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- R Hunter is a member of PHR Research Funding Board.
- F Kee is Co-Investigator on Games of Stones Trial, Supporting mums Trial, Global Health "LINKS" Research Group and TOPIC Trial. PI: The MECHANISMS Study and The HULAP Study. A member of the following panels: Public Health Research Funding Board, PHIND Funding Panel, Better Methods Better Research Panel, Non-Clinical Fellowship Panel, Future Leaders Fellowship Panel, Agile COVID Panel, Policy

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Scientific summary

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Background

Transport initiatives, such as a reduction of speed limits to 20mph, are expected to result in lower traffic speeds and fewer casualties, leading to an improvement in the perception of safety and a subsequent increase in cycling and walking.

Objectives

Objective 1. To explore the decision-making processes that made 20mph speed limits possible in Edinburgh and Belfast

Objective 1 research questions:

- What factors led to the rise of 20mph limits on the local political and policy agendas?
- What processes hindered and enabled agreement to implement the 20mph policy?
- What are the likely facilitators and barriers to long term successful implementation of the 20mph policy in these cities?

Objective 2. To describe and understand the 'how' and 'what' of implementation (i.e., the implementation processes) of the two 20mph speed limit interventions

Objective 2 research questions:

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- How was the 20mph speed limit intervention implemented in each city?
- To what extent was the intervention delivered as intended in each city, and what adaptations were made to how the interventions were delivered?
- What were the barriers and enablers to implementation in the two cities?

Objective 3. To assess impact of introducing 20mph speed limits (primarily signage) on a range of health outcomes

Objective 3 research questions:

- Does introducing 20mph speed limits result in reductions in the speed of motorised vehicles?
- What is the impact on the number and type of road collisions and casualties?
- What is the impact on population perceptions of the safety and pleasantness of their home and work environments?
- What is the impact on the number of people (journeys) cycling or walking to work or study?

Objective 4. To investigate people's experiences of, and interactions with the multiple intervention activities, examining how and why behaviour change occurred or did not occur

Objective 4 research questions:

- How are the effects (or lack of effects) experienced by various population sub-groups?
- Do the qualitative and quantitative data support the hypothesised causal pathways and mechanisms?
- Are there any unintended/unexpected pathways and consequences?

Objective 5. To carry out an economic evaluation of the 20mph speed limit policies

Objective 5 Research questions:

- How do the public health benefits compare with the costs (potentially including opportunity costs) of implementation?
- What additional benefits or consequences are there that would make implementing 20mph speed limits more or less cost-effective?

Objective 6. To assess the transferability of 20mph speed limit networks to other cities, towns or districts in the UK.

Objective 6 research question:

- What is the potential for implementing the 20mph speed limit in other parts of the UK?

Methods

Design: Mixed methods study that comprised an outcome, process, policy and economic evaluation of two natural experiments. The number and variety of individuals, groups and systems likely to be affected by the 20mph limits, and the importance of their behaviour and the interactions between them, required an evaluation appropriate for the complexity of the intervention. Therefore, guided by a programme theory we undertook a pragmatic, theory based, mixed-methods evaluation comprising several studies which between them aimed to gather comprehensive data on the 20mph intervention. The evaluation combined routinely and locally collected quantitative data, and primary quantitative and qualitative data. No single study, or methodological approach, can provide answers to all the research questions related to the overall and differential impacts of the intervention.

The outcome evaluation comprised of before-and-after (controlled where possible) studies in Edinburgh and Belfast. Matched (geographic) controls were derived from the routinely collected data. Natural experimental approaches are specifically advocated when *“[i]f it is possible to obtain the relevant data from an appropriate study population, comprising groups with different levels of exposure to the intervention”*. Within Belfast and Edinburgh, a number of stakeholders were already collecting data; it is more efficient to make use of available data, supplementing where necessary, rather than replicating costly data collection. We explored and accounted for biases which are known to affect observational methods and particularly before-and-after studies. Specifically, the implementation of the interventions and the data that were collected was decided upon and controlled by the local jurisdictions and the difficulties (ethical and logistical) of maintaining a robust evaluation design across urban areas meant that observational and natural experimental methods were employed. Outcomes included: Speed; Total number of road collisions and casualties; Public perceptions of safety, mode of travel, driver behaviour and attitudes; and Liveability.

A substantial part of this study was a process evaluation to provide lessons and recommendations which could be applied to other urban areas wishing to implement new

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speed limits for motorised vehicles. This included interviews with key stakeholders and focus groups with members of the general population in Edinburgh and Belfast. To understand the context and transferability we used key informant interviews, documentary analysis and media analysis.

For the economic evaluation, we planned to undertake cost utility analysis informed by data on changes in physical activity associated with any changes in active travel, supplemented with partial cost-benefit analysis based on data on changes in collisions and casualties and cost-consequence analyses based on data on livability, including perceptions of safety.

Results (research findings)

Pre-implementation and process of adopting the 20mph limits

20mph speed limits were deliberated in government discussions in both Scotland and Northern Ireland for many years before the schemes became a reality. In both cities the main policy goal was to reduce roads traffic collisions and casualties by slowing down traffic, although the policies were also intended to achieve wider health and environmental objectives. Strong leadership was key, and in both cities there were politicians who were important in moving 20mph speed restrictions forward. In both cities, small scale restrictions were implemented around schools and these served as pilot schemes for the larger scale-up.

In Edinburgh they also implemented an area wide pilot in the south of the city. The main opposition to 20mph came from bus operators and taxi drivers in Edinburgh, due to concerns about increased journey times, and the Federation of Small Businesses in Belfast, who were concerned that the public would be deterred from coming into the city, therefore causing a reduction in footfall for local businesses.

Implementation

The intervention activities were viewed as being broadly implemented as intended in both cities; signage being one example, likely in part due to the rigid parameters afforded by the legislation with only minor amendments being made. Enforcement activities, specific to the 20mph limits, were limited by finite resources and competing priorities in both cities and over time became 'daily business'. Public experiences of these activities varied, but an important finding was the disconnect between agents (e.g., police services) and the public in terms of how the interventions should be enforced. The processes associated with rolling out such a

large scheme in Edinburgh were identified as challenging; a dedicated '20mph team' within
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the local authority was created to address this. The creation of a dedicated official, and strong partnership and joined-up working were identified as key facilitators in both broad implementation, and the delivery of a tailored education and awareness raising campaign in Edinburgh. In Belfast, the government organisational structure was seen as a potential barrier to formal awareness raising activities. This latter point may help to explain the different levels of awareness of the 20mph speed limits which was evident between participants from the two cities.

Impact

Outcomes: In *Edinburgh* the overall percentage reduction in casualty rates was 39% (40% was observed for collision rates). The percentage reduction for each level of severity was 23% for fatal casualties, 33% for serious, and 37% for minor casualties. Mean and median speeds reduced by 1.34mph and 0.47mph respectively at 12 months. There was an increase in two factors related to perceptions – support for 20mph and rule following after implementation, which was supported by the qualitative data. There were increases in several domains of the Microscale Audit of Pedestrian Streetscapes for Edinburgh (assessing liveability). In *Belfast* there was a reduction of 2% in collisions and a small statistically significant increase in several domains of the Microscale Audit of Pedestrian Streetscapes. There was no statistical change in speed. Active travel outcomes were not able to be assessed due to the lack of robust data. The qualitative data supported the findings of the quantitative data. There was evidence that the intervention had increased both people's awareness of their own driving behaviour, and also the driving behaviour of others. In relation to perceptions of other drivers' behaviour, there was a consistent, but not conclusive, view from participants that other drivers were adhering to the limits particularly in certain areas such as residential streets. Again consistently, it was perceived that driving at precisely 20mph was only being done by a minority, but what the intervention had succeeding in doing was reducing the overall traffic speed within the city by a smaller extent, often from a speed which had been in excess of the previous limit. Insufficient data were available to determine the impact of the schemes on walking and cycling levels.

Economic evaluation

Full economic evaluation was not possible due to the absence of data on active travel and due to changes in the role of one of the economic evaluation leads, due to the COVID-19 pandemic. However, interim analyses to inform the progression decision suggested it was plausible that the benefits of the scheme in Edinburgh, associated with the reduction in

collisions and casualties, would exceed the costs. The observed increases in livability strengthen this conclusion.

Conclusions:

Speed limit interventions that use signs and lines (plus education and promotions) instead of traffic calming infrastructure can reduce casualties and have significant public support and compliance once implemented. To be most effective, they may need to be implemented at a city-wide level, or in areas where speeds are high, and be combined with significant education and awareness raising. Large scale implementation may mean there is a differential effect depending on factors such as time of day, and volume of traffic (for example, a driver would still be restricted to driving at 20mph at 2am on an empty street and the impact on casualties and other health outcomes would be negligible).

The findings of this research suggest that 20mph limits can lead to similar public health outcomes to 20mph zones and have the advantage of being less costly and less intrusive. We have not been able to undertake a full economic evaluation, however, the data suggest it is likely that the benefits of the 20mph limits in Edinburgh exceed the costs and further work is identified that could make these conclusions more robust and more generalizable to other contexts.

Implications for policy and practice

Speed reduction intervention such as 20mph limits can be implemented at various scales – from around schools, to cities and even countries. Whilst small-scale changes which have a direct impact on vulnerable road users is generally welcomed, any large-scale change, such as a city-wide implementation of 20mph speed limits, needs careful planning and consultation. Evidence of effectiveness is an important first step to getting the key stakeholders such as the police, public transport, and local councillors on board. This needs to be followed by addressing local concerns and potentially undertaking pilot studies. Linking in with other policy agendas (such as climate considerations, health, and tourism) can increase traction. Once implemented, education and promotion are key to getting the public to respond positively. The value of enforcement is complex – whilst the public who are in favour of the intervention want more visible enforcement, it may be considered as heavy handed by others. Additionally, police resources are scarce and need to be considered pre-implementation. The impact of these interventions can be primarily demonstrated through the reduction in collisions and the

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number and severity of casualties. It was not possible to demonstrate the effectiveness of the 20mph speed limits on other outcomes such as active travel (walking and cycling). However, whilst changes in casualties can be achieved through altering the speed limit, changes in active travel depend on changes in perceptions of safety related to speed. This consideration needs to be factored into any roll out of this intervention if seeking to increase active travel.

Recommendations for research (numbered in priority order)

1. Develop a statistical approach to public health interventions which incorporate variables from multiple outcomes. In our study we analysed each outcome independently of each other. Further research could incorporate prior knowledge such as estimates from Elvik's models and from relevant systematic reviews within a Bayesian framework to allow for a broader modelling approach to the evaluation of the impact of 20mph speed limits on road traffic collisions.
2. Develop population measures of active travel which can be administered simply, inexpensively and at scale. The audit of the active travel data sources has raised some important points about the difference between routinely and non-routinely collected data in terms of timing, frequency, and location, and how this can impact evaluation of natural experiments. Of course, such monitoring has to be low burden and low cost for all stakeholders. The required quality of these data combined with the more distal pathway from intervention (compared to e.g. proximal outcomes such as speed or collisions) raises crucial methodological challenges for future evaluation work.
3. Undertake further work on perceptions to establish whether a) there are sustained changes in support for the intervention over time; b) the relationship between perceptions around safety and support, and change in speed and other outcomes.
4. Further research is needed to assess the differential effectiveness of changes to speed, and effects on different socio-economic groups and communities. There are many suggestions in the extant literature of differential risk, but it remains an important question as to what happens in different groups following the introduction of speed restrictions.

5. Further research is needed on the effects on noise and air pollution following the introduction of lower speed restrictions. This should be linked to the differential effects in different communities in the previous bullet point.
6. Further research using direct observation of walking and cycling following the introduction of speed restrictions is needed. Direct observation, rather than relying on reported behaviour, will provide much more objective evidence to inform future planning and decision making.
7. There remain some important broader methodological questions raised by this project. The MRC guidance on complex interventions was helpful up to a point, but we encountered a situation in which the intervention was not a single thing, but rather multiple things going on in different places at different times, in ways over which the researchers had no control. This was truly a complex intervention in a complex environment, occurring in real time. We learned a great deal, but we think there is future scope for the complexity guidelines to be revisited to elaborate on some of the problems we encountered.
8. Undertake a full economic evaluation of 20mph speed limit interventions.

Study registration

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