in place)

However, given the relatively low numbers of casualties in each of the two pilot areas and the short period of analysis for the research, it is not possible to draw conclusions on the effect on casualty numbers. There is also less certainty regarding the effect of 20mph speed limits on other outcomes such as modal shift, air quality and noise.

The final UK study is more recent and was implemented in South Edinburgh in 2012 (Edinburgh City Council, 2014). The evaluation reported an initial reduction in average speeds of 1.9mph (from 22.8mph to 20.9mph) across 28 sites and Edinburgh City Council expect that this reduction will lead to a reduction in the number and severity of collisions.

Table 3-1 20mph Speed Reduction Initiative, Scotland

In 1997, in response to growing concern about the problem of inappropriate speed and its contribution to child pedestrian accidents, The Society of Chief Officers of Transportation in Scotland (SCOTS), invited Scottish Local Authorities to participate in a national trial programme of advisory 20mph speed limits in residential areas. Site selection criteria were issued, and 27 Councils submitted sites for consideration in the programme, with a total of 75 individual sites being accepted for inclusion in the trial. In order to monitor and evaluate the operation and outcome of the trial The Scottish Executive commissioned a three year programme of research. The research assessed the impact of these trial 20mph speed limits, some 18-24 months after the initial installation, considering limited data from all 75 trial sites, and intensive data from 8 sample sites.

Vehicle Speeds

- The study found a reduction in average speed at 60% of the sites following implementation of the 20mph speed reduction initiative.
- In general, the initiative was more effective at reducing speed at sites where the 'before' speeds were in the higher range.
- The overall average speed reduction was however modest, from 23.4mph before the scheme were introduced to 22.2mph after, a reduction of 1.2mph.
- Changes in the 85th percentile speeds followed a similar pattern, with a greater reduction observed where before speeds were higher. Overall, the 85th percentile speeds reduced from 29.4mph to 28.3mph, a reduction of 1.1mph.
- The proportion of traffic travelling faster than 20mph fell from 68% before the schemes were introduced to 62% after. At 46% of the sites in the after sample the average speed was below 20mph, compared to 32% of sites in the before sample.
- Overall, average speeds did not fall below 20mph after installation of the advisory signage, and the overall effect, whilst reducing speeds, was modest.
- Residents believed that there had been a noticeable reduction in speed with the introduction of the trial 20mph scheme, but that speeds had increased over time since then. It was felt that while resident drivers had reduced their speed, the schemes had not had the same effect on visitors to the area.

Accident Rates

- Accident data was provided by the Councils for 59 sites. There was a considerable drop in the number of recorded accidents per year after the introduction of the trial 20 mph scheme (from 31.3 to 18.2), and also a significant reduction in severity, with serious or fatal accidents reduced from 20% to 14% of the total. The 'Before' period had an average of 35 months while for the 'After' the average was 15 months.

Table 3-2 Bristol Twenty Miles Per Hour Limit Evaluation (BRITE) Study: Analysis of the 20mph Rollout Project

In July 2012, Bristol City Council voted to introduce 20mph speed limits throughout the city. This followed the completion of successful pilot schemes in South and East Bristol (implemented in 2010). The subsequent roll-out of 20mph speed limits was introduced in six phases. The first area implemented on 20th January 2014 covers Central Bristol and borders the two pilot areas. The process of introducing 20mph limits across the city was completed in September 2015.

Vehicle Speeds

Automatic Traffic Count (ATC) data was collected between 2014 and 2017 at a number of survey locations across the city, during one or two weeks a year (in winter and summer), providing over 36 million vehicle observations.

Analysis of the data showed a statistically significant 2.7mph decrease in vehicle speeds on roads where the 20mph speed limit was introduced, when controlling for other factors that might affect speed (areas, calendar year, time of day, season, type of road, and day of week). The largest reduction in speed was on 20mph A and B roads.

In the areas that stayed 30mph, there was a statistically significant negligible reduction in speed (0.04 mph).

In addition, Trafficmaster in-car Global Positioning System (GPS) data for six months before and six months after the introduction of 20mph limits was analysed. This dataset calculates speeds based on journey times along a road segment. Instead of measuring speeds at one point on the road, the data covers most routes in the city at a link-by-link level, for most times of the day.

Trafficmaster speed data showed a statistically significant reduction of 0.8mph on roads where the 20mph speed limit was introduced, with traffic speeds reducing from 17.8mph to 17.0mph. There appears to have been no attempt to control for background trends in speeds, as part of this analysis.

Accident rates

Annual rates of fatal, serious, and slight injuries are compared before and after implementation. The before period comprised between 34 months and 7 years, depending on the area of the city and actual implementation date; while the after analysis was based on between 15 months and 6 years of data.

The analysis shows annual rates of fatal, serious, and slight injuries following the introduction of the 20mph speed limits are lower than the respective pre-20mph limit rates.

However, no account has been made for background trend over time, and no statistical analysis was undertaken to interpret the results. It cannot therefore be determined whether the observed casualty reductions are related to the speed changes or are greater than the overall trend. Furthermore, the analysis separates out fatal, serious and slight injuries, despite the overall numbers involved being low.

Support

The study found a clear majority support for 20mph speed limits. However, it also identified a cynicism about lack of enforcement of 20mph limits, a lack of compliance from “other drivers” and an increased readiness to report that it is sometimes okay to drive above the posted speed limit on residential roads.

Table 3-3 Interim Evaluation of the Implementation of 20mph Speed Limits in Portsmouth

Portsmouth City Council was the first local authority in England to implement an extensive area-wide 20mph Speed Limit Scheme, covering most of its residential roads, and minor roads with schools and shops. The scheme was implemented between June 2007 and March 2008. It covers 94% of roads on the PCC road network (410km of the 438km of road length) that previously had a 30mph limit.

Vehicle Speeds

Spot speed data was collected at 223 sites across the six sectors. Data was collected from 0600 to 2200 hours, on the same day of the week in the 'before' and 'after' periods, on one day only.

- The average overall speed for the six sectors before the scheme implementation was 19.8 mph. This reduced to an average of 18.5 mph after implementation; a reduction of 1.3 mph.
- The biggest reductions in speed occurred at sites with higher 'before' speeds: <=20mph = -0.7mph; 21-24mph = -2.3mph; >=24mph = -7.4mph.
- Across all 223 sites: 50% recorded a decrease in average speed, 13% recorded no change, and 37% recorded an increase in average speed.
- Following implementation, the proportion of sites with an average speed of <=20mph increased from 63% to 71%. This suggests well over half of drivers were complying with the pre-implementation speed limit, although in many cases drivers were already driving at <=20mph.
- Primary research undertaken found that resident perceptions on speed reductions in the area were mixed with 54% stating no change and 40% stating they felt speeds had decreased.
- No comprehensive analysis of traffic volumes on affected roads was undertaken.

Accident rates

- Comparing the 3 years before the scheme was implemented and the 2 years afterwards, the number of recorded road casualties fell by 22% from 183 per year to 142 per year. During that period casualty numbers fell nationally – by about 14% in comparable areas. Detailed examination of causation factors did not show any noteworthy change in accidents related to inappropriate speeds or aggressive driving.

Mode shift

- Primary research showed that despite perceived improvements in the quality of the walking and cycling environment (46% agreed and 29% disagreed that the scheme had created a safety environment for walking and cycling), the introduction of the 20mph Speed Limit scheme had made little difference to the majority of respondents in terms of mode choice.

3.3. Summary of European Evidence

Toy et al. (2014) note that 30kph speed limits have been common place in continental Europe for over 30 years, with countries including Denmark, Sweden, The Netherlands and Germany introducing a number of schemes within main residential and retail areas.

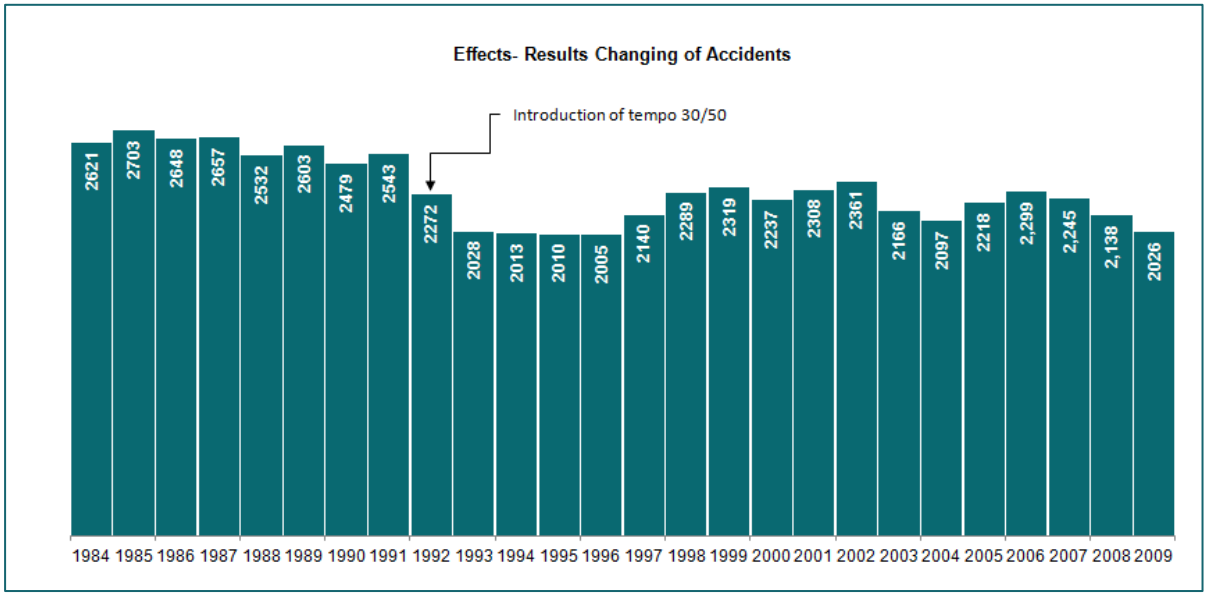
However most of these schemes involved an element of physical traffic calming, and whilst as cited by Jansen (1991); *"The safety effects of 30 km/h zones appear to have a positive effect on road safety. Speeds are lower, there is less through traffic and the residents are happy"* they are not pure 20mph speed limit schemes.

The city of Graz in Austria introduced a city-wide 30km/h trial between 1992 and 1994 which covered approximately 75% of the total road network. The trial was part of a city wide traffic plan which included a strategy to promote walking, cycling and public transport through improving infrastructure and an education/awareness campaign to limit the volume and speed of traffic in the city.

Wernsperger & Sammer (1995) undertook research to compare the before and one year after analysis of speed measurement and collision rates. They identified *'relatively small reductions in average speed'* and over the two year trial a 12% reduction in 'slight' injury collisions and a 24% reduction in 'serious' injury collisions. Whilst the trial was only for two years, it covered the whole city and thus the results are statistically significant (Wernsperger and Sammer, 1995).

Later research on the Graz scheme by Fischer (2010) compared the average number of accidents during the five years of implementation to the five years after. The research found a reduction in the average number of accidents in the immediate years after implementation; however as time progressed the number of accidents started to increase and fluctuate as shown in Figure 4.1. The causation for this fluctuation has not been concluded.

Figure 4-1 Accident numbers per year across the City of Graz 1984 - 2009



Source: Fisher (2010)

Analysis showed that the average and 85th percentile speeds dropped immediately at the commencement of the trial, with a sharp reduction in the higher speeds, whereby the proportion of those travelling at more than 50km/h in the 30km/h limits areas fell from 7.3% to 3% (Wernsperger and Sammer, 1995). However by 2002, the mean and 85th percentile speeds had increased and the speed reduction was only 0.4 km/h for mean speeds and 1.9 km/h for 85th percentile speeds (Fischer, 2010).

In addition to accidents and speed reductions, the effects on the local noise and air quality effects of the Graz scheme were analysed and are discussed later in this report (Chapter 9).

3.4. 20mph Speed Limits Summary

The review has summarised research into the limited number of 20mph speed limits schemes available across the UK and Europe and assessed their effectiveness.

Evidence from the UK is limited, but suggests that 20mph limits reduce average speeds by 1-2%. Primary research undertaken with residents' shows mixed views about whether or not speeds had decreased. However, due to research design and methodological constraints, the findings for Portsmouth and Bristol should be treated with caution, particularly in terms of explaining any measured changes in outcomes or effects.

The European evidence suggests there can be reductions in traffic speeds associated with the implementation of 20mph speed limits, but this is more likely over a period of associated enforcement, and it has been concluded that in the case of Graz, the initial speed reductions were not sustained over time. The same evidence suggests reductions in the number of collisions overall, however there is a gap of detailed evidence considering the causation factors for the reductions as well as a review of the type and severity of collisions.

3.4.1. Main Evaluation Considerations

Research has shown that data collected immediately after scheme implementation tends to be more positive (in terms of reducing collision rates), than data gathered over a year after implementation. The evaluation will look to identify case study schemes which enable a longer framework of research and if available analyse the data over more than one time period.

The types of data available and sought from our case study schemes needs to be consistent where possible and comprehensive, so not only considering speed measurements and casualty rates but also data around severity and attitudes and perceptions.

It will also be important for the evaluation to understand the drivers behind, and objectives of each case study scheme, as this data is lacking from current research. It will be insightful to consider whether there could be any measurable differences found across schemes implemented for different reasons e.g. casualty reduction versus health improvements.

4. 20mph Zones

4.1. Introduction

By definition[3], 20mph zones are where traffic speeds are limited to 20mph in combination with the provision of traffic calming road engineering measures to physically slow traffic. The design of the zones varies depending on the local environment, but typically they are marked by terminal signs at the entrance and exit of the zone, and traffic calming measures (such as speed humps, chicanes, and raised junctions) are placed every 100 metres. They are all designed to ensure slower traffic speeds using self-enforcing engineering and design features that comply with Traffic Signs and General Directions 2002 Regulations.

In 2011 AECOM, in association with the Tavistock Institute, was commissioned by the DfT to undertake a review of the implementation of 20 mph zones and limits in England. The research focused on the reason for using 20mph zones as well as the quantity and variability of the scheme designs themselves. Data was collected from a number of DfT databases and local authority case studies. The main findings were:

- There were at time of publication an estimated 2,150 20mph zones in operation across England.
- In the majority of case study authorities zones took the form of vertical traffic calming/ deflection measures, such as road humps, 1% of zones utilise horizontal measures, such as chicanes, and 3% contain a mix of vertical and horizontal measures.
- 10% of 20 mph measures in the case study authorities used for the study were speed limit controlled areas, using signing only.
- The average (case study authority) road network length incorporated within zones and limits was 2.7 km, with a range from less than 1 km to 25 km.
- In case study authorities the percentage of the total authority road network covered with 20 mph zones and limits varied from less than 1% to 44%.
- Schools provided by far the strongest rationale for introducing 20 mph zones and limits, even where there was no historic evidence from recorded casualties in the areas.
- The location of zones and limits did not appear to be linked to levels of social deprivation or the proximity to hospitals.

The following sections in this chapter summarises the findings on the general outcomes of 20mph zones, with later chapters focussing on specific outcomes including speed reduction, casualties, environmental and health benefits.

4.2. Summary of UK Evidence

From December 1990 local traffic authorities were able to apply to the Department for the authorisation of 20mph speed limit zones. By 1996, 200 schemes had been implemented across the UK and 82 of these had been granted permanent status (Webster and Mackie, 1996). From 1999, traffic authorities were no longer required to apply to the Secretary of State for permission to introduce a 20mph zone.

Webster and Mackie (1996) researched the effectiveness of 20 mph zones across England and the results indicated a significant reduction in average speeds and collisions. They examined 76 permanent schemes, 153 temporary ones and 11 planned schemes. The most quoted reason for applying for a 20 mph zone was accident reduction (60% of the reviewed schemes), indicating that safety was seen as the main justification for implementing these schemes. Most of the zones (80%) were in predominantly residential areas, with about 10% of the remainder being in town or city centres.

The comparison of before and after data for 72 of the schemes suggested the average annual accident frequency fell by 60% and child pedestrian and cyclist accidents fell by 70% and 48%, respectively (but there was no adjustment for background trends). Before and after speed data available for 32 of the schemes showed an average reduction in speed of 9.3mph, from 25.2mph to 15.9mph; leading to a 6.2% reduction in accidents for each 1mph reduction in speed. The study also found that traffic flow reduced by 27% within zones and increased by 12% outside the zones,

[3] Speed Limit Circular 01/2013. DfT

although data was only available for 19 schemes, and not necessarily the same schemes as those included in the speed data analysis. The study did not look at changes in walking, cycling, or children playing outdoors.

Following this research Mackie (1998) reviewed six UK 20mph zones in more detail, which had no new physical measures installed, although some had previously implemented earlier traffic calming measures. Analysis of the before and after data showed a small reduction in the mean speeds of approximately 1.5mph and accident frequencies showed no reduction, however it was noted the numbers were too small to draw any conclusions.

There has been a widespread introduction of 20mph zones in Hull since 1994, and by 2003, there were 120 zones covering 500 streets. Brightwell (2003) undertook an uncontrolled before and after review of casualty statistics covering the seven year period between 1994 and 2001 which showed an accident reduction of 14% in Hull, compared to an increase of 1.5% in the rest of Yorkshire and Humberside. Furthermore the zones experienced a 56% reduction in total collisions and a reduction of 90% in fatal and serious injuries. The biggest reductions were child pedestrian casualties, which fell by 74% over the seven year period. The schemes also achieved a high degree of community awareness and a low vandalism rate of the signs, with high levels of resident satisfaction with the zones. Kirby (2001), found that 25% of residents in Hull reported walking or cycling more and 60% felt that more children played outside as a result of the scheme.

The number of 20mph zones in London has increased year on year since they were first introduced in 1990/91, to a total 399 zones by 2007/08.

Webster and Layfield (2003) examined the effectiveness of 20mph zones in London. The study found that the frequency of injury accidents, road user casualties and the severity of casualties was substantially reduced. Allowing for background changes in accident frequency on unclassified roads in London, the installation of 20mph zones was found to have reduced the frequency of injury accidents within the zones by 42% and reduced the frequency of accidents involving fatal or serious injury by about 53% (across 78 zones).

Before and after speed data was only available for 14 of the schemes. The data showed average traffic speed reductions of 9.1mph following implementation. The report does not provide the before and after speeds for these schemes, but does report an average after speed of 16.6mph across 22 schemes, suggesting average speeds before implementation were around 25mph. Traffic flow reduced by an average of 15% in the 11 schemes for which flow data was available.

A major review of road casualties in London between 1986 and 2006 was published by Grundy et al. (2009). They found that during this time the introduction of London-based 20mph zones was associated with a 42% reduction in road casualties, after adjustment for underlying time trends. They found that 20mph zones were particular effective in preventing fatal or serious injuries to children, which were reduced by half (50.2%). They also established that there was a small reduction in casualties among cyclists, with a reduction of 16.9%.

The analysis further showed that the reduction in road injuries in 20mph zones occurred at a greater rate than the overall trend of reduction in casualties in London. The publication noted that this was not attributable to any regression-to-the-mean effect, and that there had been no displacement in the accident risk to roads close to the 20mph zones. Whilst they highlighted potential limitations to the research, such as the heavy use of STATS19 data, with its known under reporting they do caveat the fact that STATS19 reporting in London is better than the UK. They also acknowledge that the research cannot wholly attribute the outcomes to the introduction of the scheme as many other measures may have also had an effect.

Allot & Lomax in a report for DETR (2001) investigated through an uncontrolled study of six 20mph zones in the North West the changes resulting from the implementation of the 20mph zone. They found mean speeds fell by 5.5mph between traffic calming measures and 8.7mph at traffic calming measures across the six zones. However in some zones the 85 percentile speeds remained above 20mph. The analysis of between three – five years before and three years after of collision data showed the zones were experiencing between 30% - 100% reduction in collisions.

Steer Davies Gleave (2014) recently published a desk top review of 20mph speed limits and zones in London to inform future 20mph policy. A questionnaire was issued to all 33 local authorities with 15 responses received. The study concluded that there was clear evidence that ‘reducing vehicles'

speeds results in fewer and less severe collisions, particularly for vulnerable road users'. The 20mph signed only schemes tended to achieve smaller decreases in vehicle speeds and the challenge is to achieve larger decreases in vehicle speeds and changing driver behaviour.

4.3. Summary of European Evidence

Prior to 20mph zones being introduced in the UK, it had been recognised in the Netherlands that 30km/h was a suitable speed for residential areas and that vehicle speeds could be reduced through road design.

In 1984, regulations were introduced within the Netherlands which allowed its towns to reduce traffic speeds and volumes through such 30km/h zones. A number of Dutch studies reported a positive road safety effect as a result of such schemes. Elvik (2000) found that the average number of injury crashes decreased by approximately 25% when a residential area with a speed limit of 50km/h was redesigned as a 'Zone 30'. Similarly, Wegman et al. (2005) estimated that in 2002 654 casualties (fatalities and in-patients) were saved in the Netherlands (which was said to be 3% of the total number of casualties in the Netherlands). They go on to note that in the Netherlands, which embraced 30km/h during the 1970s, two large demonstration projects were conducted in residential areas in Eindhoven and Rijswijk in 1975/76.

Evaluation of these schemes, of which most involved physical traffic calming, found that road traffic injuries fell by 77% for all types of residential areas, and average speeds fell by 22%. Janssen (1991) (cited in Toy et al. 2014) reported on the effect, concluding that: "*The safety effects of 30km/h zones appear to have a positive effect on road safety. Speeds are lower, there is less through traffic and the residents are happy*".

Mackie (1998) reviewed research undertaken by Pfundt et al (1989) into the effects/outcomes of 24 30kp/h schemes with traffic calming measures against 36 30kp/h schemes without any physical measures (signs only). The analysis showed reductions in the 85th percentile vehicle speeds in sign only schemes was very small (average 1kp/h) in comparison to an average of 4kp/h for schemes with traffic calming measures. Furthermore the schemes with traffic calming also experienced a significant reduction in injury accidents with a 31% reduction for all injury accidents. Whilst Mackie (1998) states these results are significantly significant (at the 5% level) the results may be overstated as 'regression to the mean' was not considered. The changes in accident numbers in sign only schemes were not significant and hence reported as such.

Research by Engel & Thomsen (1992) in Denmark reported mean speed reductions of 11kp/h and a 24% reduction in collisions and 45% reduction in casualties as a result of the traffic calmed 30km/h streets.

Evidence from Europe as presented in the above and a specific case study in Australia (Woolley, 2005) support findings from the UK. The Australian evidence reported a reduction of mean speeds of between 1km/h and 2km/h on 50km/h roads and up to a 20% reduction in casualty numbers as a result of the widespread reduction of speeds to 30km/h speeds in Australia between 1997 and 2003.

Bunn et al (2003) undertook an international meta-analysis of the effect of area wide traffic calming schemes on injury collisions using controlled before and after studies. The review found that traffic calmed areas had an 11% lower risk of traffic collisions compared to control areas.

4.4. Unintended consequences of traffic management in 20mph zones

Kennedy et al (2004) studied the effect of road humps on both vehicles and their occupants, following the premise that road humps have been shown in a number of studies to be the most effective means of slowing vehicle speeds and reducing accident frequency. They reported road humps to be a very effective traffic calming device and have been used extensively across the UK as part of 20mph zones. They concluded that the levels of discomfort caused by the humps were only found at high speeds and the comfort levels were acceptable to different vehicle types, including taxis and ambulances, when driven over at a slower, more appropriate speed (not exceeding 15-20mph). The majority of the monitored vehicles showed no change in damping performance following the tests. The study did not find any evidence of vehicle damage from the

humps or significant and permanent changes to the vehicle's suspension systems, although ambulances and taxis were prone to having suspension problems if the vehicles were not driven at low speeds.

Other unintended consequences such as increased traffic emissions leading to worsening air quality are considered in Chapter 9, later in the report.

4.5. 20mph Zones Summary

From the evidence reviewed, there is a comprehensive message from across the UK and Europe demonstrating that 20mph zones can result in significant reductions in average speeds and collisions. The evidence presents reductions in casualties ranging between 20% - 45% on traffic calmed streets with the 20 mph zones, although some studies were not able to demonstrate a statistically significant change due to the small numbers. However, because of the challenges of researching the effect of traffic calming there have been very few well conducted studies in this area that enable us to state the evidence is robust or can be generalised.

There appears to be some unintended consequences of traffic calming measures implemented as part of a 20mph zone scheme: these include some journey time delays and increased emissions. It is important that the potential benefit of any 20mph zone or calming measure outweighs the wider effects, including the effect on the wider road network and air quality.

4.5.1. Main Evaluation Considerations

As far as possible from the available evidence, the main evaluation will seek to compare the outcomes of 20mph speed limits with those reported by 20mph zones. The evidence reports significant reductions in terms of speed and collisions, but wider outcomes are less well considered; hence the main evaluation is framed to collate such wider outcomes.

In general there seems to be a lack of clarity regarding 'pure' zones, 'pure' speed limits and hybrid schemes. Most research uses 'zones' and 'speed limits; as an overall term and does not distinguish between them and a hybrid scheme. The evaluation will therefore need to take account of this as far as possible when comparing effects and outcomes across case study schemes.

5. 20mph Schemes and Shared Space

5.1. Introduction

Shared space is an urban design approach which seeks to minimise demarcations between vehicle traffic and pedestrians, often by removing features such as curbs, road surface markings, traffic signs, and regulations. The DfT's Local Transport Note 1/11 'Shared Space' has been written to assist those designing and preparing street improvement and management schemes, and places a strong need for consultation ahead of implementation. The note suggests that in shared space, a design speed of no more than 20mph is desirable.

Recent studies have found that removing the traditional obstacles between traffic and people in urban areas can make streets safer and less congested (Hamilton-Baillie and Jones, 2005). The removal of barriers, signs, road markings and kerbs, compels road users (whether drivers, cyclists or pedestrians) to travel with more caution and heightened awareness for other traffic. This in turn results in slower and more careful traffic, increasing safety for cyclists and pedestrians and creating a more attractive urban environment. This informal road set up is commonly referred to as 'shared space'.

5.2. Shared space - Changes in Speed

"Shared space is a technique where the aim is to remove any implied priority of vehicular traffic over pedestrians, often by minimising the use of signing and other traffic management measures" Musselwhite *et al* (2010)

The shared space design philosophy differs dramatically from the typical 'segregate and control' approach that is normally incorporated into standard road safety design guidelines (Quimby and Castle, 2006). The shared space concept relies heavily on vehicle speeds decreasing naturally, due to the road environment changing in a way that alters the driver behaviour. Manual for Streets (DfT, 2007, cited in Moody and Melia, 2011) recommended that shared space was only appropriate in streets in the UK with low traffic volumes, and that the most successful shared space schemes relied on simplicity. There is no fixed design or speed limit for shared space schemes as each scheme adopts its own particular design features. Shared space schemes range in magnitude from junction only or limited to one road, to entire city centres (Quimby and Castle, 2006).

The successfulness of shared space schemes as a means to adapt traffic behaviour is critically dependent on speed, and hence why many European countries have also implemented 30kmh (~18mph) speed limits on all built up areas (Hamilton-Baillie and Jones, 2005), to go hand in hand with the shared space concept. It has been stated by The Department of Planning and Architecture at UWE (Sinnet *et al*, 2012), that the overarching objectives of UK based shared space schemes include a reduction in traffic flow and collisions, and an increase in pedestrian activity and other stationary activities in the area.

There have been mixed opinions on the effectiveness of shared space schemes, including opinions on the concept and views supported by findings. Opposition towards shared space schemes has been introduced from groups representing visually impaired and blind people, who benefit from a more traditional pedestrian/vehicle set up. Furthermore, the longevity of shared space schemes has been questioned, Moody and Melia (2011) state that the effectiveness of shared spaces may diminish over time as people get familiarised to the road situation. Currently, the speed reduction needed for a feasible shared space scheme is largely achieved through the creation of anxiety and unease amongst drivers and pedestrians, however this apprehension might lessen overtime as people get accustomed to using the scheme.

5.3. Shared Space Schemes within the UK and Europe

Shared space schemes have been introduced in a number of countries, most extensively in the Netherlands, and to a lesser extent in Denmark and Germany (Quimby and Castle, 2006). The UK also has shared space schemes including those in Wiltshire, Kent and London. Wiltshire County Council has been experimenting with the omission of centre line markings in villages with current 30mph limits (Hamilton-Baillie and Jones, 2005), consequently the council found that across a total of 12 sites between 2003 and 2005, collisions reduced from 17 to 11 per annum.

Hamilton-Baillie (2008) reported on a shared space scheme on Blackett Street in the centre of Newcastle-upon-Tyne, which was remodelled five years ago to allow non-motorised road users to move freely among the delivery traffic, taxis and buses that move through the urban space. It was concluded that personal injury collisions for non-motorised users has decreased as a result, although there was an informal protocol with the bus companies to maintain bus speeds to around 10mph.

Although research suggests a decrease in collisions and casualties, the perceived safety of a shared space scheme can sometimes be the overarching reason someone does not feel safe using it. Kaparias et al (2010) (cited in Moody and Melia, 2011) also state that pedestrians feel most comfortable sharing space in conditions that ensure their presence is clear to other road users. Their work found that young men were the most comfortable sharing space, whereas people with disabilities and older people felt more apprehensive about using shared space.

5.4. Shared Schemes Summary

There have been mixed opinions on the effectiveness of shared space schemes from the evidence reviewed and the longevity of shared space schemes has been questioned. There are concerns that the effectiveness of shared spaces may diminish over time as people get familiarised to the road situation. At a relatively early stage in share scheme development, there appears to be some research considering the effects of shared space schemes on traffic speeds and casualty rates but the findings are limited to small scale case studies. It is important for future research to monitor schemes over the long-term to assess if driver and pedestrian anxiety (the theory which underpins share space successfulness), diminishes over time as people get complacent.

5.4.1. Main Evaluation Considerations

Future research should consider recording traffic volumes before and after a shared space scheme has been implemented, in order to compare the collision rates. Changes in traffic volumes can have a large effect on the successfulness of a scheme, for example a shared space scheme with high traffic volumes may prove a hindrance to pedestrian accessibility, discouraging people to use it.

Shared space schemes are a form of transport initiative implemented to reduce vehicle speeds and improve safety for non-motorised road users, just as 20mph speed restrictions, 20mph zones and hybrid schemes all aim to do. Schemes that have been classified as shared space only should not be evaluated as 20mph zones or hybrid schemes, unless a 20mph zone or hybrid scheme consists of a variety of measures included shared space (i.e. a 20mph speed restriction and shared space elements).

6. Road Safety – Accidents, Collisions, Casualties & Speeds

6.1. Introduction

Lopez et al. (2006) cite that road injuries are among the leading causes of loss of life and disability worldwide and they are projected to make an increasingly important contribution to public health burdens over the coming decades (Mathers and Loncar, 2006) especially in low and middle income settings (Hyder and Peden, 2003).

Whilst the UK has a comparatively good road injury record, with injury rates among the lowest in Europe, the reduction in the injury rates remains a major aim of the DETR as evident in its *'Tomorrow's roads: safer for everyone'* publication (2000).

According to the Organization for Economic Co-operation and Development - OECD (2008), 90% of collisions are attributable to driver behaviour, such as excessive speed or alcohol consumption. Furthermore excessive speed was recorded as a contributory factor in 25% of all road fatalities in Britain in 2011 (04).

6.2. Accidents, Collisions and Casualties Definitions

Taylor et al. (2010) defines the difference between accidents and casualties. An **accident** may involve a single vehicle (for example a car colliding with a tree) but it more often involves other vehicles or other road users. A **casualty** is an individual road user who has been injured in an accident. The severity of the accident is defined by the most severely injured casualty (fatal, serious or slight). Therefore, in a personal injury accident there will be at least one, and possibly several casualties. The accident frequency is the number of accidents which occur on a given stretch of road per unit of time (usually per year).

Accidents can also be referred to as **collisions**. With accidents defined as *'an event that happens by chance or that is without apparent or deliberate cause'* some road safety professionals prefer not to use this term, instead using 'collision' which can cover both events that happen by chance and those due to a fault or deliberate act.

Most of the Government road safety statistics are based on accidents - as reported to the police (STATS19 system). These provide detailed statistics about the circumstances of personal injury road accidents, including the types of vehicles involved and the consequent casualties.

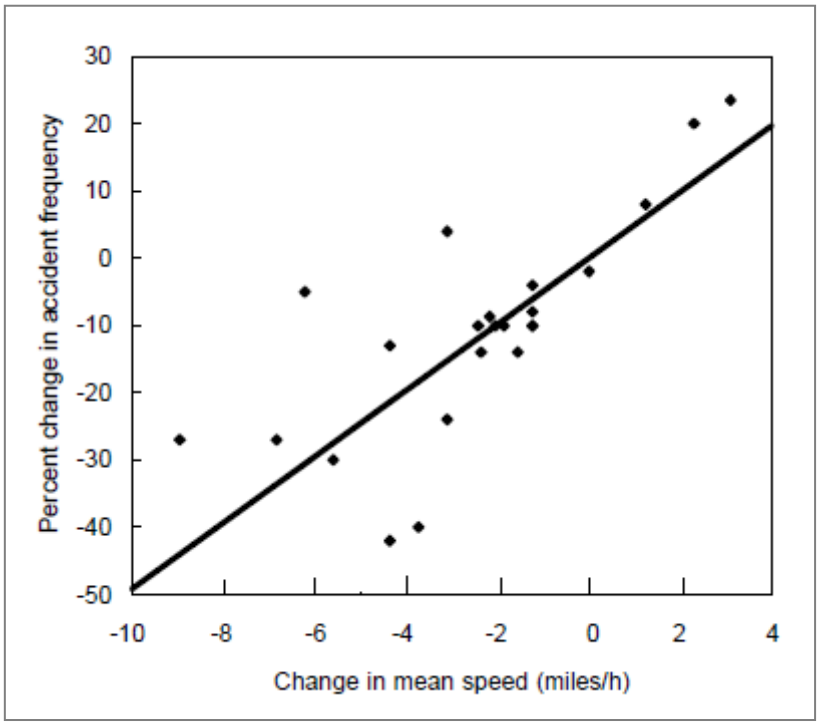
The terms used in this RER are reflective of the research papers they originate from.

6.3. Vehicle Speed and Accidents

There is a significant wealth of research demonstrating the link between increases in vehicle speeds and the increased rate of collisions. One of the more comprehensive sources of evidence is the TRL's Project Report PR58: *'Speed, Speed Limits and Collisions'* Finch et al. (1994) which provides an extensive account of the key speed and collision related research findings from the early 1960s onwards.

The research undertook a number of before and after studies of speed and collision data from across Europe, especially Scandinavia, and found strong evidence demonstrating a relationship between speeds and accidents - a decrease in speed reduces collisions, and a corresponding increase in speed increases collisions, as shown in the Figure 6.1 below.

Figure 6-1 A relationship between speed and collisions



Source: Finch et al. (1994)

Finch et al, 1994 concluded that a 1mp/h change in the mean traffic speed is associated with a 5% change in injury collisions. These findings are supported by Elvik (2009) who notes that there is good evidence internationally for the effectiveness of reducing the speed and volume of traffic for reducing injury rates.

TRL's Project Report 421 'The effects of drivers' speed on the frequency of road collisions' produced by Taylor et al. (2010) built on the above study. They found that the often-quoted broad result that a '*5% reduction in collision frequency results per 1mile/h reduction in average speed'* remains a robust general rule, but it varies according to road type and average traffic speed. The approximate reductions are as follows:

- 6% for urban roads with low average speeds;
- 4% for medium speed urban roads and lower speed rural main roads; and
- 3% for the higher speed urban roads and rural main roads.

Therefore the areas with the greatest potential for collision reduction are those within urban roads and low average speeds. However we know that driver speed is only one of a number of causes in collisions, hence why changes in speed limits only reflect a fraction of the change in average speeds.

In terms of the reasons for this Bellefleur and Gagnon (2011) suggested that increasing speed decreases a driver's field of vision, thus reducing the likelihood that a dangerous situation will be noticed in time. Additionally, increasing speed leads to an increased stopping distance, which means the distance travelled by the vehicle during the time it takes a driver to react plus the vehicle's braking time. This reduces the likelihood that the vehicle will stop in time to avoid a collision or reduce its severity.

There are a number of ways to quantify the relationship between changes in speeds and the number of accidents, with one widely applied approach being the exponential model. Elvik (2009) analysed evidence to best estimate a value of the exponents for different severity of casualty (commonly known as Nisson's power law). These values demonstrate that as speeds decline the number of fatal casualties will decrease more than the number of serious casualties.

6.4. Vehicle Speed and Pedestrians

The largest group of road user fatalities worldwide are pedestrians struck by motorised vehicles (Naci et al., 2009).

Research into the relationship between car speed and risk of injury shows that the risk of injury to pedestrians increases as speed increases (Richards, 2010) which is in line with the general speed to collision rate outlined above. Richards (2010) concluded that the risk of fatal injury rises most significantly above 30mph. At speeds up to 20mph, the risk of fatality rises very slowly and between 20mph and 30mph the risk increases slightly faster. However, Richards (2010) states that while the risk of a pedestrian being killed by a car travelling below 30mph is *relatively* low, about half of all fatalities where a pedestrian is killed by a car occur when the car is travelling below this speed. Whereas collisions between cars and pedestrians at 20mph only 5% of pedestrians are killed, whereas at 30mph about half are killed, and at 40 mph only 5% survive (Wramborg, 2005).

Similarly Rosen and Sander (2009) note that the risk at 50 km/h (31mph) is more than twice as high as the risk at 40 km/h (25mph) and more than five times higher than the risk at 30 km/h (18.6mph). They state that this shows the importance of keeping effect speeds as low as possible within city areas where most pedestrian collisions occur. This view is echoed by Public Health England (2014) who advocates a 'safe system' approach which acknowledges that human beings do make errors in traffic, but that 'road design is fundamental in preventing these errors from causing fatal or serious injury'. They go on to recommend that where speeds cannot be kept below 30mph pedestrians and cyclists should be segregated from vehicles through physical infrastructure measures.

Further to the above, the risk of injury for car drivers also increases with speed although the increase is much greater when the effect is on the side of the car as opposed to the front (Richards, 2010).

6.5. Bias in 'before' and 'after' road safety studies

Collision research, including the evaluation of the effects of safety measures, is not an exact science. The task of estimating the effect of a road safety scheme or traffic calming scheme is not straightforward and when undertaking a 'before and 'after' collision study there are a number of potential sources of error to be avoided. Whilst the mean collision frequency before and after the implementation of a traffic scheme can easily be determined, it is not simple to assign the collision frequency changes wholly to the scheme itself. Indeed, there are three main confounding factors that can alter collision frequency, outside of traffic scheme or safety 'improvements' themselves, these are:

a. Regression to the mean effects

There is the tendency for locations that have an abnormally high or low number or rate of collisions to regress over time towards an 'average' number or rate of collisions. Before and after studies need to control for this phenomenon so as to not overestimate the effectiveness of traffic schemes. This effect would be a factor for consideration where traffic scheme measures have been installed in response to an abnormally high number of collisions (Bellefleur and Gagnon 2011).

If sites are selected for treatment on the basis of a high collision frequency in the preceding (typically) three years (the site selection period), then a before/after comparison will almost inevitably lead to an exaggerated estimate of the effect of the treatment. The magnitude of this bias can be appreciable (and easily be on a par with the magnitude of the treatment effect itself) (Gains et al, 2005). However, if a scheme is not implemented on the basis of its collisions or casualties, i.e. it is selected for other reasons, then regression to the mean will not be a relevant issue.

To avoid regression to the mean, ideally, site selection should be carried out within the study, so as to ensure that the selection criteria are transparent and unrelated to prior collision frequencies Maher and Mountain (2009). If this proves difficult (e.g., because schemes have been implemented where collision rates are high), then great care will be needed in the analysis to isolate and remove the effect of regression to the mean. One approach (as described in 2010/2013 RAC Foundation speed camera report by Allsop, 2010) is to collect historical collision STATS19 data for the sites from a number of years before the scheme implementation, and use this as the baseline period alongside which the after data can be set. Either way, the post-implementation period is likely to be

short, hence the estimate of the effect of the change in speed limit is likely to be subject to appreciable uncertainty.

Hirst et al. (2004) state that in order to correct for regression-to-mean (RTM) effects in scheme evaluation, collision prediction models are used. Connors et al. (2013) state that because collision risk tends to decline over time on average, such models can become outdated and the estimated treatment effect is then exaggerated. New correction methods, such as that created by Hirst et al. (2004) should therefore be applied over time to effectively eliminate such errors.

b. Underlying collision trends

These trends are likely to be factors that are not related to the traffic intervention and include weather conditions, driving habits, public awareness campaigns etc. and need to be accounted for when determining the effect of a traffic scheme, generally by comparison with regional or national trends.

c. Collision migration

Following the introduction of a traffic scheme there can be an issue where collision locations are displaced and an increase in collisions can happen elsewhere within the road network. Explanations for this effect include “accident migration” which generally refers to traffic diversion following the implementation of a measure (Mountain and Fawaz, 1992 cited in Bellefleur and Gagnon (2011), as drivers seek alternative, possibly faster, routes.

These three factors will be mitigated as far as possible within our research.

6.6. Bias in speed and pedestrian collision data

Rosen et al. (2011) evaluated a large number of studies that considered pedestrian fatality risk as a function of car effect speed. Numerous research papers were investigated by Rosen et al (2011) with respect to data sampling procedures and methods for statistical analysis. They noted that it was correctly and uniformly reported that fatality risk does indeed increase in line with car effect speed. However, they did suggest that the risk estimates varied significantly across research papers.

Rosen et al (2011) found that without exception, papers written before 2000 were based on direct analyses of data that had a large bias towards severe and fatal injuries. The consequence of this approach was to overestimate the number of pedestrian fatalities. They also found more recent research was based on less biased data or had been adjusted for bias. While the conclusions of the research remain the same, and all showed a steep increase of risk with effect speed, the more recent papers provided substantially lower risk estimates than those written before the year 2000.

They recommend that, when using real-life collision data to establish a statistical relationship between injury risk and effect speed, it is important to consider the sampling procedures for the collision data collection. In particular, it is important to recognise most collision investigations are focused on serious and fatal end of the injury spectrum. They suggest that in the context of pedestrian casualties, it is common that sampling techniques will include some form of bias. They recommend that where this is substantial, it is advisable to derive weight factors – where the sample is compared against a national statistics database.

They note that it is also important that the study data and national data use the same definitions of injury severity. They found that in the reviewed studies, the proportions of fatally and severely injured pedestrians were generally higher than corresponding national statistics. They recommended this bias should be amended using weighting methods.

Under-reporting of national road collision data was also a problem highlighted in the reviewed evidence. Wee et al (2014) discussed how injury collisions are often not reported to, and recorded by police. They found that under-reporting of collisions varies from police force to police force and country to country. For example in Germany, The Netherlands and France, it is thought that the under-reporting of traffic fatalities varies from 5% to 12% whilst in Italy, under-reporting of traffic fatalities is estimated to be approximately 26%.

Within the UK as long as all drivers exchange details, there is no legal obligation to report a road traffic collision even if someone is injured. This leads to the problem of under-reporting of personal-injury accidents. Even when they are reported to the police the details of the accident and

casualties are not always recorded accurately, or indeed not recorded at all. The DfT (2012) has introduced questions in the National Travel Survey (NTS) asking about respondents whether they have been involved in a road traffic accident in which someone was injured within the last three years and the last 12 months. These responses can be used to estimate the total number of personal-injury casualties each year, including those that were not reported to the police.

6.7. Road Safety Summary

The reviewed evidence demonstrates that the rate of collisions increases as vehicle speed increases and vice versa. In line with this finding, the risk of injury to pedestrians also increases as speed increases.

Collision research, including the evaluation of the effects of safety measures, is not an exact science and there are a number of potential sources of error, such as regression to the mean, data sampling procedures to be mitigated and methods of statistical analysis to be applied.

6.7.1. Main Evaluation Considerations

The research will consider the extent to which traffic speeds and collision numbers alter as a result of the speed limit scheme. The evidence reinforces the importance of considering collision migration and the numbers of collisions on the wider/neighbouring road when considering the effectiveness of speed limit schemes.

Furthermore, it is also important within the provision of 20mph research to consider the effects of regression to the mean, background changes to regional and national collision trends, underlying collisions trends (such as adverse weather, local safety campaigns etc.) and collisions migration.

7. Speed Limits - Compliance and Education

7.1. Introduction

Given the correlation between vehicle speed and injury severity, it is important to consider the role of targeted speed management measures, such as education and enforcement effort, to ensure speed limit compliance. Though posted speed limit signs inform drivers of the speed, driving behaviour and speed education are elements that may aid compliance and could encourage safety and awareness of other road users.

7.2. Attitudes to 20mph speed limits

It is recognised that there are a number of challenges presented to local authorities and stakeholders when considering the implementation of, or managing, a 20mph speed limit. The attitude of drivers can effectively make a success of a scheme or limit its outcomes.

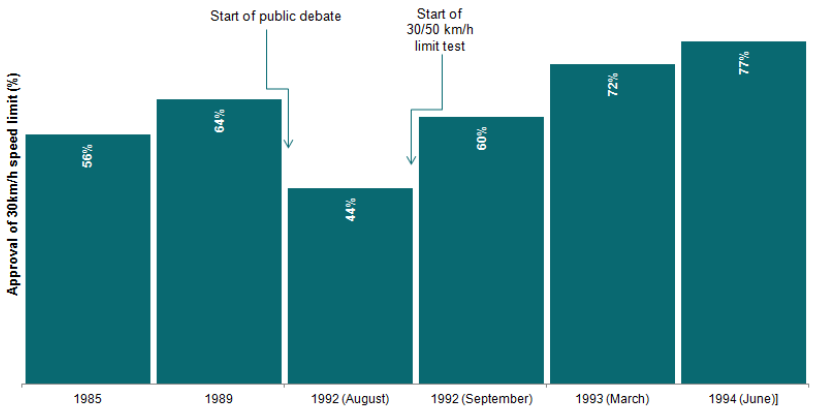
Stradling et al (2009) identified three types of drivers - low, moderate and excessive speeders. Over half fell into the low category – speed compliant, with a further 33% being moderate speeders i.e. between 5-10mph over the given limits and the final excessive speeders were more likely to drive over 10mph above the given speed limit. This evidence suggests that nearly a half of all drivers choose to drive at a speed that they feel is appropriate for the conditions, rather than driving at the given speed limit.

Supporting this evidence is Musselwhite et al (2010) who found that generally; drivers viewed speeding as dangerous but had less recognition of the link between speeds and accidents. That said, the evidence did show acceptance of lower speeds outside schools and around residential areas. They found that as a result of speed limit changes the speed reductions were often popular to start with, but could lead to increased anxiety if the limits were unrealistic and not adequately enforced.

The scheme in Graz noted the importance of public support for the 30 km/h speed limit and undertook telephone interviews before the introduction of the trial period (June 1992), just after implementation (October 1992), six months after (March 1993), and 18 months after implementation.

The results show that whilst there was initial enthusiasm for the scheme before implementation this declined just before the trial, with the majority not supporting the scheme. Wernsperger and Sammer (1995) suggest this could be because of uncertainty about the potential negative effects of reduced speeds as shown below.

Figure 7-1 Public support of the 30km/h scheme across the city of Graz



Source: Hoenig (2010)

7.3. Compliance with speed limits

Dinh and Kubota (2013) found that several demographic groups of people who are most likely to speed were identified as males, young drivers (under 30 years of age), less-experienced drivers (had their licence for 10 or fewer years), and people who travel a high number of kilometres (in excess of 20,000 per year).

Toy et al. (2014) discuss the issue of people repeatedly breaking the speed limit, despite the risk of being caught. They suggest that in this case there is a need to implement physical infrastructure methods to help to achieve better speed limit compliance. Musselwhite et al. (2010) notes that compliance could be increased through changes in infrastructure such as speed humps or through increased use of speed cameras. Both note that these measures have the potential to improve compliance at a local level but do not change long-term attitudes or underlying habits and additionally, are costly.

Toy et al. (2014) suggested that there is potential to use positive attitudes to shape behaviour change with 20mph limits, noting that evidence to date suggests that speed reductions associated with 20mph limits remain modest. They suggest that 'behaviour change' social marketing interventions could be used to support new 20mph areas to encourage drivers to comply with the lower limits. However their research paper was inconclusive, and whilst the application of a social marketing campaign may lead to changes of a few individuals, they tend to be temporary changes only in most cases.

The Association of Chief Police Officers (2013) state that it is essential for 20mph limits to be clearly identified and to 'look and feel' like the limit. In addition, ACPO wish for the communities to embrace the speed limit so they are naturally self-enforcing. Research has been undertaken to inform the National Driver Offender Rehabilitation Scheme (NDORS). Surveys were conducted with just under 1,000 motorists caught driving at 25 mph or above in 20mph zones and limits. The findings suggested that people thought 20mph zones/limits should be made more obviously different than 30mph. The majority of offenders were also local to the enforcement site.

7.4. Road Safety Campaigns

The evidence suggests that there can be reductions in collisions following road safety campaigns, particularly in the short term. Philips et al. (2011) conducted a meta-analysis of 67 studies evaluating the effect of road safety campaigns on collisions. From this they found that there can be positive associations between collision reduction and the use of personal communication and/or roadside media as part of a campaign delivery strategy. They note that campaigns with a drink-driving theme were associated with the greatest collision reductions, while some of the analyses suggested that it is beneficial to accompany enforcement with a short campaign duration (even less than one month).

7.5. Driver Enforcement

A literature review conducted for TfL considered how methods and levels of policing can affect casualty rates (Elliott and Broughton, 2005). The review of 100 studies from across the UK and Europe considers the effects of enforcement on collisions, driving violations and casualties. It concluded that whilst enforcement is beneficial, the effects are limited to the time and location of the implementation of the enforcement. The most effective enforcement measure was stationary and highly visible policing.

7.6. Speed Limits Compliance and Education - Summary and Gaps

The research shows there is mixed support for 20mph speed limits. It could be concluded from the Graz evidence that the public over-estimate the potential negative consequences of the proposal before implementation. A 2014 YouGov survey of Great Britain concluded that support is strong for 20mph limits in residential areas and busy streets but it was the view that enforcement by the police will be needed to ensure compliance. Further research has suggested that whilst enforcement is beneficial, the effects are limited to the time and duration of its implementation.

The research demonstrated the types of people most likely to speed. Potential measures to reduce drivers' speeds include physical engineering methods, social marketing interventions and road safety campaigns.

7.6.1. Main Evaluation Considerations

The research will consider the extent to which traffic speeds alter as the result of the implementation of a speed limit scheme and potential underlying factors associated with any such changes e.g. preceding speeds, perceptions of speed limits and enforcement levels.

A significant element of the main evaluation looks to understand the perceptions, attitudes and behaviours of drivers, riders, residents and local businesses. The outputs from this will identify whether there is any relationship between compliance and the success of the schemes.

8. Road Collisions and Affecting Factors

8.1. Introduction

Evidence shows that there are a number of differing factors affecting collisions and the severity of casualties which include road type, road user type, driver behaviour and socio and economic demographics of areas and local residents.

With regard to collisions and social groups Watkiss et al. (2011) found that the predominant social groups most vulnerable to road collisions include: younger and older people; low income groups; minority ethnic groups/high density housing and non-car users. 20mph speed limit schemes may have different drivers and objectives and in some cases may be implemented to aid those most vulnerable to collisions. Green et al (2011) also studied the relationship between child pedestrian casualties and deprivation (both in terms of the area and the people), using data from 783 LSOAs across Leeds and Bradford. They found that factors pertaining to the local environment were the most significant.

8.2. Accidents and severity over time

Within the UK, the risk of being involved in an accident and being hurt or killed whilst travelling on the roads has diminished over time. For example, in 1938 there were 314 casualties for every 100 million kilometres travelled whilst in 2012 there were 41 casualties per 100 million kilometres travelled. Similarly, since the 1970s the number of road deaths has fallen considerably, from over 7,700 deaths in 1972, to 1,754 in 2012 (Keep and Rutherford, 2013). Additionally the numbers of non-fatal casualties are at the lowest levels since records began, suggesting that over time there has been a relatively significantly reduced risk of being involved in an accident that leads to serious or slight injury (Keep and Rutherford, 2013).

8.3. Accidents and Road Type

Different types of roads have different levels of risk associated with them. Keep and Rutherford (2013) found that in terms of fatal accidents, 0.6% of casualties on built-up roads (typically speed limits of 30 or 40 mph) resulted in fatality compared with 1.9% of casualties on rural roads (up to 60 mph) and 1.0% on motorways (up to 70 mph). The lower rates on motorways over those found on rural roads are in part due to the higher design, engineering standards applied on the motorway road network and also the reduced number of pedestrian/cyclist conflicts.

Keep and Rutherford concluded that the risk of fatality resulting from a road accident is greater on roads with higher speed limits. However they also found that on average casualties (fatal and non-fatal) are more likely to occur on built-up roads, but the risk of fatality is decreased.

Egan et al. (2003), conducted a review of road schemes covering almost one hundred and fifty different roads. They found it possible to determine a number of effects of road types on the accident rates. They found that ‘out-of-town bypasses’ led to decreased injuries on main roads through or around towns, whilst ‘new major urban roads’ had statistically insignificant effects on injury incidence and ‘new major roads’ between towns, decreased injuries in the towns. The one caveat applied to the results was that there seemed to be a lack of information in the studies as to accident rates on secondary, parallel routes following the introduction of by-pass routes.

8.4. Accidents and Road User Type

Keep and Rutherford (2013) found that in 2012 UK car drivers and passengers accounted for 61% of road casualties, with 46% of road accident fatalities being drivers and passengers, and pedestrian and cyclist fatalities accounted for 24% and 7% of all road fatalities, respectively. Of those killed on the roads within the UK 19% were riders or passengers of motorcycles. The remainder were bus or HGV drivers/passengers.

The number of pedal cyclists killed or seriously injured increased every year between 2004 and 2012 (Keep and Rutherford 2013).

8.5. Accidents by time

Road casualties tend to occur when roads are busy and Keep and Rutherford (2013) noted that in 2012, within the UK 72% of road casualties and 65% of road deaths occurred between the hours of 4am and 6pm. Interestingly they found that the risk of a fatal accident is greatest after 6pm. Whereas one in every 125 casualties between 4am and 6pm was fatal, they found that the risk of fatality increased to 1 in 119 between 6pm and 10pm and 1 in 55 between 10pm and 4am.

8.6. Accidents and different age and social groups

Age is an important factor in assessing the likelihood of accidents. Li, H. et al. (2012) found that the involvement of older male and female drivers in serious road traffic accidents led to lower killed and seriously injured (KSI) rates than 17 to 24 year old drivers. However, there is an increased KSI rate in those aged over 70 years.

Li, H. et al.'s (2012) analysis of casualty rates of drivers by type of junction, manoeuvre and road conditions found that some gender-age groups are overrepresented in certain accident types. For example men are over represented in 'serious' accident rates, whilst older women are over represented in accident statistics when driving in poor conditions and turning right, negotiating roundabouts, crossroads and T, Y and staggered junctions.

Grundy et al (2008) evaluated the effects of 20mph zones on inequalities in road traffic casualties in London with specific analysis on area deprivation and ethnicity. The report concluded that for all casualties, child casualties, cyclists and car occupants there was no evidence that the effect of 20mph zones had been different for the three broad ethnic groups (White, Black and Asian). However analysis of KSI casualties and all pedestrian and child pedestrian casualties suggested the effects of 20mph zones had been less effective in reducing casualties in Black group compared with the White and Asian groups.

Grundy et al (2008) modelled the number of causalities that would have occurred if 20mph zones had not been implemented. This suggested that around half of those casualties saved in one year would have been in the most deprived quintiles, suggested these schemes mitigate any widening of casualty inequalities.

In terms of mode choice, Watkiss et al (2000) also found a link between the type of road user and accident rates, where the risk of serious injury or death for pedestrians, cyclists and motor-cyclists is much higher than for car drivers and passengers.

NICE (2009) a systematic literature review of the effectiveness of interventions designed to prevent injuries to children was examined. The report identified five UK based studies which had evaluated traffic calming schemes - 1 controlled (Mackie et al 1990), 3 uncontrolled before and after studies (Cloke et al 1999, DETR 2001 and Wheeler & Taylor 2000) and one smaller study (Jones et al 2005).

There is moderate evidence to suggest that area wide traffic calming may reduce child road casualty rates of any severity and in particular a reduction in KSI child pedestrian casualties. There is weaker evidence from three uncontrolled before and after studies - Chorlton (1990), Jones & Farmer (1993) and Mountain et al (2005) that single road traffic calming may reduce child road casualty rates and child pedestrian injury accidents.

A review of evidence presented in four UK based evaluation studies on 20mph zones – Webster & Mackie (1996), Grayling et al (2002), Webster & Layfield (2003) and Grundy et al (2008) showed moderate evidence that 20mph zones reduce KSI child casualty rates, and for child pedestrian rates when analysed separately.

The evidence review presented in the NICE (2009) report was updated in 2013 and identified a number of subsequent publications and research evidence. Including Watkiss et al (2000) found there were links between social class and accident rates and identified children as being particularly vulnerable, with children representing 30% of London's pedestrian casualties in 1997. MacGibbon, B. (1999) found that children in the lowest social class experienced four times more road accident deaths, and five times more pedestrian deaths than those children in the highest social class. Similarly, Christie (1995, reported in White et al., 1999) found that the risk of death for child pedestrians is highly class related and found that children in the lowest socio-economic group were

over four times more likely to be killed as pedestrians than children in the highest socio-economic groups. Moreover, NICE (2010, reported in Cairns et al., 2014) reported that the likelihood of death from car accidents among children and young people was over five times higher for those whose parents were unemployed, and this figure is over 20 times higher for pedestrians and cyclists. Furthermore, over a quarter of pedestrian injuries in children occur in the most deprived wards, which they suggest is caused by exposure to danger (i.e. high speed traffic being disproportionately located in lower socio economic status neighbourhoods) than individual behaviour.

Lowe et al (2011) undertook research on road user safety and disadvantaged areas on behalf of the DfT and reported that the likelihood of people from disadvantaged areas being involved in traffic accidents were related to living in more hazardous environments (dense housing and high levels of on street parking), higher exposure to road traffic (not being able to afford a car and hence walking) and not having access to safe spaces for children to play in.

On behalf of the Scottish Executive, White et al. (1999) completed a review of literature on road accidents and children in disadvantaged areas. White et al. (1999) concluded that, on the basis of the available evidence, children from disadvantaged areas seem to be exposed to greater levels of accident risk. They suggest possible reasons are that children in low-income families spend more time walking or cycling as they have less access to other modes of transport, they also lack access to a car for journeys to and from school, and lack of alternative modes of transport, all of which expose them to potentially more dangerous journeys on foot. They found that lack of access to a car could be associated with a doubling of the risk of injury as a pedestrian.

8.7. Accidents and ethnicity

Lawson and Edwards (1991) looked at accident rates in Birmingham, using fatality statistics (covering multiple years), police and health service data, as well as interviews with victims and drivers. They did this in order to map the geographic aspects of the data and the relevance of ethnicity in the findings. Their study found significant differences in accident rates across different neighbourhoods. They found a greater concentration of accidents in what they termed 'priority areas', which were described as areas in need of regeneration, or showing deprivation. Their study concluded that there was no significant overall difference in accident rates for ethnic minorities, however they did find a statistical difference in the rates for Asian children (aged 0-19). They found that the accident rate for Asian children was double that of non-Asian children, including those of other ethnic minorities. They found that there was a much higher incidence of Asian children being injured whilst emerging from between parked vehicles.

White et al., (1999) completed a review of literature on road accidents and children in disadvantaged areas for the Scottish Executive. They found significant differences in child pedestrian injury rates based on ethnicity. One of the studies considered in their review found that ethnic origin came through as an important accident indicator especially for 'non-white' children aged less than 11 years old.

Edwards et al (2006) show a relationship between deprivation and injury risk across London, with the strongest relationship with deprivation being associated to pedestrian *'the most deprived are over twice as likely to be injured as the least deprived'.* They suggest that there is something over and above such factors as road conditions, geometry and other local conditions that link these higher injury risks to those in more deprived areas. Exposure has been cited as being one reason, in that children and those with Black ethnicity are more likely to be travelling as pedestrian in deprived areas and thus more exposed to the risk of road traffic injury.

Christie et al (2010) revealed through analysis of child pedestrian casualties in the London Borough of Hounslow that children of black ethnic origin were over represented in these casualty figures, with many occurring in Somalia communities. Although the research was never intended to assess the effectiveness of engagement with such communities it highlighted the importance of identifying and engaging with all communities, especially within the more disadvantaged areas, where engagement is commonly limited.

8.8. Road Accidents and Affecting Factors - Summary and Gaps

This chapter concludes that accident rates for drivers, riders and pedestrians vary by time of day, road type, road user demographics and ethnicity. Such variation will need to be considered and tested within the research.

8.8.1. Main Evaluation Considerations

Given that, within the UK, the risk of being involved in an accident has diminished over time, it will be important for us to consider the underlying UK trends in accident statistics within any statistical analysis.

The evidence reviewed suggests that different types of roads have different levels of risk associated with them and so the research will need to consider how different road geometries and types could affect the success of 20mph schemes.

The research will need to be mindful of different social groups, ages and ethnicities, and in general vulnerable users, when selecting focus group participants for the research.

9. 20mph Limits and Environmental Factors

9.1. Introduction

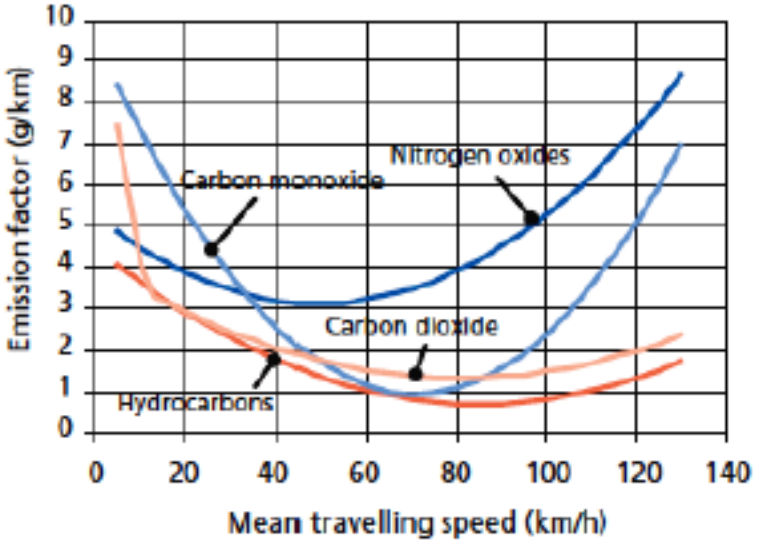
Traffic calming strategies are primarily promoted as a way to reduce traffic speeds and subsequently collisions and the consequential casualties, but it is also likely that they can affect the health of those living nearby. In particular, driving speeds and traffic volumes can be directly linked to air pollutant emissions and environmental noise levels (Bellefleur and Gagnon, 2011).

9.2. Air Quality

Traffic emissions are responsible for a significant portion of air pollutants including nitrogen oxides (NOx), carbon monoxides (CO), particulate matter (PM) and a variety of other unwanted chemicals. The air pollution caused by the presence of these emissions has been associated with increases in occurrence and prevalence of particular health problems, such as premature death, cardiovascular and respiratory diseases and cancer (Bellefleur and Gagnon, 2011). The quantity of vehicle emissions produced by vehicles varies depending on a number of criteria, one of which being the speed at which traffic is travelling.

As illustrated below in Figure 9-1, the relationship between vehicle emissions and vehicle speed generally follows the same trend as fuel consumption, which appears graphically as a U-shaped curve. Both fuel consumption and vehicle emissions are greatest at lower and higher speeds (Bellefleur and Gagnon, 2011).

Figure 9-1 Relationship between vehicle emissions and vehicle speed



Source: Bellefluer and Gagnon (2011)

Air quality findings for 20mph zones so far have been varied; some have resulted in no change in emissions and some that have seen an increase or decrease (Grundy et al., 2008). However, schemes that promote steady speeds can improve traffic emissions (TRL - Lawton et al 2012).

Williams (2013) shows that emissions differ according to fuel type and engine size, and concludes that it would be incorrect to assume a 20mph speed restriction would be detrimental to ambient local air quality. Williams evaluated the estimated impact of a 20mph speed restriction on vehicle emissions on six routes in central London. The study found:

- A greater range of speeds were observed on 30mph route segments compared to 20mph segments; and average cruise speeds were found to be higher on 30mph routes.

- NO_X emission factors were higher for petrol vehicles over 20mph drive cycles compared to 30mph drive cycles; for diesel vehicles they were lower. Given the higher contribution of diesel vehicles to emissions of NO_X, this is an important result.
- PM_{10} emission factors are lower for both petrol and diesel vehicles at 20mph compared to 30mph, with the exception of vehicles with engines in excess of 2.0 litres. The order of magnitude is such that future trends in fleet composition will be important.
- CO_2 emission factors follow the same pattern as NO_X showing increased fuel consumption when travelling at lower speeds.

Table 9-1 Impact of 20mph drive cycle on emissions in central London

Vehicle type	Drive cycle speed limit	NO_X (g/km)	PM_{10} (g/km)	CO_2 (g/km)
PETROL 1.4 – 2.0 litre, EURO IV	20	0.0726	0.00218	271.95
PETROL 1.4 – 2.0 litre, EURO IV	30	0.0673	0.00237	266.35
Impact of 20mph drive cycle		+7.9%	-8.3%	+2.1%
DIESEL 1.4 – 2.0 litre, EURO IV	20	0.7437	0.01758	201.58
DIESEL 1.4 – 2.0 litre, EURO IV	30	0.8104	0.01917	203.48
Impact of 20mph drive cycle		-8.2%	-8.3%	-0.9%

Traffic calming measures can affect vehicle emissions due to changing vehicle speed and acceleration rate (Boulter and Webster, 1997, cited in Grundy C et al., 2008). Although vehicle emissions are usually smaller at lower speeds, emissions may increase in 20mph zones as vehicles use more fuel to accelerate between calming measures. According to Williams (2013), measures with the least detrimental impact on vehicle emissions are those that induce the least variation in speed. Emissions were monitored on 10 routes with a range of different traffic calming methods (vertical deflection, horizontal deflection and psychological). Vehicles were often seen to exhibit a greater variability in speed on links with vertical deflection than those without; however, the impact of such traffic calming features was not thought to be as large as that of other traffic management features, such as pedestrian crossings and signalized junctions.

Additionally, traffic flows should also be a factor in deciding on an appropriate limit, as the quality of local air depends upon the number of vehicles using a road. It is therefore possible that in some situations the amount of traffic using a particular road could be reduced following the introduction of a traffic calming scheme (Atkins 2010), which would result in a decrease in emissions.

The recent DfT Circular (2013b) stated that air quality is one of a number of indicators that should be taken into consideration by traffic authorities, when implementing changes in speed limits. Butcher (2013) has suggested where limits of air quality are in danger of being exceeded, compliance with the air quality limits could be an important factor in the choice of speed limit. However, it is also emphasised that implementing speed limits is not always the solution, and that for any strategy to be effective there needs to be a good level of driver compliance. This compliance can be aided through the existing road characteristics and residential support.

9.3. Existing Air Quality Studies

Bristol City Council (2012) produced a monitoring report in order to assess the effect of two 20mph pilot areas had on the city, these were implemented as 'signs only' 20mph limits. These include the Inner South pilot and the Inner East pilot, which were implemented in May and October 2010 respectively. The council stated that modelling techniques had been used to measure changes in air quality as a result of the pilot studies, however the effect on air quality had been too small to be accurately measured (Toy, 2012). However, Bristol City Council (2012) also stated that there is a possibility that air quality may improve over time, as increasing numbers of people switch from driving to more sustainable modes of travel.

Due to uncertainties in the extent of the effectiveness of 20mph limits and zones can have on air quality, only some evaluations of 20mph limits have attempted to quantify the affects. Portsmouth City Council did not evaluate noise and local air quality as a result of 20mph implementation (Atkins 2010), as they did not envisage any negatives. However, in other studies air quality has been measured. In Graz, Austria, 30kph (18mph) zones were introduced in the 1990s, through most of

the city. Here it was found that there had been a dramatic reduction in both air and noise pollution (Pilkington, 2000).

TRL research, Boulter et al. (2001), considered the effect of traffic calming measures on air quality. The evidence reported that the mean emission rates of Carbon Monoxide, Hydrocarbon, Nitrogen Oxide, and Carbon Dioxide from petrol non-catalyst, petrol catalyst, and diesel cars increased by up to 60% following the introduction of traffic calming measures. However, it was estimated by TRL that the increased emission rates were not expected to lead to poorer local air quality.

Williams (2013) monitored the impact of 20mph speed restriction in central London, and concluded that it would be incorrect to assume a 20mph speed restriction would be detrimental to ambient local air quality.

9.4. Noise

Although there are fewer reported health effects as consequence of increased noise levels than those associated to air pollution, Bellefleur and Gagnon (2011) state that an increase in noise annoyance can result in deterioration to the quality of life for local residents. Noise is an underestimated threat that can result in several short and long term health complications, for example sleep disturbance, cardiovascular problems, poorer work and school performance and hearing impairment (WHO Regional Office for Europe, 2014[4]). Furthermore, Bellefleur and Gagnon (2011) also state noise disturbance can lead to fatigue and feelings of depression and obesity.

Bellefleur and Gagnon (2011) report that a range of traffic calming studies have concluded that the following five situations can influence the level of motorised noise within an area, these include:

- A change in vehicle speeds;
- A change in speed variations;
- A change in traffic volume;
- The implementation of textured materials; and
- The introduction of vertical deflections (i.e. speed humps).

Vehicle noise increases with speed (Bellefleur and Gagnon, 2011). However, increasing the magnitude and frequency of accelerations and decelerations, tends to also increase the noise generated. This type of driving is characteristic of areas with traffic calming. Local residents are likely to have concerns about how a change in vehicle speeds will affect the noise and air pollution levels near where they live. The type of measure implemented can have very different effects on noise, Grundy et al (2008) state that slower moving traffic tends to be quieter, however the constant braking and acceleration between traffic calming measures can increase noise and disturb local residents.

Additionally, the types of vehicles using the road may also have varying effects, noise surveys in Slough and York (Taylor et al. 1997, cited in Grundy et al., 2008) found that traffic calming measures reduced vehicle noise for light vehicles but heavier vehicles tend to be noisier. However, Bellefleur and Gagnon (2011) state that on traffic calmed roads, cars tend to generate more noise as a result of slowing down and speeding up as a result of a varied road layout, than heavy vehicles. This is supported by Kennedy *et al*., (2005) who state vehicles having to travel around vertical deflections can generate increased noise and vibration.

9.5. Existing Noise Studies

Monitoring of the implementation of 20mph areas in Bristol's Inner South and Inner East 20mph limit areas (Bristol City Council, 2012) has shown that the introduction of 20mph areas has had a negligible effect on traffic noise (the same result it concluded for air quality). However, during a residents' consultation over the same area, the residential perception of the local traffic noise levels had changed. The proportion of residents in a survey carried out prior to the pilot areas who felt that traffic noise was noisy/bad was 50% (Inner South) and 34% (Inner East), post implementation this had decreased to 30% (Inner South) and 26% (Inner East) of residents. In conjunction with the resident survey another survey was carried out for those who live and work on the busier main roads that pass through the pilot areas. The respondents from this survey also felt noise had decreased, but not to the extent the residents had perceived.

[4] http://www.euro.who.int/en/health-topics/environment-and-health/noise

Bristol City Council (2012) concluded that there had been a very slight decrease in noise, but it was not enough to make the effect significant. It was also stated that the model used may not capture the full benefit of the scheme in terms of noise reduction as it is not sophisticated enough to capture the effect of smoother driving behaviour, which may result as a consequence of the decrease in speeds.

9.6. Environmental Factors Summary and Gaps

From the evidence reviewed, it is apparent there have been mixed results. Notably, Portsmouth 20mph limits did not attempt to quantify the effect on air quality and noise levels as a result of the 20mph limit implementation, as they did not predict that there would be any change. Both air and noise levels were measured for the Bristol 20mph limit study, but these results proved too small to quantify and therefore the results were reported as negligible. The evidence appears to conclude that when emissions have been measured the change is small and the direction of the change is on the whole inconclusive.

Although theoretical research suggests variations in speed would have an effect, it suggests this would be felt in 20mph zones, which include traffic calming, and not in areas with 20mph limits, which have been noted to initiate a smoother driving style. The traffic calming apparent in 20mph zones, causes vehicles to accelerate and break more frequently, which can produce more emissions and create more noise. This can be exacerbated by high traffic flows and is heavily dependent on the vehicle types using that road.

9.6.1. Main Evaluation Considerations

As there is little existing data and information on the effect 20mph limits and zones have on air quality and noise levels, it is important that in future evaluations where this data is available, it is collected and analysed. The evidence suggests that changes in exhaust emissions are difficult to measure and therefore the schemes included within the main 20mph speed limit evaluation will not attempt to quantifiably measure the effect of the schemes on air quality.

Additionally, it is important that methods for data collection are continually improved. This is particularly important for monitoring air pollutant levels, as using detection receptors is usually the only means of capturing this data. On the other hand, changes in noise levels can also be addressed through public consultation, as changes in noise are better perceived than changes in air pollutants.

10. Encouraging Active Travel & Community Cohesion

10.1. Introduction

Reducing vehicle speeds can reduce social exclusion and increase 'healthy' modes of transport such as walking and cycling, with one of the many objectives and desired outcomes of speed reduction schemes being to encourage active travel (walking and cycling) and create cohesive, vibrant communities. Both these outcomes lead to improved health and wellbeing of local people and consequently an improved quality of life.

10.2. Encouraging Active Travel

Morrison et al. (2004) assessed the secondary health effects of a traffic calming scheme using a randomly selected sample of the local community and pedestrian counts to determine the effect of a road six months before and six months after the implementation of the traffic calming scheme (zone). They found that there were increases in observed pedestrian activity in the area after the introduction of a traffic calming scheme. They noted that after the introduction of the traffic calming scheme 20% of respondents said that they walked in the area more as a result of it. There were smaller percentages of respondents who said that they cycled or allowed children to play, walk, or cycle as a result of the traffic calming scheme.

Similarly, Martin (2006) notes that historic research has shown that pedestrians are happier to cross a road when traffic speeds are low, and that when traffic volumes are high, pedestrians will increasing use more formalised crossing points (Gardener, 1989, Daff et al, 19991 cited in Martin, 2006).

Parkhurst and Shergold (2009) identified a gap in the evaluation of safety, which they state as being the 'fear' of collisions. They report that there is little research into how the 'fear' of collisions may suppress travel by modes such as walking and cycling. Failure of drivers to change behaviour that intimidates non-motorised road users may also contribute to perceptions of fear: data show that 'near miss' incidents are a key factor shaping cyclists' perceptions of risk and likelihood to cycle (Sanders, 2013). Thus, improving driver behaviour has the potential to encourage active travel.

However Parkhurst and Shergold (2009) also note that sometimes mitigation measures designed to help pedestrians and cyclists may not actually be used as intended, leading to safety issues. In a case study involving a ring-road around a country town (James, 2005, cited in Parkhurst and Shergold, 2009) where it was observed that pedestrians still undertook dangerous road crossings on the new road, even though a 'safer' route had been provided near (but not actually on) the pedestrian 'desire line'.

An umbrella review of the effects of 20mph zones and limits by Cairns et al. (2014) found mixed evidence regarding walking and cycling levels. A study by Kirby (2001), which assessed 20 mph zones in Hull, found that 25% of residents reported walking or cycling more and 60% felt that more children played outside as a result of the scheme. However, studies by Webster et al. (2006) and Babtie (2001) found no significant changes in cycling, walking or children playing outdoors, and a study by Social Research Associates (2001) reported a negative effect of 20 mph zones with unanticipated declines in walking and cycling.

10.3. Health Effects

The International Transport Forum research report (2012) considered the health benefits of walking. Several studies have researched the effects of regular physical activity which include preventing/delaying the onset of high blood pressure and cholesterol, reducing the overall risk of developing cancer (Cavill et al. 2006), reducing the risk of developing type 2 diabetes and improving cardio-respiratory fitness (Warburton et al. 2010). In addition to improvements in physical health, active travel can also improve people's mental health; reducing risks of depression and cognitive decline through social interaction (WHO, 2010)

Promoting active travel may result in modal shift from car travel which facilitates the environmental effects presented in the previous chapter. These effects will have health related consequences including reduced respiratory and cardiovascular disease (Woodcock et al, 2007) and sleep disturbance and stress (Berglund et al, 2005).

NICE (2010, reported in Cairns et al., 2014) also reported that health inequalities can be reduced though the use of traffic calming measures, which can improve safety perceptions and consequently encourage the uptake of physical activity (such as more walking and cycling).

The main risks associated with active travel is increased exposure to emission and injury through collisions with vehicles, and whilst the evidence shows that increased rates of walking and cycling do not increase the number of pedestrian/cyclist accidents proportionally (Jacobsen, 2004) they may improve the awareness of motorists of their presence.

The WHO (2011) released a Health Economic Assessment Tool (HEAT) for walking following on from the early released cycling tool which enables practitioner to monetise a net health benefit for introducing policies, schemes encouraging active travel.

The health and economic assessment tool (HEAT) for cycling and walking:

- is intended to be part of comprehensive cost–benefit analyses of transport interventions or infrastructure projects;
- complements existing tools for economic valuations of transport interventions, for example on emissions or congestion;
- can also be used to assess the current situation or past investment;
- is based on best available evidence, with parameters that can be adapted to fit specific situations. Default parameters are valid for the European context.

HEAT can be applied in many situations, for example it can value the mortality benefits from current levels of cycling or walking, such as benefits from cycling or walking to a specific workplace, across a city or in a country. It can also be used to provide input into more comprehensive cost–benefit analyses, or prospective health effect assessments in order to estimate the mortality benefits from achieving national targets to increase cycling or walking, or to illustrate potential cost consequences of a decline in current levels of cycling or walking.

10.4. Summary and Gaps

To date the reviewed research has found only limited conclusive evidence that speed limit changes in isolation from other measures have an effect on walking and cycling levels. However, this is not to say that changing speed limits does not influence walking and cycling activity in some cases.

10.4.1. Main Evaluation Considerations

As there is little existing data regarding the effect 20mph speed limits have on pedestrians and cyclists, it will be difficult to compare our findings to any past research. The majority of the research has focused on physical measures such as traffic calming and 30mph road environments.

Changes in perception of any model shift or reduced feeling of risk could be addressed through focus groups.

Appendix A. Key Search Terms

A.1. Key Search Terms

No	Search terms
1	20mph speed limit
2	speed limits
3	speed limit road traffic collisions/collisions
4	traffic calming
5	speed limit zones
6	hybrid traffic schemes
7	advisory road signs / signs-only
8	speed limit signing
9	speed social groups
10	speed road safety
11	speed limit vehicle operating costs
12	speed limit wider economic benefits
13	speed limit noise
14	speed limit air quality
15	speed limit severance
16	speed limit accessibility
17	speed limit physical fitness
18	speed limit aversion behaviours
19	speed limit intrinsic value/journey quality
20	speed limit NMUs
21	speed limit compliance
22	speed limit distributional effects
23	speed limit effects of transport policy
24	speed limit elderly
25	speed limit children
26	speed limit public transport
27	20mph zones
28	20mph hybrid schemes
29	speed quality of life
30	speed road geometry
31	speed mode shift

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