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**Go slow: an umbrella review of the effects of 20mph zones and limits on health and health inequalities**

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## **Abstract**

**Background:** Transport is an important determinant of health and there is a well-established association between socio-economic status (SES) and risk of road accidents. Effective traffic calming interventions such as 20mph zones and limits may therefore improve health and reduce health inequalities.

**Methods:** Systematic review methodology was used to identify systematic reviews of the effects of 20mph zones (including speed limits and road humps) and 20mph limits on health and SES inequalities in health amongst adults and children.

**Results:** Five systematic reviews were included. Overall, they provide convincing evidence that these measures are effective in reducing accidents and injuries, traffic speed and volume, as well as improving perceptions of safety in two of the studies. There was also evidence that such interventions are potentially cost effective. There was no evidence of the effects on SES inequalities in these outcomes.

**Conclusion:** 20mph zones and limits are effective means of improving public health via reduced accidents and injuries. Whilst there was no direct evidence on the effects of interventions on health inequalities, targeting such interventions in deprived areas may be beneficial. Further controlled evaluations that specifically examine SES effects are required.

Abstract word count = 189

## BACKGROUND

Transport is a well-known social determinant of health [1]. There is also a well-established association between socio-economic status (SES) and risk of road accidents, with the lowest SES group in England and Wales being five times more likely to be injured in accidents compared to those in higher SES groups [2]. Moreover, the 2010 NICE guidance report [3] on preventing unintentional injuries among children and young people states that the likelihood of death from car accidents (as a car occupant) is 5.5 times higher for those whose parents are unemployed and this figure is more than 20 times higher for pedestrians and cyclists. In the same way, over a quarter of pedestrian injuries in children occur in the most deprived wards [3]. The NICE report further suggests that the main factor behind this is exposure to danger rather than individual behaviour. For instance, high-speed traffic is disproportionately located in lower SES neighbourhoods. SES inequalities in road traffic accidents are evident in other parts of Europe and the US. For example, a 2007 report by the European Transport Safety Council report, found that the most deprived areas have higher rates of injury from road traffic accidents and car occupant death [4]

Traffic calming originated in mainland Europe and it was introduced in the UK following successful schemes that had improved safety in urban areas of Europe [5]. Traffic calming is defined as measures to reduce speed and hence improve safety, especially for vulnerable road users, including reduced speed limits or reduced speed zones (where road humps, mini-roundabouts, cushions etc are used to reduce traffic speed) [6]. Measures may be sophisticated in design as illustrated by the Dutch 'Woonerf' model (otherwise known as *Home Zones*) implemented during the 1970s whereby cyclists and pedestrians were given priority over cars [7] through physical alteration to streets. However, the standard methods usually implemented in the UK are less broad and tend to just include road humps and road narrowing NICE recommend that such traffic calming measures be implemented to reduce speed (including changes to the speed limit such as implementing area-wide 20 mph limits) and with the aim of reducing casualties. In addition, the Department for Transport [6] has also recently advocated 20 mph zones or limits (see

Inclusion Criteria section\_for distinction) in primarily residential areas and in towns or cities where pedestrian and cyclists are highly concentrated, such as around schools. There have been suggestions that such measures can be effective in improving health by reducing accidents [8,9].

Local authorities in the UK have used traffic calming measures to reduce accidents since the 1990s [1]. For example, the first 20 mph speed limit was introduced in the UK in the 1990s when Sheffield implemented a 20 mph speed limit in Tinsley. Shortly after the Tinsley scheme, Kingston-upon-Thames and Norwich introduced 20 mph zones. Given the transfer of public health teams into local authorities, NICE guidance, and the growing evidence base around traffic calming, provides a real opportunity for local authorities to connect transport and health in an effective way. This has been reflected in a recent call to reduce health inequalities through local action on speed [2]. For example in 2011/12, Burnley trialled 20mph zones (and saw reductions from 46 to 25 casualties).[7] The intention behind 20mph zones and limits is often multi-faceted but improving population health and reducing health inequalities by reducing accidents is often a key factor. However, despite the increasing popularity of such interventions, there have been no recent attempts to systematically synthesise research on the effects on health of these interventions (since the work of Morrison et al in 2003) [9], and there have been no prior attempts to synthesise the effects on health inequalities. Nor has there been the opportunity to compare different types of traffic calming e.g. 20mph zones compared to limits. This is despite suggestions that such interventions can be effective in reducing SES inequalities – for example by targeting more deprived areas which often have higher traffic density and higher accidents and casualties.[8] Health inequalities may also be reduced through traffic calming measures that encourage the uptake of physical activity (e.g. more walking and cycling due to better road/pavement design, increased perceptions of safety), thereby overcoming some current barriers to active transport (walking/cycling) [10].

Examining evidence from systematic reviews (an umbrella review) regarding the effects of 20mph zones and limits on health and health inequalities is thereby an important first step in establishing an easily accessible and policy-relevant evidence base for local authorities considering different types of traffic

calming measures. It will also identify any evidence gaps for researchers planning to conduct primary evaluation studies or new systematic reviews. In 2013, we were requested by Durham County Council to produce an umbrella review of the health effects of 20mph zones and limits to inform their decision making in this important area.

## **METHODS**

### **Research question**

What are the effects of 20mph zones and limits on health and health inequalities?

### **Study design**

Systematic review methodology was used to locate and evaluate published systematic reviews of the effects on health and health inequalities of 20mph zones and limits ('umbrella' review) [11-12]. Umbrella reviews are an established method of locating, appraising, and synthesizing systematic review level evidence. [13] They use systematic review methodology to locate and evaluate published systematic reviews of interventions. Umbrella reviews are therefore able to present the overarching findings of such systematic reviews (usually considered to be the highest level of evidence) and can also extract data from the best quality studies within them. [11] They therefore represent an effective way of rapidly reviewing a broad evidence base. Umbrella review methodology is an increasingly commonly-used technique in public health research. [11]

### **Inclusion Criteria**

Following standard evidence synthesis approaches, [12] the inclusion criteria for the review were determined *a priori* in terms of PICOS (Population, Intervention, Context, Outcomes and Study Designs).

- *Population:* Children and adults, all ages.
- *Intervention:* 20mph zones and limits. 20 mph limits consist of simply changing the speed limit to 20 mph using signage, whereas zones include additional traffic calming measures in whole areas in addition to changing the speed limit. Such traffic calming measures may, for example, include installation of road humps or mini-roundabouts.
- *Context:* Any country, any location, English language only and publications from 1990
- *Outcomes:* Health and SES inequality outcomes. Health inequalities were defined as differences by income, education, or occupational class, including area measures e.g. area-level deprivation. Primary outcome measures included morbidity, health behaviours (especially physical activity such as walking and cycling), mortality, accidents, and injuries. Where additional data was provided, secondary outcomes included cost-effectiveness, public acceptance of schemes, and perceptions of safety.
- *Study Design:* Systematic reviews of quantitative evaluation studies. Following the methods of previous umbrella reviews [11], publications had to meet the two mandatory criteria of Database of Abstracts of Reviews of Effects (DARE): (a) that there is a defined review question (with definition of at least two of, the participants, interventions, outcomes or study designs), and (b) that the search strategy included at least one named database, in conjunction with either reference checking, hand-searching, citation searching or contact with authors in the field.

### **Search strategy**

Twelve databases were searched from 1990 to September 2013: Campbell Collaboration, Cochrane Library (includes Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, Cochrane Methodology Register, Database of Abstracts of Reviews or Effects (DARE), Health

Technology Assessment Database, NHS Economic Evaluation Database, and About the Cochrane Collaboration), EMBASE, PsycINFO, Centre for Review and Dissemination, Database of Promoting Health Effectiveness Reviews (DoPHER), EPPI CENTRE, SafetyLit, Transport Research Information Service (TRIS), PROSPERO, MEDLINE, Applied Social Sciences Index and Abstracts (ASSIA). The electronic search strategy is presented in Box 1. To complement these searches, grey literature was also searched as well as the following websites: ROSPA, NICE, Department for Transport.

**Box 1: Electronic search strategy**

systematic review OR synthesis OR meta analysis OR meta-analysis) AND (health OR death OR mortality OR disease OR ill\* OR morbidity OR injur\* OR accident\* OR casual\* OR ) AND (traffic calming OR traffic-calming OR traffic OR traffic speed OR speed limit OR speed reduction OR speed camera OR speed hump OR road hump OR roundabout OR road design OR road modification OR road environment OR street environment OR 20 mph

### **Data extraction and quality appraisal**

One reviewer screened all titles and abstracts identified from the literature search for relevance. Full paper manuscripts of any titles/abstracts considered relevant were obtained and assessed against the inclusion criteria. Only those studies meeting all aspects of the inclusion criteria were data extracted and quality appraised using standardised forms. Each systematic review was quality appraised using a checklist list adapted from DARE and used in previous reviews [11, 14, 15, 16]. The methodological quality of each systematic review was appraised using adapted DARE criteria (<http://www.crd.york.ac.uk/CRDWeb/AboutDare.asp>) as used in previous public health umbrella reviews – see Box 2.. Reviews were categorised as low (met 0-3 criteria), medium (4-5) or high (6-7) quality, with one point attributed for each of the questions answered ‘yes’ on the methodological checklist in Box 2. Inclusion, data extraction and quality appraisal were checked by a second reviewer.

## **Box 2: Methodological quality checklist**

### 1. Is there a well-defined question?

The question should define at least the participants, the intervention, the outcomes and the study designs.

### 2. Is there a defined search strategy?

The search strategy should include at least one named database combined with reference checking, hand searching, citation follow-up, or expert contact.

### 3. Are inclusion / exclusion criteria stated?

The review should make the grounds for study inclusion and exclusion transparent in terms of participants, intervention, outcomes and study design.

### 4. Are the primary study designs and number of studies clearly stated?

The review should outline the designs of included studies and make it clear which and how many studies are in the final synthesis.

### 5. Have the primary studies been quality assessed?

The review should clearly describe the quality assessment process, which quality appraisal tool is used, and the relative quality of each included study.

### 6. Have the studies been appropriately synthesised?

The review should use meta-analysis or narrative synthesis, whichever is most suitable given the heterogeneity of studies and their methodological quality. If studies are very heterogeneous, narrative synthesis is appropriate.

### 7. Has more than one author been involved at each stage of the review process?

To minimise bias, the review should have at least two reviewers involved in each stage (study selection, data extraction, quality appraisal, synthesis) of the review.

Source: Adapted from Main et al (2008), Bambra et al (2010; 2014), Footman et al (2014) [14, 15, 6].

## RESULTS

A total of 2879 papers were identified by the searches. After initial screening by title, 238 potential studies were identified and the abstracts of these were read. This identified 18 full papers which were obtained, of which five were agreed to meet the inclusion criteria as they related to 20mph zones or limits. There were no reviews that focused exclusively on 20 mph zones or limits but within these five reviews there were a total of ten unique studies on 20 mph zones (n=8) or limits (n=2). Four of the systematic reviews were high quality and one was rated medium quality. The studies focused on accidents and injuries, traffic speed and volume, perceptions of safety and physical activity. None of the studies, however, examined SES inequalities in these outcomes.

Towner et al's [17, 18] two high quality reviews (which updated two others from 1993 and 1996) [19, 20] [PubMed](#) examined the effectiveness of interventions for preventing unintentional injuries in children (aged 0-14 years). Interventions covered the role of education, environmental modifications and legislation. Three of the studies in the review examined the effects of 20 mph zones or limits. One before and after study conducted by Webster and Mackie (1996) [21] evaluated the effects of 20mph traffic speed reduction zones (speed humps and mini-roundabouts) in 200 small residential areas throughout the UK. The study found a 61% reduction in total injuries, 70% reduction in child pedestrian injuries, 48% reduction in child cyclist injuries, as well as accidents being reduced by 6.2% for each 1mph reduction in vehicle speed. On average, speeds were reduced by 9mph (from 25mph to 16mph), and the public reaction to these 20 mph zones were generally favourable. Two of the other studies included in the Towner et al review [17] were conducted in the Netherlands and showed similarly positive result. Vis et al's (1992) controlled before and after study [21] of area-wide measures to reduce traffic speed to less than 20km/h (including road narrowing and speed humps) found positive results with a 5% reduction in accidents and a 25% reduction in injuries, with 85% of traffic travelling at a mean speed of <30km/h in most of the intervention areas, traffic volume reduced by 5-30%, and there was also high level of acceptance amongst the local residents for the 30km/h zone. Similarly, Janssen et al (1991) [23] found

that limiting speed of traffic to 30 km/h (i.e. 20 mph) reduced injuries by up to 25% over a 15 year period. The intervention was found to be cost-effective. This study was also reported in Speller's (1995) [24] medium quality review of the effectiveness of injury prevention interventions in children and young people, and was the only study in this review that specifically examined traffic calming measures.

A Nice Public Health Collaborating Centre review on physical activity in the environment in 2006 [25] examined the effectiveness of transport interventions – including traffic calming - in increasing physical activity. Four of the studies included in the review focused on 20 mph zones in the UK. The review included randomised controlled trials, controlled trials, case-control studies, cohort studies, time series and correlation studies. A study by Kirby (2001), which assessed 20mph zones, found that 25% of residents reported walking or cycling more and 60% felt that more children played outside as a result of the scheme [26]. However, studies by Webster et al (2006) [27] and Babbie (2001) [28] found no significant changes in cycling, walking or children playing outdoors, and a study by Social Research Associates (2001) [29] reported a negative effect of 20 mph zones with unanticipated declines in walking and cycling.

A high quality review by Bunn et al 2009 [30] examined the effects of area-wide traffic calming measures on preventing traffic-related crashes, injuries and deaths. This review included four studies which examined 20mph limits (n=1) and zones (n=3). The review only included controlled before/after studies (although none of them were randomised). A German study by Brilon and Blanke (1990) [31] of 30km/h speed limits found a 25% reduction in crashes in the intervention area. Another study conducted in Denmark by Engel and Thomsen (1992) [32] assessed the effects of 15km/h and 30km/h zones and found a 64% reduction in road user injuries. Likewise, a London-based study by Webster and Layfield (2007) [33] found that 20mph zones reduced road user injuries by 45%. This review also included the Netherlands study conducted by Vis et al (1992) [22] (previously described in the Towner et al 1996a review) [17] which also reported positive results.

## **DISCUSSION**

### **Summary of findings**

The five reviews included ten independent studies of 20 mph zones or limits. Overall, they provide convincing evidence that these measures are effective in reducing accidents and injuries, traffic speed and volume, as well as improving perceptions of safety in a couple of the studies. There was also evidence from a study in the Towner et al reviews [17, 18] that such interventions are cost effective. Where reported, there was also evidence of positive attitudes to such schemes by local residents, who generally favoured the schemes. However, effects on physical activity – most notably walking and cycling and children playing outside – were less clear. This may have been because the interventions evaluated in these studies (standard road humps or zones) might not have provided the cultural change necessary in terms of residents' and road users' attitudes to speed and safety. A focus on wider cultural change by making street design more aesthetically pleasing, more intensive street redesign (such as the Dutch Woonerf approach) to increase feelings of safety, or by raising awareness via accompanying physical changes with health promotion and educational interventions around physical activity may have led to better outcomes. Notably, none of the reviews – or the relevant studies included in them – examined the effects of 20 mph zones or limits on health inequalities.

### **What is already known on this subject?**

It is well established that transport is an important determinant of health and that there are SES inequalities in accident rates internationally [1][2][4]. It has been widely suggested that the impact of 20mph zones and limits on health are positive.[3,6, 8, 9] This umbrella review confirms these findings and that 20mph zones and limits can reduce accidents and casualties. It also highlights the need for high quality controlled evaluations as whilst the reviews in this study contained a number of these study types, there were also a high number of uncontrolled before and after studies which were less robust.

### **What this study adds?**

This study builds on the umbrella review of Morrison et al (2003) [9] which found only one systematic review on 20mph zones or limits. We found five – suggesting an enlarged evidence base in this area. Our study is also the first to examine systematic review level-evidence on both the effects on health and health inequalities of 20mph zones and limits. It thereby identifies what we already know in terms of the effects of these interventions on health and health inequalities; and also where further work needs to be done. The review has found that 20mph zones and limits are effective in reducing accidents and injuries. It also highlights that including local stakeholders in the planning process can help with public perceptions and approval of such schemes. This umbrella review specifically looked for evidence on the differential impacts of such interventions by SES and have found that it is absent in the systematic review evidence base. However, it is still possible to extrapolate the findings and suggest – as others have [8] – that targeting measures in deprived areas may reduce health inequalities. Our work suggests that a clear priority for future traffic calming research in public health is to explicitly examine any impacts on health inequalities.

### **Limitations**

This umbrella review is by definition, limited to evidence from existing systematic reviews. The searches covered only twelve databases, and it is possible that a broader search strategy would locate more relevant studies – though there would be a trade off in terms of researcher time.[34, 35] The review failed to find evidence of the impact upon health inequalities of 20mph zones and limits; this may have been because the evaluations included in the systematic reviews did not record data which would allow an analysis based on health inequalities, or because the systematic reviews did not themselves specifically look for health inequalities data.

## CONCLUSION

Overall the systematic review level evidence synthesised here suggests that 20mph zones and limits are effective in reducing accidents and injuries, traffic speed and volume, as well as improving perceptions of safety in studies that made this a focus. A key challenge in implementing traffic calming schemes to improve population health is to think about affecting cultural change in terms of public attitudes towards roads and speed as without changes in the mentality of both drivers and residents, the success of such schemes may be limited or even have counterintuitive effects. Whilst there were no direct studies of the effects on health inequalities, it is possible to suggest that targeting such interventions in more deprived areas may be beneficial. Better data collection and further evaluative research is needed into whether these interventions are able to reduce SES inequalities in accidents and other health outcomes.

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